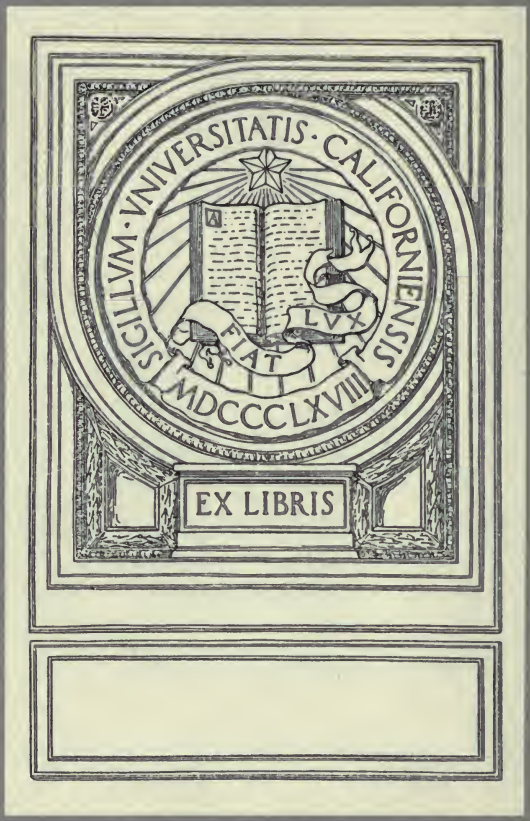
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GAS AND FLAME

MAJOR S. J. M. AULD, M.C.

Lieut. W. G. Thayer, of the Gas Defense Division, U. S. Army, is the artist of the drawing here reproduced which was designed for the purpose of bringing home the necessity of care in all that pertains to the use and manufacture of the gas mask.

In order to impress upon the soldier in training the need of care and speed in adjusting the mask in case of gas attack, the poster was printed with this wording:

KEEP YOUR HEAD; HOLD YOUR BREATH,—
BE QUICK!!
AND THIS WON'T HAPPEN TO YOU

That the workers engaged in the manufacture of gas masks might realize the importance of care and flawlessness in their work, the same poster was placed in the factories with a legend reading:

THE FINAL INSPECTOR

GAS AND FLAME
IN MODERN WARFARE

BY

MAJOR S. J. M. AULD, M.C.

ROYAL BERKSHIRE REGIMENT

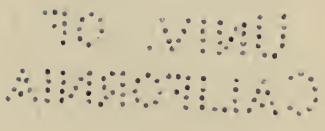
Member of the British Military Mission to the United States

FRONTISPIECE BY

W. G. THAYER

NEW YORK

GEORGE H. DORAN COMPANY



Printed in the United States of America

PUBLISHER'S NOTE

Need for the education of vast numbers of men in various branches of Gas Service and those in camps on the position of Gas Warfare at the front, has made imperative the publication of this book, as has also the need of educating the public, owing to the many misleading newspaper reports, sometimes merely misinformative, sometimes distinctly mischievous, appearing from time to time.

Major Auld, chemist and teacher before the war, and as he modestly styled it, "amateur soldier," volunteered for service at the front as a "Territorial," at the very outset of the conflict.

Some months after the first gas attack, he was taken into the Gas Service, owing to his training and ability as a chemist, and later became Chief Gas Officer to Sir Julian Byng's Army. He was awarded the Military Cross after the Battle of the Somme, and was wounded in an expedition into No Man's Land to observe the effect of a British Gas attack. He has therefore been in touch with gas warfare from the beginning and knows all phases.

As the natural consequence of all this, the Government of the United States welcomed him as the representative of Great Britain in its counsel to America on all aspects of gas warfare. In this official capacity the Major has been engaged here assisting in organization and development of training, research and production aspects of Gas, and lecturing at camps, the War College, and West Point.

The American Gas Service has, for all these reasons, deemed the publication of Major Auld's experiences very desirable.

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GAS AND FLAME

GAS AND FLAME

CHAPTER I

The first rumours of German gas attacks—Sceptically received—First attack in 1915—Canadian pluck under gas—Nernst and Haber the inventors of German gas—The difficulties of getting practicable gases—The technic of gas attacks—A German prisoner's account.

In the early part of April, 1915, we were in the trenches opposite Messines. We enjoyed the usual morning and evening "hate"; we sniped and were sniped at; we patrolled and wired and attempted to drain away the superfluous water, and there was much mud and humour and expectancy. It is true there were no Mills grenades or Stokes mortars or tin hats, but trench warfare was not so very different then from what it is now—with one great exception: There was no gas. And there were consequently no respirators to carry day and night. It is almost impossible now to re-

member the time when one did not carry a respirator in the trenches. Somehow it makes you feel quite naked to think of it—and yet there we were, imagining we knew what war really was like!

The newspapers we got at that time were generally a good many days old, and censored at that, and our chief source of news about the war in other people's parts of the line was a summary of so-called information issued from headquarters, which percolated down to the battalion and, like every other summary before and since, went by the name of "Comic Cuts."

Somewhere about the middle of the month we heard that in somebody else's summary had appeared a paragraph to the effect that a deserter from the German lines up in the salient had told a cock-and-bull story of how they intended to poison us all with a cloud of gas, and that tanks full of the poison gas were already installed in their trenches.

Of course nobody believed him. The statement was "passed for information for what it is worth." And as nobody ever believed anything that appeared in Comic Cuts in any case, we were not disposed to get the

wind up about it. And then, about a week later, on April 22, 1915, was launched the first gas attack; and another constant horror was added to an already somewhat unpleasant war. Details about the attack are still somewhat meagre, for the simple reason that the men who could have told much about it never came back.

The place chosen for the first gas attack was in the northeast part of the Ypres salient at that part of the line where the French and British lines met, running down from where the trenches left the canal near Boesinghe. On the French right was the ——- Regiment of Turcos, and on the British left were the Canadians.

Try to imagine the feelings and the condition of the coloured troops as they saw the vast cloud of greenish-yellow gas spring out of the ground and slowly move down wind toward them, the vapour clinging to the earth, seeking out every hole and hollow and filling the trenches and shell holes as it came. First wonder, then fear; then, as the first fringes of the cloud enveloped them and left them choking and agonised in the fight for breath —panic. Those who could move broke and

ran, trying, generally in vain, to outstrip the cloud which followed inexorably after them.

The majority of those in the front line were killed—some, let us hope, immediately, but most of them slowly and horribly. It is not my intention to try to play upon feelings, but those of us who have seen men badly gassed can only think with horror of a battlefield covered with such cases, over which the Germans subsequently advanced.

The Canadians on the British left fared both better and worse than the French coloured troops. Only their left appears to have been in the main path of the poison cloud, but there is little doubt that in the thickest part those who did not escape either to a flank or to the rear were killed on the field. Thousands of those in the support trenches and reserve lines and in billets behind the line were suffocated—many to die later in the field ambulances and casualty clearing stations.

Of those on the fringe of the cloud many saved themselves by burying their faces in the earth. Others wrapped mufflers round their mouths and noses or stuffed handkerchiefs into their mouths. Many of these

men were saved by their presence of mind, for though gassed at the time they recovered later, after treatment in the hospitals.

" It is on record that the Canadians, with handkerchiefs or mufflers tied over their mouths, continued to engage the Germans and that a number of them actually charged back through the gas cloud in an endeavour to reach the enemy. What became of them is not known."

In this way a big gap was made in the Allied lines, through which the Germans advanced. But the Canadians quickly formed a flank on the left and stoutly engaged the enemy, with such success that they first slowed up and then brought to a halt the advance of the Germans. It was this prompt action and gallant resistance that probably saved the day.

Whether the German high command had underestimated the probable effect of the gas and had arranged for only a limited objective past which the local commanders did not take the initiative to go, or whether the latter were unaware of the real weakness of the Canadian line is unknown. The fact remains that they did not press their ad-

vantage to the full. They had taken the Allied front line on a wide front, killed or captured thousands of men and taken sixty guns, and seemed to have a clear way through to Calais; but they were stopped by the pluck of a handful of Canadians. Reinforcements of men and guns were rushed up, and the immediate danger was over.

It is a matter for surmise how long the Germans had been planning and preparing their use of gas. The idea may have been a pre-war one, but it is difficult to believe that a project deliberately planned for years would not have been developed so as to make it a sure winner—for it could easily have been that. If, for example, they had made the attack over a wider front with such strong gas clouds as are now used nothing could possibly have stood against them. Every living thing to a depth of fifteen miles or more could have been killed.

On the other hand it is impossible to imagine the use of poison gas as having been decided on without better preparation having been made to meet retaliation, unless it was assumed either that the use of the gas would be decisive or that at any rate the war

would be finished before the Allies could hit back with the same weapon.

In any case the preparation must have been going on for months. All the production of material, organisation of personnel and so on takes a long time. This we realised ourselves later, for though the decision to retaliate with gas was made in May it was September before an attack could possibly be made. If we assume that a like interval of four months elapsed for the perfecting of the German arrangements it means that the decision to use gas was made about Christmas, 1914.

The onus of urging the Kaiser's advisers to adopt the use of poisonous gases had been laid at the door of Professor Nernst, professor of chemistry at the University of Berlin. Professor Nernst is a noted chemist, and even before the war was a notorious Pan-German and Anglophobe—one of the "professors" who carried too much weight in Germany and whose arrogance and shortsightedness helped to lure her to her downfall. Some time after the use of gas was started Professor Nernst was made a count by the Kaiser for his "notable serv-

ices"—meaning presumably the use of gas in warfare.

The actual carrying out of the gas operations was intrusted to another professor of chemistry, this being one Haber, of the Kaiser Wilhelm Physical Chemical Institute at Berlin. In 1914, long before the war started, Professor Haber and his assistants are known to have been working secretly with some intensely poisonous arsenic gases and liquids, and one of the assistants was killed and another is reported to have had his arm blown off during the researches.

Haber's particular job was to make all the scientific arrangements in the field; to decide on the gases to be used, and the quantity to employ; to study the wind directions and decide exactly when to make the attack. In the weeks preceding the twenty-second of April, Haber was continually at the Front receiving reports from the wind observation stations and in close touch with the men in charge of the cylinders in the trenches. On several occasions during this time the attack was fixed for a certain hour, but was postponed by Haber, owing to the wind's being unsuitable.

The actual arrangements that had to be made were much more complex than the carrying out of the attack itself. First of all, decision had to be come to as to the gas to be used in the fiendish attempt. Such a gas had of course to be highly poisonous. Then it must be cheaply and easily made in large quantities; it had to be compressible, so that it could be transported easily; it must be heavier than air, so that it should keep close to the ground when first liberated; and for preference it should not be unstable —that is, decompose easily and enter into nonpoisonous combinations with materials, other than man, that it should come across in its passage through the air.

Any chemist to whom such a problem is put will inform you there are very few gases that fill the bill. The German choice rested on that gas well known to students of chemistry—chlorine. Chlorine in large quantities was available from the alkali works in Germany, and it meets all the other requirements except that of not easily combining with other things. This deficiency was fortunate, for it meant that protective chemicals were easy to find when it became nec-

essary to provide respirators to the Allied troops.

Then there was the question of transport and emission. The gas was eventually put up in steel cylinders, about thirty inches long and eight inches across and stout enough to stand a pressure of about ten atmospheres, the gas being stored in them compressed to a liquid. On opening such a cylinder the liquid boils and gives off the gas again, but this would not do for field work, because of the intense cold which is produced by the sudden expansion. This would freeze up the pipes and slow down the discharge to such an extent that the gas attack would be too weak.

To get over this difficulty the Germans fitted their cylinders with internal siphon tubes so that actually liquid chlorine was forced into the air, where it evaporated without affecting the gas remaining in the cylinder. By this means the whole of the gas in the cylinder, amounting to forty-five pounds, is emptied into the atmosphere in less than three minutes. The sudden expansion of the chlorine in the air also makes both it and the surrounding air cold and

helps to keep the cloud close to the ground.

The actual handing of the gas attacks was allotted to two regiments of pioneers—the 35th and 36th Pioneer Regiments, which were specially organised for this purpose. These regiments have the ordinary organisation of two battalions per regiment, with three companies and a park or transport company per battalion. The rank and file are ordinary pioneers, but the officers are specially picked and include chemists, mechanical experts, meteorologists, and other men with special scientific qualifications.

The choice of country in which to make a gas attack was a serious matter to the enemy. The gas of course will go with the wind, but it depends largely on what the country is like where the wind will go. The Germans themselves say they prefer a flat country without any marked under features and sloping gently toward our lines, just as they had at Ypres. Indeed, they went the length of saying that a gas attack could not be carried out in hilly or very broken country; and they suffered in consequence later on, through being taken unawares by the French in just such country in the Vosges

when retaliation was commenced. But taking it altogether the Germans were wise in their choice of position.

Another thing that had to be considered was the outline of their own trench system, so that they would not let off the gas in such parts of the line that it would float back and gas their own troops in the neighbouring trenches. To do this they invented a "factor of safety," which represented an angle between the direction of the wind and the line of the trenches. No attack was to be made if the wind direction came within forty degrees of any trench within gassing distance. This worked very well.

Another consideration was the strength of the wind. The wind must not be too strong when the gusts disperse the gas cloud, or it will weaken it so that it loses a lot of its effect and will be blown over the enemy too quickly; nor must it be so weak that it will take a long time to reach the opposing trenches.

Another great danger in winds of too low velocity is that these are just the winds which change their direction most frequently, and anything under two miles per

hour is just as likely to blow the gas back to the place from which it came. It was disregarding this principle on one occasion later on that caused the Germans numerous casualties from one of their own gas clouds. In general, however, it may be laid down that the most favourable winds are those between four and twelve miles an hour, so that with a wind of eight miles an hour the cloud would move just twice as quickly as a man walking rapidly, and would take only twelve and a half seconds to cross No Man's Land in places where the trenches are fifty yards apart.

Let me try to give an account of the procedure of carrying out gas attacks as it was told me by a German prisoner taken not so very long ago. He said:

"I am not one of the gas pioneers, but being an engineer by trade and having been in the trenches for many weeks with the 35th Regiment of Pioneers I have got to know their methods fairly well. Indeed I assisted on one occasion in carrying cylinders into the trenches for an attack against the British. Gas is not popular with us; we have had too many mishaps, and the cylinders are

a nuisance to carry into the trenches. They weigh ninety pounds and they are always carried in by the infantry. A gas regiment does not do that for itself. It is a long carry and it is really more than a one-man load. At the most two men are allotted to carry in each cylinder, whatever the distance.

"Several thousand of these cylinders must be taken into the trenches, and then we have the job of putting them in position. Deep holes are dug just underneath the parapet of the trench, and into these holes are placed the separate cylinders with the tops flush with the ground. As each cylinder is placed into position the hole is covered with a board, on top of which is placed a thing we call a *'Salzdecke,'* which is really a kind of quilt stuffed with peat moss and soaked in potash solution so as to absorb any of the gases that may leak out.

"On top of the *Salzdecke* are built up three layers of sandbags, so that there is not much danger of the cylinders' being hit by shell fragments. This also serves to hide the cylinders in case a raid is made, and the sandbags form an excellent firing step. In fact, you would never guess that the gas

was ready in position to make an attack. All of this takes a long time to do, and then we have to wait for a wind that is favourable.

"It may be weeks before the right time comes, but all the time the pioneer officers and *Unteroffiziere* make observations of the wind and report back to somebody at headquarters. On the night fixed for the attack all the infantry are warned beforehand. If the wind continues favourable the sandbags are taken off, the domes removed from the cylinders, and to each cylinder is attached a lead pipe which is bent over the top of the parapet into No Man's Land, with the end slightly bent up, so that if any liquid comes out it is not wasted in the ground but evaporates in the air. The end of the lead pipe is weighted with a sandbag, so that it will not kick when the gas is turned on and blow the gas back into our own trenches, as happened in one or two of the earlier attacks. It is this kind of thing that makes gas unpopular in the German Army.

"Eventually the time really does arrive for the attack, and the pioneers stand by the cylinders, of which twenty form a battery;

and to each battery there are two pioneers and one noncommissioned officer waiting to unscrew the taps. A signal is given by means of a rocket. All the infantry have been eagerly waiting for this signal, which means that they have five minutes to clear out of the front-line trenches before the gas is turned on; and I can tell you they do not waste any time. Everybody makes a rush to the support trench and leaves the front line entirely to the pioneers.

"We all keep our masks ready to put on at a moment's notice, because in the earlier attack the wind on two occasions blew the gas back again into our own trenches and killed a lot of the infantry who were unprepared for its return. According to the length of time the attack is to last the cylinders are turned on, from one up to five at a time, in each battery.

"As soon as the taps are turned on the pioneers make for cover, but they have a good many losses from bursting cylinders, from leaks, and from the shrapnel and high-explosive shells which invariably greet the start of an attack. The promptness with which this happened at the time I was in the

line made us believe that your people had known all about our gas preparations for some time. The infantry are all very glad to be away from the front-line trench when the cloud is sent over."

This method has been practically unaltered throughout the time the Germans have made gas attacks. In the first attack they probably had one gas cylinder on every yard of front on which gas was installed, but the number was increased in subsequent attacks.

CHAPTER II

The first respirators—First-aid devices—the smoke helmet—Anti-gas sprayers—Their use and delicacy—The English chemists set to work—The task of training the whole army

THERE is no need to dwell on the execration with which the use of gas was met by the whole civilised world, and I will merely try to recount how it was taken by the men in the trenches.

The British Tommy is a difficult man to terrify, and the moral effect on the men, though quite unprotected, was remarkably small considering the terrors of the game. For two or three days all we heard about were the things we should do in the event of being similarly attacked. It appeared that great chemists from England had immediately taken up the question of providing efficient respirators, and until they came out were advising people as to emergency measures. Some of these methods seemed to us very funny. We were told, for example,

that a respirator could "easily" be made by knocking the bottom off a bottle, filling the bottle with earth, and then learning to breathe with the neck of the bottle stuck in the mouth. The breath was to be taken in through the bottle and let out through the nose; but as bottles were scarce and few of them survived the attempt to get the bottom broken off there was not much doing.

However, we learned that handkerchiefs filled with earth and kept moist would keep some of the gas out, and by the time the first novelty had worn off we were receiving private respirators from England. These had all been made in response to an appeal by Lord Kitchener to the women of England to make respirators for the troops out of cotton wool wrapped up in muslin or veiling. The result of this was that the War Office was absolutely swamped with millions of these respirators within a few days, and most fellows in the trenches had one or two sent out by post straightaway.

Besides these, arrangements were made by the various divisions for respirators to be made in towns behind the lines; and the government factories in England got to work

to turn out a simple type of respirator which had been devised by the English chemists as the quickest to make and the simplest to use. The result was that within about one month we had four or five different kinds of respirators issued to us. Most of these were simple pads of either cotton wool or cotton waste. The earlier ones were soaked in washing-soda solution, and the later ones were moistened with a special solution consisting of ordinary photographic hypo and washing soda mixed with a little glycerin.

One type that we had for a week or two in the trenches consisted of the usual pad of cotton waste together with a small wad of the same material which was kept separate. The respirators were stored in boxes let into the paradoses, or rear walls of the trenches. On the alarm being given each man in the trench made a dive for a respirator, stuffed the wad into his mouth as a first protection, and then bound the pad round his mouth and nose, the wad being afterward taken out of his mouth and stuffed round his nose so as to make a tight fit.

These practices were popular for once or twice, but when it began to be realised that

the wads were not always used by the same man the novelty waned. We thought we were getting pretty smart at it when we could get every man in the trench fully protected—that is, with the tapes tied—in forty seconds from the word "Go."

Later on we had the official "black-veiling respirator," which was issued to all the British troops and which went through two or three of the earlier attacks as the chief protection.

It was from one of these attacks delivered in the salient again, on the twenty-fourth of May, that the first benefits of good training in the use of the respirator were seen. One of the regiments which had been on the flank of the first attack and had seen the effects of the gas and what it really meant had taken the training very seriously, and the officers had insured that every man had a respirator, kept it in good condition, and knew how to use it in the quickest possible time should occasion rise. Other regiments were not so good, and it was just this training or lack of it that made all the difference between heavy casualties and light casualties in subsequent attacks.

On the twenty-fourth of May the regiment mentioned above happened to be in the very thickest part of the cloud, and though the battalion on either side of it suffered serious losses they themselves came off almost scot-free. Instances of losses from insufficient education in the use of the respirator were numerous on this occasion. A lot of men took their respirators off in the middle of the attack in order to wet them with solution again; and as they did not wring them out sufficiently the respirators were difficult to breathe through and the men thought they were being gassed and repeated the dose—the result being that they could not draw air through the sodden cotton waste, and they were gassed either from pulling off the respirators altogether or from the air coming in at the side.

One very bad instance was quoted by a medical officer at an advanced dressing station which was taking in gas cases as they came down from the line. Two or three men from one battalion came in pretty badly gassed, but still able to walk. The M. O. asked them if they had respirators issued to them. They said "Yes."

"Well, why didn't you put them on?"

They said: "We did put them on; we've got them on now."

And so they had—strapped across their chests!

At that time respirators were generally carried by the men tied round their caps, and in some cases could not be removed in time; and the May twenty-fourth attack made it apparent that the respirators should be carried in a position ready for immediate use. For this purpose a waterproof cover was provided and the respirator kept in a small pocket inserted into the jacket, or else in a pouch slung over the shoulder.

The other bad feature about the preparations was the arrangement for dipping the respirators in solution in the trenches, as referred to above. During the attack a lot of the men dipped their respirators in water; which of course washed the chemicals out of the respirators and made them ineffectual much sooner than they should have been. But all of these matters were remedied before another gas attack was made.

After the first emergency respirator had

been issued every effort was made to devise a more effective form of protection than that given by the cotton-wool pads, in expectation of a recurrence of German attacks. As a matter of fact there were no attacks between the beginning of June and December, 1915, because the wind was unfavourable to the Germans. This was another point that they had apparently overlooked, because on investigation we found that the prevailing winds in Flanders blew from west to east, and that about three-quarters of the total winds were in our favour and against the Germans.

The long interval of the summer of 1915 gave us a splendid opportunity to develop the protection against gas which had been commenced in the spring while attacks were still being made. The most important of these developments were the invention of the celebrated "smoke helmet" and the use of sprayers for the removing of gas from the trenches. We also found out the exact value of certain other devices and methods which had been suggested for combating the gas clouds, and a lot of impossible ideas were consequently turned down.

The latter might be discussed first of all. One suggestion which was made and believed in by most people at various times—including the Germans themselves—was that fires built in the trenches or on the parapet would cause such an upward draft as to lift up the gas cloud and carry it safely over our heads. Experiments showed, however, that this idea was absolutely false, because though an upward draft was certainly formed the incoming air carried with it just as much gas from the surrounding atmosphere, and nothing was gained by it. It was a long time before the Germans tumbled to this, and even many months later their own instructions on defence against gas included statements that showed their reliance on this procedure.

One suggestion which actually reached the point of being acted on was that the gas cloud could be dispersed by an explosion, and for this purpose we were provided with wooden boxes filled with black powder and with fuses attached, which we were supposed to light at the crucial moment and throw into an advancing cloud. This heroic procedure was never actually made use of, however, be-

cause experiments in the meantime again showed that such explosions had very little effect on a cloud of gas.

Two suggestions which really did turn out to be winners were those referred to previously—the smoke helmet and the Vermorel sprayer for clearing the trenches.

The idea for a respirator in the form of a helmet to go right over the head is stated to have originated from an idea of a sergeant of the Canadians who was gassed at Ypres, who stated that he had seen some of the Germans through the gas cloud with things that looked like flour bags pulled over their heads. It was thought that something of this kind could actually be made use of, and experiments showed that it was really a practical idea, because breathing is done through a very big surface and not only through the chemicals directly in front of the mouth and nose, as in the case of the respirator. By having a big surface it is possible to have thinner material and there is, therefore, less resistance to breathing. All that is required is to tuck the helmet down inside the jacket and button the latter tightly round it at the neck, and if this is done there is little pos-

sibility of gas leaking in. As a matter of fact there is no evidence that the Germans ever did use anything of the kind.

The first types of smoke helmet were made of flannel and had a window for seeing through which was made of mica or celluloid. The helmets were soaked in the same kind of solution—hypo, carbonate of soda and glycerin—that had been employed for the respirators. Helmets of this kind were capable of standing up against really considerable concentrations of chlorine, and they were quickly recognised both by the troops and by experts as being a very big improvement on the old respirator.

These helmets were made and issued to the troops as quickly as possible and a few of them were actually used in the attack of May twenty-fourth. Men unpracticed in their use were apt to find them hot and stuffy, and, not realising that the feeling wears off, were often inclined to think that they were being suffocated or gassed. As a matter of fact well-drilled men could do almost anything while wearing the helmet, the chief difficulty being that of limited vision. After wearing the helmet for a short time the celluloid win-

dow got clouded over from the moisture in the breath, but this could easily be remedied by wiping it on the forehead. In many cases also the windows got cracked or broken from the rough treatment they were bound to meet in trenches, and this was a constant danger until men learned how to fold the helmet properly so as to protect the celluloid and to place a small sheet of cardboard or thin wood over the window before folding.

The sprayers previously mentioned were originally suggested for use against the gas cloud itself, the idea being that chemicals should be sprayed at the cloud so as to neutralise the poisonous gas and thereby purify the air. Nearly everybody with even a nodding acquaintance with chemistry wrote in suggesting ammonia for this purpose, oblivious of the fact that the chemical reaction between chlorine and ammonia in these circumstances produces a dense cloud which is most irritating to the eyes and throat, and that this together with the excess of ammonia would be almost as bad as the original gas.

In any case it is impossible to deal with the gas cloud by spraying, because of the

enormous amount of chemicals and apparatus that would be required to neutralise the attack. A cloud of chlorine from one thousand cylinders, for example, would require more than forty tons of the strongest ammonia solution obtainable to kill all the gas, even if none of the spray were lost in the ground. Besides this the spraying might have to be continued for hours, some of the attacks having lasted intermittently for more than three hours.

It was quickly seen that this was an utter impossibility, but experiments showed that a spray of the hypo solution was quite capable of removing what remained of the gas cloud out of trenches and shell holes and from dugouts into which the gas had penetrated. This of course applied only to chlorine. Arrangements were therefore made for supplying a large number of these sprayers, which are exactly the same as those used for spraying fruit trees and potatoes with fungicides, and men were specially trained in their use so that they could be employed after an attack was over. These men were officially known as the "Vermorel sprayer men," and were popularly supposed

to preface all their operations with the words "Let us spray."

The solution to fill the sprayers was kept in all the trenches in corked rum jars, and there were many amusing incidents rising out of the dual purpose to which these revered vessels were put. It is stated that a certain battalion on going into the line for the first time saw these rum jars safely ensconced in niches in the parapet and immediately thought that they contained the rum ration concerning which they had heard so much before they came out. Some of the more adventurous ones surreptitiously tried out the supposed rum and drank a few mouthfuls of the nauseous liquid before discovering their mistake. The real joke lay in the fact that even after they realised that the liquid was not rum they continued to drink it, and by the time they finished their two days' tour of instruction there was not a drop of Vermorel sprayer solution left in any of the trenches.

The sprayers were somewhat delicate pieces of apparatus to keep in good condition in the trenches, and were apt to get

crusted with mud and out of order unless they were well looked after. Like everything else connected with the defence against gas, their condition in the trenches varied with different regiments according as they were well trained and disciplined or otherwise, but as a rule the sprayers were well enough looked after, and proved extraordinarily useful on many occasions after their first appearance in the line.

As stated before, the long interval of the summer and autumn of 1915 gave the chemists and the army plenty of opportunity for thinking about the gas question, developing organisation and methods to meet attacks in the future, and making arrangements for the training of the troops so that they should be thoroughly prepared when the next attack should arrive.

One of the most important things that was done was to start a big field laboratory for dealing with questions of gas warfare. And as it had already been realised that the whole basis of defence against gas was going to lie in the hands of the troops themselves by increasing their steadiness, developing their discipline, and generally ac-

customing them to the idea that gas was now an ordinary method of warfare, chemists and instructors were appointed for attachment to each of the British armies.

These men were all chosen from the line. For the most part they were infantry officers who could realise the real needs and limitations of the troops, but they were picked in each instance because they had, at any rate, some chemical knowledge and could translate into practice for the benefit of the troops various chemical measures which had been adopted for the latter's safety. Their first chief job was to see that respirators and smoke helmets were issued in sufficient number; to see that they were in good condition; and then to arrange for the training of all the troops in the army in their use. This was a heroic task, to be accomplished in as short a time as possible, but by dint of speaking to large bodies of officers and men at the same time it was so far completed that all ranks were given practical instruction in the use of the helmet.

When it is realised that each of these officers had to deal with at least one hundred thousand troops it will be seen that it was no

mean feat that was accomplished. What was started then has never been completely accomplished, partly because of the continual development of gas warfare and partly because it is a matter of education—which is always slow—but very largely also because of the continually changing personnel and the enormous numbers of men that have had to be trained.

CHAPTER III

Popular terror of gas—Necessity for drilling and early personal experience—Sure defence from gas possible—The first gas alarms—The prussic acid scare a myth—The phosgene scare a reality—The helmet made to combat it—Necessity for renovating the helmet.

THE final object in the training of men in defence against gas is that troops shall be able to protect themselves completely and as quickly as possible in all the multitudinous circumstances in which they may encounter the poisonous gas in the field. To attain this it is necessary to inspire confidence by letting them in as far as possible on the principles underlying the use of gas and the tactics which are adopted by the enemy; and, secondly, to bring their practical proficiency and discipline up to such a standard that they make the very best use of the apparatus that is given to them.

It must be remembered that one of the greatest difficulties in talking to people about gas is the mystery of it. Even edu-

cated people hardly understand the word "gas" in connection with war and are apt to think of coal gas and dentists' gas in consequence. The result is that the gas of the Germans was sometimes credited with all sorts of impossible qualities of movement and deadliness, and it can hardly be realised what alarm and distrust may exist in the raw recruit with regard to gas until he has been given some instruction. This is even as great a danger as the over-confidence of the veteran soldier, who may know just as little about it.

Mere drilling and assertion are not sufficient to inspire confidence and acquire proportion, and it was realised very early that personal experience was needed. To gain this arrangements were made for every man to see and smell gas in concentrations that would at any rate produce severe discomfort if dwelt in for any length of time, and for each soldier subsequently to be exposed to gas while wearing a gas helmet in such a concentration that negligence in obeying orders or in using the smoke helmet correctly would lead to real danger to life. By this means confidence could be inspired in

everybody, though there is always a certain danger due to recklessness among the more adventurous types.

Besides this it was necessary to give as many men as possible some idea of the common sense of the operations in which the army was being drilled. This could only be done by giving a clear idea of how the gas is used; how gas travels; where it accumulates; how it can be removed, and so on; and under what conditions a respirator or smoke helmet protects or ceases to protect its wearer. It was on these lines that instruction was built up; and to do it thoroughly it was found that a large number of instructors were required in order to train the officers and noncommissioned officers and to get them to treat their respirators with as great respect as their rifles and to learn to carry them through a gas-defence drill in just as smart a manner as the ordinary arms.

For this purpose special schools of instruction were started at each army headquarters, and as many regimental officers and noncommissioned officers as possible were given a four or five days' course of gas training, so that they in their turn could go

back to their regiments and spread the gospel, as the responsibility for getting things done must eventually fall upon them. Not only was it found impossible to provide specialist officers for each regiment or battalion, but it was recognised that such a procedure would have a bad effect on the gas-defence measures.

Gas defence was a matter which affected everybody and was in no way to be regarded as a specialist's job; battalions were already full of specialists. Indeed the colonels were apt to complain that they had nobody but specialists to command. There were bombers, snipers, signalers, machine gunners and sanitary men; and at that time the trench-mortar personnel was also a part of the infantry battalion. With all these things the feeling was that if a job could be looked on as being a specialty it should be put on the specialist officer concerned, and nobody else worried about it much. Now if gas defence was to become Lieutenant Snook's job, it meant that it was going to be nobody else's job, and it was essential that the idea should grow up in the army that gas defence

was a purely military matter and affected everybody.

What was said then is just as true to-day —that the defensive appliance is a certain protection if it is used properly and in time. Defence against gas is thus on an entirely different footing from defence against shells and bullets, where protection cannot be assured; and, to quote instructions on the subject: "For destructive effects gas must depend on surprise, on poor discipline or on defective appliances. Consequently gas casualties are preventable if the soldier is trained continually to exercise vigilance and is well drilled in the use and care of his respirator."

The basis of the whole thing, therefore, was that every officer should see that the men under his command were properly instructed in defensive measures against gas attacks, and that all orders on the subject were thoroughly understood. It was then up to the officers to see that their men could get their helmets on properly in the minimum time, and this involved considerable amount of drill practice. It was pointed out to the officers that since protection had been

provided, those battalions which had been carefully instructed had come through practically unharmed, while those battalions in which instructions had been neglected suffered severely.

It was also up to the officers to explain to their men as much as they themselves had learned about gas clouds, and to impress on them, for example, that by moving to the rear they would move with the gas, and that if they got flurried they would breathe more deeply and would run much more risk of being gassed.

Besides these questions of instruction and drilling a lot of other arrangements had to be made, so that warning of German gas attacks should be spread in the quickest possible time. Arrangements were made to install alarms of various kinds in the trenches. Of course no reliance could be placed on any method of communication which involved the use of the lungs. A man cannot blow a bugle or a whistle while he has a helmet on, and if he waited to give a signal by such a method before protecting himself he would be almost certain to be gassed. What was

done was to place bells and gongs made from shell cases up and down the trenches.

At first these were rather futile things, the bells generally being much too small—some of them merely cow bells. The shell cases were a bit better and are still used for local alarms; but the arrangements for giving warning were not really very good at that time. The best devices were a number of motor horns, which were obtained locally, but the supply was insufficient and there was no general issue. Later on the alarm arrangements were tremendously improved. In some cases signal lights were used, but so many different kinds of rockets were already employed for signalling to the rear that there was great difficulty in finding a light sufficiently distinctive. There was also the danger that it could be quickly copied by the boche, who would thus amuse himself by giving us all kinds of shocks from false alarms.

Quite as important as the provision of signals was the making of observations to see when the wind was in a dangerous quarter. This was done partly at the meteorological stations at headquarters and partly on the

front line itself. The latter was regarded at the time as the most important, and orders were given that each unit in the front line should rig up some kind of wind vane and learn to ascertain the strength of the wind, so that they should be immediately prepared for an attack whenever the wind was in a dangerous quarter.

Wind vanes in the trenches were of the simplest types and a great deal of ingenuity was displayed in fitting up weathercocks that would be capable of turning in really low wind—say, one with a speed of only two miles an hour. The bearings for the central rod were the greatest difficulty, but it was found that by boring out a rifle bullet a sharp pointed stick or a thick piece of wire could be got to revolve in the hollow bullet quite easily, what remained of the lead core acting as a kind of lubrication.

The greatest nuisance of these wind vanes at first was that they were made so generally obtrusive that they could be seen from the enemy's lines, and they nearly always drew fire from snipers, and sometimes actually from the artillery. Presumably the enemy thought that where the wind vanes were in-

stalled company headquarters were probably situated. The position of the wind vanes consequently had to be chosen so that the direction and speed of the wind would be measured several feet above the ground without the apparatus being too obvious. One of the simplest types of vane adopted, and one which could hardly be seen from any distance, was a bit of a stick to the end of which was tied ten to twelve inches of thin thread with a tiny bit of cotton wool at the end. When the wind is blowing the direction taken by the thread shows the line of the wind fairly exactly, and the behaviour of the cotton wool in rising and falling indicates the strength of the wind. The latter, however, was supposed to be measured by reference to Beaufort's scale, which depends on the movement in wind of natural objects. Beaufort's scale, which was devised long ago by an English admiral of that name, is as follows:

Smoke moves straight up, speed of wind is *nil;* smoke slants, speed is two miles an hour; the wind is felt on the face, speed is five miles; paper, etc., move about, speed is ten miles; bushes are seen to sway, speed is

fifteen miles; tree tops sway and wavelets are formed on water, speed is twenty miles; tree tops sway and whistle, speed is thirty miles.

All of these arrangements for training and equipment of the troops were hurried on as quickly as possible, but at the same time sight was not lost of the probability of the German's using gases different from the chlorine which had originally formed their stand-by. It was felt that a good all-round protection should be capable of keeping out not only chlorine and similar gases but also others which were quite likely to come into use.

During the whole of this time we were getting a lot of information from the intelligence branch as to materials which the Germans were making for use against us in their next gas attacks. Some of this information was really farcical, but on the other hand some of it was very good and helped to confirm the conclusions to which our own scientists were coming as to the likelihood or unlikelihood of particular gases. In the former category may be classed one story which came to us containing a very circum-

stantial description of some experiments which were stated to have been carried out in Berlin. These trials were stated to have been made in what we considered a very proper place, namely, Hagenbeck's menagerie, where, in the presence of a large number of military representatives, a new gas was tried out.

A noncommissioned officer appeared with a tank of the gas on his back, the spraying nozzle coming out under his arm. A camel and an elephant were brought out. The noncommissioned officer advanced toward them, and at twenty paces' distance he pressed down the lever on the tank and out came some small black bubbles of gas, which floated down the wind toward the faded animals. The bubles burst, giving off a yellow vapour, and the minute this vapour came in contact with the camel and the elephant the beasts dropped down dead!

This sounded very terrible, but even in the conditions we were at the time it was not taken too seriously, and of course nothing of this kind has ever made its appearance.

Another story which commenced to make its appearance at that time and which we

have heard a great deal about ever since was that the Germans were busy making prussic acid in enormous quantities for a huge offensive which was to finish the war. It was stated that the Kaiser had at last been persuaded to use this terrible weapon in order by its use to finish the war at once and prevent needless suffering.

When they first made their appearance stories with regard to prussic acid had to be taken a great deal more seriously than those like the "little black bubbles." For one thing we were unprotected against prussic acid, and for another it was known of course to be an extremely deadly poison. Indeed before the war it was regarded as the most poisonous vapour known, so a great deal of weight was attached to these statements, and experiments were at once put on foot to find protection against prussic acid and to see exactly how poisonous it was compared with other gases.

As a matter of fact prussic acid has not been used by the Germans simply because it is not poisonous enough. It is not so poisonous, for example, as phosgene, and a lot of captured German documents show-

ing the relative toxicity of different vapours always put it on a rather low basis. It was this and not a desire to avoid utter barbarity which decided the Germans not to use it. The ordinary German soldiers, just like ourselves, still consider prussic acid as the most dangerous possible material, and whenever they have a story to tell of a new gas being invented or being got ready to use against us they will tell you in awestruck tones that it is prussic acid.

The most valuable piece of information which we got was a complete set of notes of some very secret lectures given to specially selected senior officers at a conference in Germany. We gathered that this conference was held behind closed doors and triple lines of sentries, and all that kind of thing, and I cannot of course indicate how the information came into our hands, but there it was. It described a lot of new gases which had been considered, and stated among other things that they intended to make a big gas attack against either the French or ourselves in Flanders in December, 1915, some time before Christmas when the wind was favourable. For this purpose they were going

to use a mixture of chlorine with another gas, phosgene—the amount of phosgene to be twenty per cent of the whole.

Now phosgene had been realised by our own chemists as a very likely gas to be used. I cannot say that it is more poisonous than chlorine, but it is infinitely more deadly because it is much more difficult to protect against and is more insidious in its nature. For one thing, though it is an asphyxiant like chlorine it is possible for a man to be only slightly gassed and think he is all right, and then, especially if he takes any exercise in between, to fall dead several hours later from heart failure.

The information was so complete that our arrangements to provide a helmet which would protect against phosgene were hastened as much as possible; and it was as well that they were, for the attack actually did come off just about the time and place mentioned, in the Ypres salient.

It was realised of course that any change in protection would have to include both prussic acid and phosgene; and this is not nearly so easy as it sounds. Phosgene is peculiarly chemically inert for such an active

poison, and it was some time before a reasonable protection was found which could be incorporated in a smoke helmet. The substance actually decided upon was a solution of sodium phenate—that is, carbolic acid dissolved in caustic soda, the mixture containing an excess of caustic. This solution is quite capable of dealing with reasonable concentrations of phosgene and would successfully protect against three parts of phosgene to ten thousand of the air, which in the circumstances was quite good enough. The French also altered their protection at the same time and used sodium sulphanilate as the basis of protection against phosgene. The objections against the sodium phenate were that it could not be absorbed into a flannel helmet owing to its destruction of the fabric, and on account of its being strongly caustic it would tend to burn the faces of the men it came in contact with. These difficulties were overcome by making the helmet of two layers of flannelette instead of one layer of flannel, and by mixing with the sodium phenate a large quantity of glycerin. This kept the fabric moist and prevented the caustic from exerting its corrosive action.

It was realised from the start that a smoke helmet containing free alkali would deteriorate considerably on exposure to air, and it was found advantageous to provide a breathing tube in the mask so that a man would breathe in through the helmet and out through an outlet valve; in this way the breath, which contains a lot of carbonic acid, would have no bad effect on the chemicals. The use of an outlet valve was also found to have the advantage of keeping the air purer inside the helmet and preventing the stuffy feeling which accompanied the older types of helmet.

This additional complication to the helmet was not looked upon favourably at first by the troops, but it was very quickly realised that only a little practice was required to make a man breathe quite normally in the way mentioned above, and that the advantages accruing from the alteration were very great indeed. We found that we could carry on for much longer stretches of time without being fagged out, and more exact trials by the scientists showed that a man's temperature, pulse and rate of breathing did not increase nearly so rapidly if he used an

outlet valve as when breathing out and in through the same material. This is largely due to what is called "dead space," which means the volume of air in between the lungs and the atmosphere and in which the air is largely composed of breath exhaled from the lungs. The smaller this space the easier it is to breathe.

This principle of using an outlet valve has been retained in all the British respirators which have been invented since and is regarded as one of the very highest importance.

Another thing which had to be taken care of was that the new helmets, which were called "tube" or "P" helmets, would gradually deteriorate on exposure to air, and would consequently have to be withdrawn from the troops in the line from time to time in order to redip them in chemicals and make them as effective as before. For this purpose large repair factories were started at the bases and were placed in charge of Englishwomen who were brought over for the purpose. These factories were organised with local labour, helped out by a little military personnel, and were capable of wash-

ing the helmets returned from the line, re-dipping them in new solution, and sending them back in good condition again.

This was no small job, as the smoke helmets which were sent in were generally filthy dirty, sometimes soaked in mud and sodden with water, and requiring very careful handling to be brought back into good condition. All sorts of things got back with these helmets to the repair stations, and it was not an uncommon thing for the satchels containing the helmets to be found to hold anything from a live hand grenade to the photograph of some girl, which had been stored there for safe keeping. Both then and later we always had considerable difficulty in preventing Tommy from using his helmet satchel, and later on his box respirator satchel, for these illicit purposes. He seemed to consider that if he had to carry another haversack he had a perfect right to put in it whatever he liked—rations, knives and forks, ammunition, private knickknacks of all kinds. This of course had to be stopped, owing to the damage these things might do to the respirator and the

difficulty they might make in getting it out quickly.

During September and October, 1915, there were several scares as to the imminence of gas attacks by the Germans, and on one or two occasions it was definitely stated that the cylinders were actually in position in their trenches. This helped to hasten things up, and the factories in England and the repair stations in France kept themselves busy in producing the new type of helmet. A large number of them were actually issued to the troops by the time the Battle of Loose was started, and were consequently employed by our men when the first gas attacks were made, in September of that year.

It was these helmets which appeared in so many of the picture papers showing the charge of some British Territorial infantry through the gas cloud at the beginning of the battle, and there is no question about it that the men had a very fearsome appearance. With the hood over the head and the two big goggle eyes, and the outlet valve sticking out where the nose should be, it is

small wonder that the Germans described them as "devils," and were so terrified as not to be able to put up much fight on the front where the particular charge was made.

CHAPTER IV

The attack of December, 1915—The Allies' good training tells—The casualties analysed—The new element of surprise—Evidences of the use of phosgene—The incident of the bulb—Improved alarms—The Strombos sirens—Accidents to the horns—The Tear Gas Shell—Its chemical analysis—Combated by anti-gas goggles —Tommies scoff at Tear Gas —The Germans make it formidable.

THE expected German gas attack was actually made on December 19, 1915, at about 5:15 A. M., just before "Stand to" in the morning, the venue being the north of the Ypres salient, from the canal bank at Boesinghe down to Wieltje, a distance of three miles. It was preceded by the appearance of parachute lights of an unusual kind and by a number of red rocket flares. Almost immediately afterward gas was smelt in the front trenches. In some cases a hissing sound made by the gas's leaving the cylinders was heard and was taken as a warning by the soldiers in the trenches. In other cases the noise seems to have been deadened by rifle fire. Taking it altogether, however,

there was very little warning, as the wind was favourable and the gas traveled surprisingly quickly.

There was absolutely no confusion, and the men put on their helmets at once and lined the parapets within a minute. Where the trenches were close together the men had some difficulty in getting on their helmets in time. This was particularly the case in listening posts where we had patrols out quite close to the German wire. In the support and reserve trenches the arrangements for spreading the warning were not so good as those in the front line, and a number of men were caught by the gas before they had their helmets on. Indeed in a number of cases, especially in batteries, the gas was smelt before the receipt of the warning.

The actual gas wave lasted only about half or three-quarters of an hour, but in some places the helmets had to be kept on for four hours, as the gas hung about in hollows and dugouts for a long time. This was particularly noticeable in the neighbourhood of the canal. The cloud was felt as far back as Vlamertinghe, eighty-five hundred yards behind the line, and was still visible at this

point. For at least three miles back behind the front line helmets had to be put on everywhere, and for six miles behind the line the smoke helmets were generally worn, some men who did not put them on at this distance being gassed.

The actual gas wave was accompanied by a heavy bombardment of the front line and of Ypres and the villages behind it, shrapnel and high-explosive shell and also tear shell being used, the latter shell being fired particularly against our artillery. This bombardment lasted throughout the day and most of the following night. Though our wire had been cut in many places by the artillery fire, the Germans made no serious infantry attack, and small patrols which left their trenches in a few places were immediately shot down, as our fellows were continually on the alert and had not suffered to any considerable degree.

Altogether a large number of troops were exposed to the gas, but, compared with its extent, the cloud caused only a small number of casualties. This was very satisfactory after our experiences of the spring. Men who were gassed but not killed were all

subsequently questioned as to the reason for their being gassed, and in each case a definite reason was forthcoming. In no single instance was the fault laid at the door of the smoke helmet, which apparently had been quite capable of standing up to the highest concentrations in any part of the cloud.

Among the reasons given for the casualties were things like the following: Some men in the fire trenches did not get on their helmets quickly enough owing to the short distance between the trenches, lack of warning in the support line and insufficient practice. Some officers and men sleeping in dugouts did not have their helmets attached to them or they were caught away from their dugouts without helmets. Helmets in many cases were under the overcoats, which made it very difficult to get them and put them on quickly, as it was necessary to undo the overcoat, the top button of the jacket and the cardigan waistcoat before the helmet could be tucked in. One cause of casualties was that the "P" helmet smelt very strongly of carbolic, and a lot of men who had not had this explained to them thought that the peculiar smell was that of gas coming in and

they took their helmets off with a view to replacing them with other helmets. This of course was fatal. One sergeant was gassed through his helmet's being holed by a bullet, though he himself was not wounded. In some cases wounded men tried to remove their helmets and were gassed in this way, and it was found necessary to watch men who were hit to prevent this.

In many ways this attack of the Germans was of the greatest importance, as it displayed all of the features on which the subsequent development of the gas cloud was based. These features were: Increased concentration; the use of new material; surprise. These three things are really the basis of all gas warfare, even at the present day, whether the attacks are made in the form of clouds or by the use of gas shells or other projectiles.

The increased concentration was obtained chiefly by the reduction in the time occupied by the attack. The first attack of all lasted about one hour and a half. The next attack lasted about three hours. The one in question lasted only thirty minutes, so that if the same amount of gas was used the concentra-

tion of the cloud must obviously have been increased six times over that of May twenty-fourth, as there is little doubt that the cylinders had been installed in approximately the same numbers—that is, one to a meter of front.

Probably the most important feature of the attack was the introduction of phosgene. Now there never was any actual chemical evidence of the poisons of phosgene in the German gas clouds until some of their cylinders were captured by us when they retreated on the Somme in the beginning of 1917. But unfortunately the peculiar effects of phosgene on our men who were gassed were only too apparent. There were a large number of "delayed" cases—men who thought they were only slightly gassed but who became ill or even died several hours or sometimes a day or so later from heart failure, especially if they had taken any heavy exercise in between.

In these cases there was hardly any coughing. What was really wanted was rest, but this was not realised at the time, and many men walked to the dressing stations—sometimes a mile or more—through deep mud

and became quite exhausted. One officer of the Durhams had been slightly gassed at the beginning of the attack but felt perfectly all right until about noon, when he became faint and exhausted, though not apparently seriously ill. After lying down he felt better, but in the evening got worse again, and in walking to the ambulance to go to the field dressing station he suddenly collapsed and died. This was fourteen hours after the attack.

Another weighty piece of evidence as to the nature of the gas was given by the smell, which to trained observers was quite different from the typical chloride-of-lime smell of chlorine; and by the peculiar effects on the taste of tobacco to men who had smelt the gas. If you take a good smell of dilute phosgene and then smoke a cigarette the tobacco tastes like nothing on earth. Tommy's nearest description of the taste and smell is "mouldy hay." This peculiar effect is quite typical of phosgene and is known as the "tobacco reaction."

In the hope of getting samples of the German gas clouds for analysis a large number of gas vacuum bulbs were distributed up and

down the line, and selected men were taught how to use them. This was supposed to be done by nipping off the drawn-out end of the gas bulb, whereby the contaminated air would rush in. The end was then to be closed with a hollow stopper containing wax.

To get these samples was asking a great deal. Even when packed in special boxes glass bulbs are somewhat fragile things for trench life, and the wooden boxes made excellent kindling wood, which was always being sought for. The result is that when the cloud does come along the vacuum bulbs are often conspicuous only by their absence. Even if they are kept whole it is asking rather a lot of a man to take an accurate scientific sample during the excitement of a gas attack which is accompanied by a bombardment by explosive shells and gas shells.

For a long time none of the bulbs found their way back to the field laboratory. Eventually one did come, carefully packed in shavings and wadding. I happened to be present when it was brought in, and there was a good deal of excitement at the little prodigal's return. The bulb was taken out, but under it was found a leaf from a field-

service note book, on which was written: "Danger. This bulb was found in a hedge. It seems to have been dropped from an aeroplane and probably contains cholera germs. Fortunately it has not been broken."

The "surprise effect," which was mentioned above as being the third fresh feature of this new-era gas-cloud attack, took the form of making the attack in the dark and at a time when men were least prepared—that is, just before the morning "Stand to," the hour before dawn, when all troops in the trenches stand to arms. By making the attack at night, or at any rate in the dark, the boche achieved two objects: First of all, there were better wind conditions for an attack, because the night winds tend to flow down toward the earth and keep the gas cloud low-lying and thick, whereas in the day the sun warms the ground and produces so many upward currents of air that the cloud gets lifted up and dissipated; in the second place it was impossible to see the cloud when it was first liberated, and this reduced the means of detecting the attack to only two—the hissing noise of the gas

escaping from the cylinders and the smell of the advanced parts of the cloud.

Later on it was known that the best hours for all gas attacks, both cloud and shell bombardment, are in the night; and as a matter of fact practically all gas warfare is now carried out at night, but at that time the significance of this was not grasped, and many of our casualties were due to lack of preparedness, numbers of men being caught "on the hop" and overwhelmed.

Some most important steps in improving our protecting measures were taken as a result of the lessons learned from the attack; in fact, it may be taken that all measures in defence against gas have been learned from bitter experience, and to this extent the sufferings of the victims may be taken as having at any rate some compensating value. In such a new and strange and continually developing kind of warfare very little can be done by *a priori* argument. This fact we have always tried to impress on the men—that the gas warfare orders, sometimes apparently trivial and frequently wearisome and annoying, have all been made

as the result of lessons learned from actual attacks.

Among the chief things that were done after the December nineteenth attack was the improvement of our system of alarms.

The bells and horns in the front line had been found quite insufficient, especially for warning people in the rear; and the telephone could not be depended on for this purpose owing to the possibilities of the wires being cut by shell fire. To protect them from being cut, all wires would have to be buried at least six feet deep in the ground, and this is practically impossible owing to the work involved.

It would consequently be fatal to depend on telephonic communication, especially as a gas attack is nearly always accompanied by a pretty heavy bombardment of rear lines. In one case I knew, during just such a bombardment, the staff captain at a brigade headquarters was talking to one of the battalions when the whole telephone instrument seemed to burst into a sheet of flame in his hands, owing to a cut wire. The battalion concerned was isolated for more

than an hour as a result, and anything might have happened in the meantime.

For these reasons it was decided to adopt for gas alarms sirens worked by compressed air, which would make a noise sufficiently loud and distinctive to be heard long distances away. The type of siren which was used has been kept in use ever since in continually increasing numbers and has proved extraordinarily useful. It is known as the Strombos horn, and consists of the horn proper and two iron cylinders of compressed air charged to a pressure of one hundred and fifty atmospheres. Only one cylinder at a time is connected to the horn, the other being kept as a reserve.

The Strombos horns are mounted in the trenches in such a way as to protect them from shell splinters as far as possible. This is generally done by packing them round carefully with sandbags, only the mouth of the horn being displayed and pointing toward the rear. Every sentry must know how and when to sound the horn. All he has to do when he realises that a gas attack is being made, or on receiving instructions from an officer to do so, is to loosen the tap

on the cylinder one complete turn, when the horn will sound continuously for more than a minute. The noise is terrific and in an enclosed space or in a quiet region it is absolutely deafening. In the trenches, however, it is none too loud, and the distances between the horns in the front system of trenches are never more than four or five hundred yards. Farther back in the chain, toward the rear, the distances can be increased. Horns are now installed at battalion, brigade and divisional headquarters. By turning them on when the noise of those in front is heard it is possible to pass the alarm in an incredibly short space of time and thus forestall the cloud of gas to such an extent that every man in the support trenches or in rest billets or the villages behind the firing line is aware that an attack is in progress and gets ready to protect himself.

Naturally, things don't always work out exactly according to schedule. The horns are frequently damaged. In one place I was at, just this side of the canal, near Boesinghe, a heavy German trench mortar wrecked three of our Strombos horns

within a week, and another and less suitable position had to be found for the alarm. Then there are occasional false alarms. These sometimes arise from individual men "getting the wind up" from a bombardment by gas shell and thinking that a cloud attack is being made. Others I am afraid have been more in the nature of experiments "to see how it works." After all, it must be a great temptation to a sentry to be in charge of a Strombos horn and never have the pleasure of turning it on.

False alarms are a great nuisance, however, and good arrangements have now been made to prevent their spreading. It is possible to avoid all the unnecessary disturbance to which troops are subjected by a false gas alarm. This disturbance is particularly objectionable in back areas where regiments returned from the trenches are in billets. When the alarm goes everybody has to turn out—probably in the middle of the night. Sentries wake the officers and men in all the billets; messengers have to be sent post-haste to outlying villages or farms with which there is no telephonic communications; respirators are hurriedly

inspected and placed in the alert position; the gas-proof curtains of cellars and dug-outs are adjusted; the officers move about in the darkness to see that all their men are accounted for and ready; every one is in a state of expectancy—and then the word comes through that it is a false alarm, and the men go back, cursing, to their billets. Not only is an occurrence of this kind wearying to tired troops, but it has the old disadvantage of crying "Wolf, wolf!" when there is no wolf—the consequent determination on the part of the men not to take the next alarm so seriously.

Though it was not realised at the time, it is almost certain that the Germans started to use gas in shell almost simultaneously, and probably actually in the first attack, with the use of the poisonous gas clouds in the attacks of April and May, 1915. Many instances came to notice of men's eyes being strongly affected to such an extent that they could not keep them open. There seemed to be something in the air which made an unprotected man weep copiously if he tried to keep his eyes open, and of

course if he closed them he could not see what he was doing.

These effects, and a peculiar smell which was noticed both during and after the gas-cloud attacks, gave rise to the belief that something like formaldehyde was being used by the Germans mixed with some chlorine gas. Others described the smell as being that of chloroform or ether, but nobody could say definitely what the material actually was. It was only after a number of blind shell had been obtained and examined that it was realised that the Germans were firing shell filled with liquid which had a powerful lachrymatory effect.

It does not appear certain whether the use of lachrymatory liquids for putting men out of action by making their eyes water is in itself contrary to The Hague Convention, as the vapours need not actually be poisonous. This was the case with the first German gas shell, as it was found that the liquid contained consisted only of a material known chemically as "xylyl bromide." The vapour of this liquid and of many similar substances has a most powerful effect on the eyes, like that of onions but much

stronger. Except in very high concentrations it cannot be regarded as poisonous—at any rate not in the sense that chlorine is poisonous.

Examination of the German lachrymatory shells showed that the liquid was contained inside the shell in a sealed lead vessel so that the material should not come in contact with the steel of the shell, which it destroys gradually. Shell of this kind, though termed gas shell, are not really such, as the liquid has to be broken up into fine droplets by the explosive charge of the shell before the vapour can produce its effect. The liquid has no pressure of its own inside the shell and depends entirely on the bursting charge to get it distributed into the atmosphere.

The xylyl bromide used by the Germans was not pure, but contained a big proportion of benzyl bromide, showing that it had been made by the action of bromide on coal-tar light oil from which most of the toluene had been removed for the manufacture of the well-known high explosive, trinitrotoluene.

The effect of xylyl bromide on an unpro-

tected man is instantaneous and remarkable. Even such small proportions as one volume of vapour diluted with one million volumes of air will at once make a man weep so copiously that he cannot possible keep his eyes open.

Obviously a material of this kind has great military value, for though it does not put men out of action permanently by killing them it neutralises their effectiveness to such an extent that for the time being they may be regarded as of no military importance. In strong concentrations the effect on the eyes is most powerful. I have walked into an area which was being bombarded with lachrymatory shells and suddenly got the effect just as if I had been hit in the face. Fortunately the lachrymation has no lasting effect on the eyes, and a man on getting into pure air very quickly recovers.

Throughout the spring and summer of 1915 these lachrymatory shells were used in considerable numbers, especially in the vicinity of Ypres, and at times the ramparts of that much bombarded town reeked of lachrymatory vapour and nobody could stay in certain spots for any length of time with-

out having his eyes protected by specially constructed goggles or by wearing a gas helmet right over his head.

Taking it altogether we were not troubled nearly so much by this new type of gas as were the French, in the southern part of the line. In much the same way that the gas cloud was developed by the Germans against the English the gas shell were developed chiefly against the French, and very much larger numbers were employed against the French positions than we had to contend with during the first six months or so. Later on things were more equalised in this direction. Captured German documents and statements by prisoners showed us that the Germans were counting very considerably on the effect produced by the lachrymatory shell, and detailed instructions for their use in various circumstances were carefully laid down. The lachrymatory shell was known by the Germans as "T-Shell," and the xylyl bromide as "T-Stoff," and instructions were laid down for the use of this material. Another kind of shell was known as "K-Shell," which up

to that time had not been used against us, or at any rate had not been recognised.

The T-Shell was particularly to be used against positions which it was not intended to occupy immediately, the reason for this being that T-Stoff hangs about for a long time. Some of the liquid is apt to be spread about the ground and gives off enough vapour to make the neighbourhood of the shell hole uninhabitable for many hours, and in favourable condition—for the enemy—for several days. The K-Shell, on the other hand, was intended to be used against infantry positions and strong points which it was hoped to assault and capture within an hour or two of the bombardment or on areas which it was hoped to traverse during a big attack.

The advent of the lachrymatory T-Shell incommoded us considerably, but, as it was quickly realised that the gas was not poisonous, the Tommies were not much taken back, and the "tear shell," as they were quickly called, were not considered by the rank and file to have importance, which as a matter of fact they have; but at the same time we heard rather alarming stories

of the effects of gas shell as used against the French.

It was rumoured, for example, that in the Crown Prince's big advance in the Argonne, in the late spring of 1915, that such enormous numbers of gas shell had been used against the French positions that the infantry occupying them were not only put out of action by the effect on their eyes but that the amount of gas used was so large that the French soldiers were actually anæsthetised and were taken prisoners by the Germans while in an unconscious condition.

Whether this was true or whether it was exaggerated is not certain, though it is certainly true that the Crown Prince's advance was prefaced by a hurricane bombardment of gas shell, the tactical effect of which was considerable.

Stories of this kind, however, combined with the effects which we ourselves were experiencing, made us realise that protection against tear gas was essential, and for this purpose arrangements were made to supply every officer and man in the front line with a pair of anti-gas goggles. The

earliest types of these goggles were very simple in construction, and we are told were copied from a French pattern. They consisted of a waterproof fabric lined with flannel containing a wire spring for the nose and fitted with celluloid eyepieces. By bending the wire to the shape of the nose it was possible to close the nostrils and at the same time give a reasonably good fit to the flannel on the face.

In some cases the flannel was anointed with some kind of grease so as to make a still closer fit, in order to keep out small traces of gas which are quite sufficient to produce lachrymation. Later on we had a much better type of goggle backed with rubber sponge to make a tight fit to the face.

With the small numbers of gas shell used against us we had no experience of any effect on the lungs, and it was found also that the helmet form of respirator was enough to keep out, at any rate, low concentrations of the lachrymator; but we got a rude awakening when the boche began to use his tear shells in larger numbers. Such a case happened to us in the beginning of

1916, at the celebrated village of Vermelles, a little ruined town just behind the lines near Loos. The enemy tried out an attack on us over about a mile front for the purpose of bagging some of our trenches, and he attempted to keep reinforcements from coming up to counter attack him by putting down a tear-shell barrage through Vermelles and north and south of it over the roads on which our fellows would have to advance. He used thousands of his tear shells and the neighbourhood absolutely stank of them. Fortunately, it was almost impossible to put down an effective standing barrage with gas, and our reserves got through on two roads that had not been blocked effectively. The boche attack was a fizzle, but Vermelles was a little private hell of its own for that day and most of the next forty-eight hours as well.

During and immediately after the bombardment, troops passing through the village wore both goggles and gas helmets, but the concentration of lachrymator was so great that many of our fellows were sick and actually vomited inside their helmets. If you can imagine men going up to a battle

with these flannelette bags over their heads and then being sick inside them, you can realise that the boche was not particularly popular with us at the time.

Besides this, Vermelles was much used by troops in reserve and was full of cellars and dugouts occupied by the waiting infantry and also by signallers, headquarters of various kinds, and so on. The vapours—and some of the shells themselves, for that matter—got down into these cellars and made them almost uninhabitable for days, except in those cases where they had been properly protected by double lines of blankets hung at the entrances.

About the same time in 1916 the enemy began making surprise bombardments with a new lachrymator and with the K-Shell mentioned previously, for the purpose of assisting in raids. Both of these gases rejoice in long names, the lachrymator being bromethylmethylketone, and the K-Shell gas monochlormethylchloroformate. These gases are much more poisonous and do not hang about as long as the old "T" tear gas.

One such raid in which they were used

was carried out at a place called La Boiselle —afterward famous as a jumping-off point in the Somme Battle.

I was not in at the raid, but heard details of it afterward. The boche rained his gas shells into the selected area and at the same time prevented reinforcements from getting up by putting down a so-called box barrage with explosive shells round the trenches to be attacked.

Our men were taken completely by surprise. Many of them were badly gassed, all were temporarily blinded; and then after a short interval the boche came in. He timed his arrival so that most of the gas had disappeared. Then there was some very fierce fighting—so fierce that a number of our men died afterward because of the exertion following on the breathing of the K-gas.

But gassed and blinded men, however brave, cannot fight successfully against others fresh and unaffected, and the enemy captured a number of prisoners and two Lewis guns.

Curiously enough, during the Somme Battle a few months later we did in properly the regiment which had carried out the

raid and captured the official report of the commander of the raiding party. In this report he said: ". . . the men of the Royal Irish Rifles created a fine impression both as regards their physique and their mode of repelling an assault. Had it not been for the use of the gas shells it would have been impossible to clear the section of trench attacked."

Rather a fine tribute—and one thoroughly deserved!

Of course surprises of this kind cannot be pulled off twice, but occurrences like this and the bombardment at Vermelles let us see that the enemy intended to develop his gas-shell industry much more than we had anticipated, and our protective measures were taken in hand so as to meet future eventualities. In fact it was about this time that the box respirator was being hurriedly developed so as to protect us against any further devilment that Fritz might send along.

CHAPTER V

Summer of 1916 the highwater mark of the German gas cloud—Their improved methods—The need of speed and secrecy—Gas as a rat exterminator—Causes of Allied casualties—Germans killed with their own gas—Gas masks for horses and mules—Reduced Allied casualties—Humorous incidents.

THE great time for the German gas troops was undoubtedly 1916, and from April to August of that year they carried out five big cloud gas attacks on the British alone, not counting several on the French Front and a number against the Russians.

During the interval from the December attack of the previous year they had obviously been thinking hard and preparing lots of gas, for the new attacks showed several fresh features both as regards extent and tactics. Along the lines of making the gas more poisonous, using greater quantities and higher concentration and the springing of surprises, everything was done to make the gas cloud an even more deadly affair than it had been in previous shows. That

our own casualties were much less than before, and that the boche in at least one case had a lot more killed by his own gas than we had, were very satisfactory results of all the labour and research as far as we were concerned.

For the same reason that the December attack had been reduced in duration to half an hour, the new clouds lasted only ten to fifteen minutes; thus once more multiplying the concentration by two or three. On top of this the amount of phosgene was increased up to at least twenty-five per cent and probably to about fifty per cent, so that in this way also the cloud became much more deadly than before. It is interesting to note that pure phosgene cannot be used, otherwise the Germans would undoubtedly have employed it. Straight phosgene does not come out of the cylinders satisfactorily—it must have a big proportion of something like chlorine mixed with it to force it out and get it into the air as quickly as may be.

All of this made the gas cloud a nasty thing to face. As it became progressively more deadly it required less and less to kill. A couple of breaths of the poisoned air be-

came enough to kill a man; but as our protection was good enough, it meant that the most important thing for the enemy to do was to take us unawares by getting his gas over so quickly or deceiving us in some other way that we should be down and out almost before we knew it. This is where his surprise tactics came in.

These tactics consisted in attempting a great secrecy in the preparations, in the use of smoke clouds to put us off the real track of the gas, and the putting over of a number of different waves of gas at varying intervals. The value of the last two will be more apparent from the accounts of the individual attacks, but the importance of the first-mentioned method must be emphasised a bit.

It must be remembered that the carrying in of the gas cylinders is the work of the infantry and, as we discovered ourselves when we started retaliation, is a very unpopular job owing to the difficulties of the carry. Any carelessness in allowing the cylinders to clank by bumping against each other or against any other metal objects in the trenches, or metallic sounds made by

rather bored pioneers in unscrewing the domes or attacking the pipes, are going to give away the fact to the opposing side that something unusual is going on. And something unusual going on or suspected generally spells g-a-s in the trenches.

In some cases, too, the opposing trenches can be seen from observation posts—O. P.'s or O. Pips, as they are called in British Army parlance—and in such cases if the carrying is started or the installation of the cylinders is continued during the day there is a good chance of the whole show being blown on by some watchful observer with a telescope to his eye a mile or so away. All this the boche realised and made his arrangements accordingly. But in at least one case, in April, in his anxiety to get the cloud over without diminution of strength and so that we should have little time for protecting ourselves and spreading the alarm, he chose as his venue for the attack a big portion of the line where the trenches were very close together—seldom, in fact, more than fifty yards apart. Of course it is just in such circumstances that secrecy of preparation is of the greatest importance—but at

the same time it is of the greatest difficulty to maintain. As a matter of fact the Germans overreached themselves by this choice of position, and little indications spotted by our watchful sentries and patrols made us pretty certain that a gas attack was impending, and our watchfulness and preparedness were correspondingly increased and a constant state of "Gas Alert" kept up.

The first two attacks of the year were made against the 16th—the Irish Division. This was the division in which Willie Redmond was a captain, and it was composed of some of the best fighting material in the world—all Nationalist Irishmen and anxious to get one over at Fritz. Whether the Irishmen were chosen as a target with the foolish idea of "putting the wind up," or whether it was out of revenge for their appearance in the British ranks after all the labour that had been expended in trying to spread sedition in Ireland, we do not know. Whatever the idea was it terminated in most abject failure, for the Irishmen came through both attacks wonderfully well and absolutely smashed up the German infantry advances which were attempted

after the passage of the cloud. Both attacks were made on that part of the line near Hulluch running for about two miles south from Cité St. Elie.

The Germans opened the ball by letting our support and reserve lines have a heavy bombardment of tear shells. Almost immediately after, in the dim light of the early dawn, the first gas cloud floated over. It was very thick and had been largely mixed with smoke in the hope of leading our fellows to believe that it was terribly strong. It was not. But the cloud was so dense that even at brigade headquarters, three miles behind the front line, it was impossible to see across the road. There was enough gas in this mixed cloud to make it very dangerous and uncomfortable to unprotected men, but there were very few casualties. The alarm was quickly spread, the men remained cool, and an attempted attack by the enemy infantry to follow up the cloud was smashed up without being able to get closer than our barbed wire.

After this first wave there was a tendency among the men to regard the danger as over and to congratulate themselves on the ap-

parent and obvious boche failure. As they were prepared to go through with anything the boche could put over, there was a natural tendency to underrate the effects of gas, seeing it had caused them no losses. It is undoubtedly true that a number of helmets were discarded entirely—some of the soldiers thought they were useless after being through an attack, and threw them away, depending entirely on their reserve helmets. These they omitted to place in the "Alert" position, pinned up on their chests ready for immediate use. In one or two cases which came to my notice officers and men went off to the latrines or to headquarters without helmets at all. This of course, was not general, but it shows how some of our men fell for the boche ruse, which consisted of putting over a second wave two hours later on exactly the same Front.

The second cloud was a frightfully strong one, composed entirely of gas in the highest possible concentration. It was this wave which caused all our losses on April twenty-seventh, as it took a number of men completely by surprise. But even so, the Irishmen were not a bit dismayed, and when the

Germans again attempted to advance—parties of their bombers in some cases appearing immediately behind the gas cloud—they were met by such a stout resistance that those who were not shot down retired in disorder to their own trenches.

The intensity of the second wave can be gathered from the fact that buttons and ammunition were quickly corroded and turned a villainous green colour. In a few cases rifles stuck and Lewis guns jammed, owing to the effects of the gas on the ammunition and the breach mechanism. One good thing about the attack was that most of the rats in the trenches were killed. In some parts of the line the trench rats are an absolute plague. They eat any food or candles left lying about or kept in cardboard boxes. They swarm in the dugouts and appear in all sorts of odd corners. They disturb the little rest one does get; and I have had them run all over me, even over my face, while lying in my dugout. All attempts to clear them out were useless. But what ferrets and terriers and virus could not accomplish the boche gas did. Mister Rat cannot stand up to a strong mixture of chlorine and phos-

gene without a gas mask, and so in this attack, as in others we experienced, he died by hundreds; and nobody mourned him.

Curiously enough two kittens, which inhabited the dug-out of the commanding officer of one of the battalions of the Scottish Borderers, who were in reserve, came through alive. The kittens were badly gassed and lay breathing rapidly, suffering from spasms and with profuse salivation. Possibly their fur helped to absorb some of the gas, for five hours later the little victims were almost themselves again, though they continued to cough occasionally and drank water continually. The water they took in preference to milk.

The effects of the poison on the soldiers who were gassed were pretty much the same as has been so frequently described in the press before. In the lighter cases it was mostly severe and painful coughing and bronchitis, with occasional retching and vomiting. The severe cases had the frothing at the mouth, the painful fight for breath and the blue face with staring eyes which are typical of severe gassing with chlorine and phosgene. I was told that

there were not many delayed cases—that is, men being taken seriously ill hours after the attack, though apparently unscathed before.

The casualties were really remarkably small in the circumstances, and even despite the surprise tactics, were not as numerous as those of the December attack. Apart from the men who were caught without their respirators, most of the casualties were the result of some special circumstances. The helmets themselves when properly inspected and adjusted gave good protection. In connection with the laying aside of the respirators after the first cloud a sergeant told me that when the second wave came over he had seen two soldiers trying to get into the same helmet. The humorous side of this had apparently appealed to him even in the middle of the attack.

Of course with the trenches so close together a lot of men had difficulty in getting protection in time. Parties of men in advanced saps and listening posts had the greatest difficulty, and numbers of these men were killed. One pioneer of a tunnelling company came out of a mine gallery know-

ing nothing about what had been happening aboveground, and walked straight into the middle of the gas cloud.

A man in one of the companies of the Irish Rifles was wounded in the head by shrapnel through both his steel and gas helmets. In spite of the wound and the hole in his gas helmet he held the latter close round his mouth and nose and was not gassed at all—a clear case of presence of mind saving his life.

One thing which impressed every one with the need for thorough gas training at home, and which should be taken to heart by all men in training at the camps or likely to go there, was the way in which reinforcements and men who had recently joined up suffered. Their casualties were out of all proportion to their numbers and were due entirely to the fact that insufficient attention was given at that time to the gas-defence training of the recruits. Many of them had never put on a helmet before, and none of them had ever smelled gas.

In one particular instance a batch of twenty men had come straight over from England and were in the gas attack the day

after their arrival in the trenches. The only training they had had was a lecture from their own regimental officers, and consequently they knew little or nothing about the use of their helmets. Every one of these men was gassed. It is true that they had scrambled into their helmets somehow, and none of them died; but the fact remains that absence of training at home cost the fighting line twenty men in one company. In this company they were the only men gassed. Largely as a consequence of this, gas-defence training was taken up very seriously in the early training of recruits, and big gas schools were established at all the camps both in England and at the bases in France, so as to catch the young soldier early.

The boche made another gas attack on the Irish Division on the same Front two days later. Once again he let off two waves—this time with an interval of only a quarter of an hour. But despite his idea of "mixing them up" he could not bring off that particular surprise again.

The second attack was one of the most interesting on record, for it was here, near

Hulluch, that the gas blew back on the Germans and killed many more of them than our total gas casualties. The thing happened in this way: The first gas wave was loosed off at three-fifty A. M., opposite the celebrated Chalk Pit Wood. Fifteen minutes later a heavy cloud was discharged on the Hulluch front. But the wind was too light and variable. The cloud came over our line and then the gentle wind first dropped altogether and then gradually veered round. The gas hung on No Man's Land and over both sets of trenches for a short time, and then with increasing pace drifted back right over the German position, just where Fritz had been seen massing for an attack on the Hulluch sector. We did not see the confusion which reigned, but almost simultaneously with the arrival of his own gas our barrage came down and the German attack dispersed.

All that day our observers reported the carrying out of German casualties from the trenches on stretchers and a constant stream of ambulances coming up and then returning along the roads to the rear. We surmised that the boche had swallowed some of his

own poison, but it was not until several months later, from some documents captured during the Battle of the Somme, that we were able to appreciate his disaster to the full.

The first of these documents was the diary of a soldier who had been in the neighbouring trenches. It ran: ". . . We went along the trenches to find the headquarters of the ——th. It was awful. Everywhere lay dead bodies or men gasping for breath and dying from the gas. Somebody must be to blame. At first I could not go on. One almost had to step on them to get through. I asked an officer of the ——th what had happened. They were going to be relieved. . . ."

But the other documents were more explicit, as they happened to be the official report on the matter from the war office in Berlin. It appears that the Germans had eleven hundred deaths from their own gas. A most rigid enquiry was held and it was found that many of the men were not carrying respirators, either in the trenches or in the area immediately behind the line. But this did not explain the extent of the dis-

aster, so eight hundred of the respirators collected from casualties were sent to Berlin for examination and report. Even allowing for those which might have been injured in transit, there were still thirty-three per cent of the masks so defective that their owners were certain to be gassed. To see whether this applied only to the area affected a large number of respirators were collected from up and down the whole Western Front, and it was found that even among those as many as eleven and a half per cent were similarly at fault. It would seem that there had been very poor inspection of the respirators both in manufacture and after issue to the troops. Apart from the joy of seeing the boche hoist with his own petard it was rather a relief to find that the efficient German Army was not so frightfully efficient after all.

This matter of inspection is taken very seriously in the British Army. Besides the rigorous factory inspection all respirators are inspected thoroughly every day even in the trenches, and Tommy is expected to look after his respirator just as he looks after his rifle. As an official statement issued after

the April attack said: "A defective helmet frequently leads to the death of the wearer. Inspection of respirators must be frequent and thorough." A sergeant who was notorious for his thorough dealing with recruits got away with it in even better terms when addressing a squad on parade. In thundering tones he said: "If you don't look for the 'oles in your 'elmet, they'll soon be looking for a 'ole for you."

Another thing that resulted from the attacks just described, and from another similar attack shortly afterward in the salient, was the putting on the screw with regard to the carrying of respirators continuously by every one in the trenches. A very good and well-known story on the British Army in this connection is that of a brigadier general who was proceeding to the line for his daily inspection when he discovered that he was minus a gas bag. He stopped the first orderly he saw, borrowed the man's helmet and serenely went his way with a clear conscience. Arrived in the trenches, one of the first sights that met his horrified gaze was a soldier without a gas mask. In virtuous tones he demanded the reason for its ab-

sence, and then, waving aside the halting explanation, went on loudly to assert his belief that the soldier would not know how to use a respirator even if he had one.

"Here," he said, "take mine and show me whether you can put it on in quick time."

The awe-stricken Tommy slung the satchel over his shoulder, and on the word "Gas!" from the general thrust his hand into the haversack and pulled out—a very dirty pair of army socks.

The fourth German attack of 1916 was made on June seventeenth in Flanders, near Messines; in fact, just north of the Wulverghem-Messines road. Like those of April, it was intensely strong, very short, and sent over in successive waves at intervals of about twenty minutes. There were really no fresh features about the show, but the cloud seems to have been even stronger than before. I had no personal experience of this attack, but the cloud must have been very strong, for it killed animals at "Plugstreet"—the only name we used in the British Army for Ploegsteert—three and half miles away, and was quite distinctly perceptible even at Béthune. At the "Piggeries"

—the remains of a model farm in rear of Plugstreet Wood belonging to a notable French sportsman, a place well known to so many British soldiers—a calf was found dead, after the passage of the cloud, with the body very much blown out. Dead rats lay in close proximity.

Even farther back than this animals were seriously affected. The army mules in the line of the gas were seized with fits of coughing and kicked violently, making them even more difficult to handle than usual. It is probably not realised that horse masks are now issued on a scale sufficient to provide protection for all horses and mules, such as those of the first-line transport and the artillery, which have to approach anywhere near the lines. The present form of these respirators is that of a big bag soaked in chemicals which fits over the animal's nostrils, leaving its mouth free so that the use of the bit is not interfered with. When not in use the horse respirator folds up very nicely and neatly into a canvas case which can be carried on the breastband of the harness or any place from which it can be quickly adjusted. Some of the animals take

to these masks—"Horspirators," some wag called them—quite quickly, but others are strenuous objectors; some of those hardened sinners, the mules, transforming themselves into masses of teeth and hoofs whenever an attempt is made to fix on the gas bags.

In one case where a horse and a mule in the same supply column were fitted with their masks at the same time the difference was most marked. The horse was dressed up without much trouble, though he did not like it. He whinnied and sneezed, breathed hard and perspired and looked rather pitiable, but stuck it out. The mule, on the other hand, had to be roped to get the mask on at all. Then he danced about, heels in the air and head down, and tried to rub off the objectionable appendage against the rope, and then against a tree. This did not effect its removal, and for a minute the cunning animal stood still with his ears cocked at different angles. Then suddenly he put his head to the ground and before anything could be done to prevent it put his foot on the respirator, pulled his head up smartly and left the respirator under his hoof.

These masks have proved of the greatest

value and have saved any number of horses' lives. The cavalry are not provided with them, as it is not anticipated that they will be near enough to be affected by gas-cloud attacks, and when the cavalry are mounted and in action it is unlikely that they will meet even poison-gas shells in large numbers. Added to this is the fact that a horse can stand more gas than a man without being distressed.

The casualties in the June attack were lower than in any one previously. Indeed, it was a satisfactory feature of the whole gas business that despite the increasing deadliness of the German clouds the losses they caused became less and less. Of course the proportion of severe cases in those gassed became greater, for with such strong clouds it had become a case of hit or miss. Either a man was protected completely or he was caught out badly; and this spoke well for the protection supplied, for otherwise there would have been a much bigger proportion of light cases.

Of the minor effects of these boche gas clouds, that on vegetation is the most marked and gives a good idea of the strength

of the gas. For miles in the track of the cloud all green stuff is burned up or wilted. Grass is turned yellow, the leaves of trees go brown and fall off, and the garden crops are entirely destroyed. I have seen root crops in the fields and garden crops of onions, beans and lettuce quite destroyed. But curiously enough, farther back, in places where this still happens to the garden crops, the cereals and the hedges seem to escape serious injury.

Of course over a wide area all metal work is thickly tarnished, and this might be a danger in the case of telephone instruments and other delicate appliances, except that the exposed parts are always kept slightly oiled and then cleaned thoroughly after the attack. The same thing is done with rifles and machine guns and their ammunition, and with the clinometres, fuses and breech mechanism of guns and trench mortars. Since this war started very little difficulty has occurred through corrosion, but the chief thing is to clean off the grease and reoil all metal parts exposed to the gas immediately after the attack is finished, otherwise the greasy surface seems to hold the

gas or the acid it engenders, and allows it to eat in at its leisure.

During the attacks of 1916 the alarm arrangements worked very well, and the Strombos Horns in particular justified their use. Even above the noise of machine-gun fire and the bursting of shells their shrill, unmistakable note could be heard for long distances, giving warning to all troops on the flanks and in the rear. There were very few instances where they were not let off in time and the sentries posted over them apparently knew their jobs better, for instance, than one man who was questioned on the subject. This particular sentry was asked by a noncommissioned officer going the rounds in the trenches what he would do in the event of a gas attack being made. "Oh," replied the bright boy, "that's easy. If any gas comes over it blows the horn and I call the platoon sergeant and tell him about it."

A much more conscientious sentry over a Strombos Horn had been told to be particularly on the lookout for a gas attack, as one was expected at any time. The officer on duty, going round about midnight, heard a

suspiciously regular sound coming from one of the fire bays, and thinking that one of the sentries was indulging in a stolen forty winks he cautiously rounded the traverse. Here he found the sentry lying on the top of the parapet staring into the darkness and going sniff, sniff, sniff with his nose.

Being asked more forcibly than politely what was the matter with him the man replied: "I'm sniffing for gas."

Sniff, sniff, sniff.

"Can you smell any?"

"No, sir; but I want to smell it if it does come, as I'm a gas sentry and the leftenant told me always to keep smelling for gas."

Sniff, sniff, sniff.

The job of seeing that the air cylinders of the Strombos Horns are kept at their full pressure is intrusted to the divisional gas noncommissioned officers, who go round periodically with pressure gauges and test them out. If they fall below a certain pressure they are replaced at once by fresh ones from the divisional store. Some Australians going up the line one night were carrying a number of such cylinders for replacement, when one of them got turned

on accidentally and they didn't seem able to stop it.

A passing officer hearing the hissing noise called out: "What have you got there?"

"Air bottles," was the answer.

"What for?" persisted the officer.

A pause, and then out of the darkness: "Oh, hell! To put the wind up the boche, of course."

This story will probably be appreciated more by Britishers than Americans, though I think the latter in many cases already know the significance of the expressions "getting the wind up" and "putting the wind up." They refer of course to what official reports or newspaper men would style as "reduction of morale."

CHAPTER VI

The last German gas cloud sent over August, 1916—Its intensity—"Delayed" gases of phosgene gassing—Cigarettes as a test of gassing—Dangers of carelessness—The sprayer abandoned for Mrs. Ayrton's fan—Respensibilities of the divisional gas office—Russian gas victims—The day of the gas cloud over.

THE last German gas cloud to be discharged against the British Front was in August, 1916. In every way it was the greatest test to which our men had been put. It was the strongest cloud attack the Germans had made—not only were the individual waves of only ten minutes' duration but the boche had more cylinders in his line than usual. According to his own admissions the bottles were put in at the rate of three every two yards and in some places two per yard. Added to this he had brought up the proportion of phosgene to the maximum that can be used. The circumstances, too, were very unfavourable to us. It must be remembered that the Battle of the Somme was in full swing, and that

for once in its war history the Ypres salient, where the gas attack took place, was a "quiet" sector where divisions used up in the battle went to "rest" and reorganise. The result was that the divisions attacked were composed very largely of fresh drafts. They had lost very heavily in officers and most of the company noncommissioned gas officers had been knocked out. Their gas training was therefore not at the high standard that it had attained previous to the battle.

Added to this, a relief was going on in the trenches. This, by the way, was the second time that our fellows were caught by a gas attack during a relief. Whether it was that the boche intelligence was particularly good or whether it was simply that his luck was in is not certain, but it meant that our trenches, both the front line and the communication trenches, had just twice the number of men in them that they would have had normally. And every man, both incoming and outgoing, was carrying his complete "Christmas Tree" rig—rifle, ammunition, full pack, haversack, greatcoat, gas masks, and all the rest of it; in some places hardly

able to squeeze through the trenches in his bulky marching equipment.

Into this congestion the boche let off his gas on the eighth of August about ten o'clock P. M. It says worlds for the steadiness of our fellows that the total casualties from the three waves he sent over remained at the same low ebb that they had reached in the June attack. Of course but for the adverse circumstances they would undoubtedly have been still lower. It is interesting to note that the position on which the attack was made—namely, the line between Bellewarde Lake and the Yser Canal—included much of the line over which the first attack of all had been made a year and a half previously.

The intensity of the cloud can be realised from the fact that helmets had to be worn at a division headquarters nine miles from the point of discharge, and the gas was perceptible, though not so dangerous, many miles beyond this point.

The most distinctive feature of the whole affair was the number of men who suffered from the delayed action of the phosgene and collapsed several hours after the at-

tack, especially if they had taken any exercise or eaten a heavy meal in between. The latter is not very likely, though it does occur, for a man even slightly gassed with phosgene feels very depressed—"fed up" and not particularly inclined for a hearty meal. But the getting of the exercise is only too easy, what with the necessary work in the trenches and the possible walk back to the aid post or the march back to rest billets in the event of a relief. It was men who had done this kind of thing who suffered most.

After the attack we received official orders that no man suffering from the effects of the gas should be allowed to walk to the dressing station, and that if possible after a gas attack troops in the front trenches should be relieved of all fatigue and carrying work for twenty-four hours. It was also ordered that during the passage of the gas all movement should be reduced to a minimum and there should be as little talking as possible. These were very wise orders, for there had been too many officers and noncommissioned officers gassed through moving up and down to control the

positions of their men and from shouting orders through their helmets. A certain amount of talking is necessary, of course, but too much of it makes a man breathe more deeply and may be just the added strain sufficient to affect his heart and cause his collapse.

Of course after a gas attack there are always a certain number of malingerers—"Skrimshankers," as we call them—who affect to be gassed in order to get away from the line for a bit. These are generally spotted easily enough by the doctor men. One medical officer I knew, harassed by the number of slightly "gassed" cases who would have to be evacuated, and suspicious about the genuine character of some of them, handed round cigarettes. All those who accepted and smoked their cigarettes were kept back. Later examination showed that he was right in every case.

A similar instance that I heard of, this time in a practice attack in a camp in England, concerned a very poor specimen who pretended to be badly gassed. He was taken to the orderly room on a stretcher; but unfortunately for him the medical corps

sergeant recognised him as a man who had fallen out during a march a short time before, and knew all about him.

Meantime the man was feigning unconsciousness, but the sergeant winked at the medical officer and said: "It's a pity that order about sick leave prevents men from going home in a case like this unless they live in London. What this poor fellow needs is a couple of weeks in his own home."

The corpse thereupon sat up and said: "That's all right, sir. I live in Bow. When can I go?"

As in all the previous attacks an analysis of the casualties showed that where the helmets had been kept in good condition and had been used properly and in time they had given perfect protection. The casualties were all due to preventable causes —some of them lamentable, others humorous, had it not been for their tragedy.

Many men were gassed through taking off their helmets too soon. It is really up to the officers and noncommissioned officers who have attended a course at a gas school to decide when the atmosphere is safe, and it is not nearly so risky to do this as it

sounds. All that is necessary is to let a little air in from the outside by cautiously opening up the face piece of the mask—or the skirt of the helmet in the case of the old gas bag—and sniffing cautiously. Of course if it is not done cautiously and there happens to be a lot of gas about, the rash man suffers.

A number of men were gassed through going into unprotected dugouts before they had been ventilated or through wandering into pockets of the gas after the attack. They should have been on the lookout for these patches, as the gas notoriously keeps close to the ground at night, and sheltered places are bound to remain unhealthy for much longer periods than the open. It is curious that by some vagary of the wind the cloud farther back hopped over some houses that were used as billets and affected neither the inhabitants nor the unprotected animals on the ground, whereas some fowls that were roosting in the trees and on the tops of the houses were killed.

One instance that shows how carelessness spells casualty in gas warfare was that of a working party of thirty or forty men who

were busy on railway work a mile or two behind the line. They had taken off their coats and gas helmets and placed them on some trucks, but when the alarm was given and a rush was made for the helmets the trucks were found to have gone.

One thing that was done after the August attack was definitely and finally to withdraw the Vermorel sprayers for use for clearing the gas out of the trenches and dugouts. These instruments, brought up for the work of spraying fruit trees and vineyards, had done some first-class fighting of the German gas, right in the front line, as long as the gas was chlorine. But with the introduction of large quantities of phosgene the work of the sprayers was gone. They could not touch the phosgene, and consequently Tommy's dependence on them was a snare and made things more dangerous for him than if they had not been used at all. For a dugout might be sprayed and thought, therefore, to be quite healthy to sleep in and yet contain as much phosgene as would at any rate cause minor and delayed effects.

To clear out the gas recourse was had to

ventilation by means of fires and by specially constructed canvas fans.

These fans were the invention of an English lady namedAyrton—the widow of the physicist of that name—and were originally intended by her for fanning back the gas cloud to the German trenches. Of course they were quite incapable of doing any such thing, but during trials with them it was found that they were quite good, after an attack, for fanning the gas out of the trenches or creating such a draft of air into a dugout or cellar as to force out the impure air from the interior.

These anti-gas fans, or flapper fans as they were called, are made of canvas supported by braces of cane and attached to a hickory handle about two feet long. The blade of the fan, which looks like an immense fly swat, is hinged in two places and measures about fifteen inches square. When the fan is brought down on the ground it bends over on the back hinge and produces a sharp puff of air, in just the same way that the sudden shutting of an open book does.

By working the fans in series, one man behind another, it is possible to keep a

current of air going which will ventilate a room or clear out a trench in remarkably quick time. In clearing out a trench the fan is brought back over the shoulder, and this helps to "shovel" the contaminated air out of the trench after it has been brought off the ground by the lower stroke, which is more like a smart slap.

These fans are kept as trench stores, which means that they are handed over on relief to the incoming unit taking over the line of trenches. They have proved very useful, especially in skilful hands their chief value being that, unlike the sprayers, they do not distinguish between different kinds of gases and they will deal as unceremoniously with tear gas and phosgene as they do with chlorine.

By the time of the last gas-cloud attack the organisation of the British Army for defence against gas had been brought to a pretty high state of efficiency. A special branch of the gas service had been detailed for the purpose and special gas officers were appointed to the staffs of the various formations, from army down to division.

The position of divisional gas officer is

no sinecure. Besides having the job of screwing up the gas discipline of his division and having a general oversight of all gas-defence training and supplies, he is responsible to the divisional commander for the preparedness of the line to meet a German gas attack. He is the "intelligence" officer of his general as regards all things pertaining to gas and has to be a walking dictionary on the subject. He has to be a great part of his time in the front trenches and it is up to him to see that all enemy blind shells, and so on, are examined and brought in if they seem to be anything new. As he must deal direct with the battalion commanders he must know them and the senior officers of each regiment personally, so as to smooth the way in getting things done. Then if a gas attack or bombardment is made he must get there quick, so as to find out all about it from personal experience.

Altogether he is a very important and busy person, and to those acquainted with his work the following incident will appeal. I happened to overhear part of a conversation between two Cockney Tommies on the road:

"What's this 'ere divisional gas officer, Bill?"

"Why, he's the bloke what goes round and blows up these observation balloons."

The divisional gas officer has a number of specially trained noncommissioned officers to help him, and each company of infantry and battery of artillery has at least one noncommissioned officer. It is the first and most important job of these noncommissioned officers to help the commander in everything pertaining to defence against German gas. He assists at drills and inspections, help in the arrangement and fitting up of alarms, in the taking of wind readings and the protection of the shelters and dugouts. In his charge are placed the gas fans and the sampling apparatus. A good company gas noncommissioned officer is a real joy and can polish up the gas discipline of the company tremendously, as well as take a lot of responsibility off the overworked company commander's shoulders. A bad noncommissioned gas officer, on the other hand, can be the direct and indirect cause of the loss of many lives when the gas attack does come.

This ended the British experience of German gas-cloud attacks, for though the 35th and 36th Pioneers made three subsequent visits to the Western Front it was each time to gas the French. The last cloud attack of all was made near Nieuport, at that time in the French lines, on April 23, 1917.

Since then the only cloud attacks have been made against the Russians and the Italians.

Probably the chief reason that has caused the boche to hold back with his cloud attacks has been his conclusion that they were unprofitable against well-disciplined, highly trained and thoroughly protected troops. With a limited amount of gas available he naturally chose the method that would give him the best results. For the cloud attack his cheapest target was the Russians, who were incompletely equipped with gas masks of a modern kind and who for a long time were badly disciplined in anti-gas measures. Against such troops the gas cloud is just the thing, and the Germans have estimated that ten to fifteen per cent of all troops exposed to a successful gas cloud would become casu-

alties. This was probably true on the Russian Front, but was certainly not true in the West.

Then the gas cloud has almost reached its apparent limit of development. There is a limit to the number of gases that can be used from cylinders, and there is a limit to the number of cylinders that can be discharged at one time. Besides this the gas cloud is largely dependent on infantry labour for carrying and installation, and it is mighty difficult to bring off a complete surprise owing to the time it takes to prepare an attack.

On top of all this the whole procedure is wrong as regards efficiency, for it puts up the highest concentration of gas where the boche does not want it—just in front of his own trenches instead of in ours.

For all these reasons the boche during the past year has specialised on the development of his gas shells. Of course he may come back with the cloud again, and we do not relax our vigilance or it certainly would reappear. But unless he discovers something new in the cloud line, and if we keep

up a high standard of training, he will not do much damage, though for that matter the same thing is true about gas shells and trench mortar bombs.

CHAPTER VII

The rising importance of the gas shell—The variety of gases practicable with the shell—The deadly Green Cross Shell—Risks of transporting "duds" for chemical analysis—Reduced Allied casualties—German blunders in shelling tactics—Importance of universal discipline.

ONE of the most interesting things about the development of gas warfare has been the way in which the gas shell, from being the least important method of poisoning the air, has become the chief gas weapon in the German armoury.

The reasons for this extraordinary development, though various, are not far to seek. They lie chiefly in the fact that unlike the gas cloud we have not even yet approached the limit of the number or size of the gas projectiles that can be used. Nor, which is even more important, is there any limit to the variety of the poisons that can be used in gas shell.

The fact of the matter is that the gas shell

is not really a gas shell at all. It is nearly always a "liquid" shell and sometimes even a "solid" shell. The term "gas shell" is used because the liquid or solid contents are atomised by the explosion of the bursting charge or are distributed round in the form of such tiny particles or droplets, as the case may be, that they act almost as a gas. In the latter case they form what might be described as a mist or smoke, but with this difference from ordinary smoke—that the gas mist or smoke is generally, though not always, invisible.

Just imagine what would happen supposing a shell were filled with water. Burst such a shell with a sufficiently big charge of high explosive and all the water would be distributed into the air in the form of such finely divided spray that it would form a mist. This mist would either vapourise into the atmosphere completely or hang about like a cloud, according as the air was dry or moist. In any case, if the burster were big enough no water would be spread on the ground; nor would any big drops be formed.

This is just what happens with any of the poisonous materials filled into a shell. In-

deed if the burster were big enough and carefully chosen it would be possible to form a "gas" with treacle. With a volatile material like gasoline on the other hand all that would be needed would be a burster just big enough to open the shell.

It can be seen therefore that the choice of materials for gas shell is practically unlimited and is governed only by their being poisonous enough and by the ease of production.

Another thing in which the gas shell has the advantage over the cylinder gas is in getting surprise, which is naturally much easier to effect with shell. By the way, if the reader wishes to be counted among those who knows, he will always speak or write the plural of shell without adding a final "s." To talk of a number of shells is very civilian.

As I pointed out before, we were expecting something new to happen in the gas-shell line during the whole of 1916, and had an idea that the new arrival would be something of a cyanide nature—possibly prussic acid itself. When it did come, however, it proved to be a liquid filling closely related chemically to phosgene and to the K-Stoff,

which I have previously described. These new gas shell were the first of the present series of German gas shell, which are all distinctly marked with coloured crosses and named accordingly. These particular shell were the Green Cross Shell, a green cross being painted on the base of the cartridge or on the side of the shell or sometimes on both. They made their appearance on the Somme Front about a fortnight after the battle had started—that is, about the middle of July, 1916—though a few of them had been used against the French on the Verdun Front sometime in June.

It was not long before blind or unexploded shell—"duds," we call them—were collected and sent back for examination. This is one of the disadvantages of using gas shell—your opponent can always keep track of what you are doing. Sooner or later a fuse will not function or a bursting charge will not explode and your watchful enemy carefully collects the shell, and has for examination a considerable amount of the poison material. I say "carefully collects," for it is no child's play dealing with shell which may go off in your hands

on the slightest provocation. However, it has to be done, and as it is the gas officer's pidgin he manfully shoulders his task and the shell and has it brought in. Very frequently the fuse fails to act because a powder pellet holding up the striking needle has not burned away; but I remember one case where the gas officer of one of the armies took back a big dud gas shell. It meant transporting the weighty souvenir in a not particularly well sprung car over very bumpy roads, and he was quite relieved to arrive at his destination—the field laboratory. Here it was reverently taken to bits by the experts. Imagine the gas officer's horror to find he had been bumping along for several hours in the company of a shell the powder pellet of which had burned away and whose only safety device was the weakest of weak creep springs on which the striker rested. A hard knock or a drop of six inches would almost certainly have exploded it.

The laboratory officers, who are experts at the game, may have to go up to the Front themselves to solve important duds which are regarded as dangerous and require ex-

pert attention. In one instance the officer concerned—in civil life a very celebrated professor at one of the London colleges—went up to the salient and explored about a mile and a half of trenches and finally located his prey—a fine dud 4.2-inch howitzer gas shell—out in the open.

Though the place was pretty unhealthy he "climbed the bags" and made a careful examination of the shell where it lay, finally bringing it back in with him. I forget whether he drew its sting on the spot, but in any case it was a pretty good effort, especially for a man no longer in his first youth.

Chemical analysis of the blind Green Cross Shell showed the contents to be a colourless liquid known to chemists by the extensive name of "trichlormethylcholoroformate." Its effects are just as ferocious as the name implies, and experience showed it to be very poisonous. Indeed it is as poisonous as phosgene itself. The Green Cross Shell gas—"diphosgene," to give it its short name—has many effects and symptoms that make it a dangerous weapon. When dilute it has a peculiar though not particularly nauseating smell, a smell variously de-

scribed as "earthy," "mouldy rhubard"—whatever that smells like—and damp hay. Unlike the shell gases we had encountered before, it has very little effect on the eyes and causes practically no lachrymation. And this was a trap, because we had been used to lachrymators, so that many men despite the obvious smell were not particularly quick in protecting themselves because of the new symptoms.

Of course this applies only to such low concentrations as would take a long time to gas a man. In the higher concentrations the Green Cross very quickly asphyxiates—just as phosgene and chlorine do—and there is no question of whether it is deadly or not. The old Army quip about there being only two kinds of people in gas warfare, namely "The Quick and the Dead," certainly applies if you get a Green Cross Shell bursting close to you. But even for gas shell bursting some distance away immediate and complete protection is necessary because of the delayed or after effects of the gas, which are exactly similar to those of phosgene. Every care that is taken with regard to men

poisoned with phosgene has to be taken for men poisoned with Green Cross gas.

Those suffering from the effects of the gas are not allowed to exert themselves at all or to take heavy meals. They are kept under close observation for at least two days, and are treated, in fact, as casualties even though they are not apparently ill. Before the need for this was understood an officer I knew was slightly gassed with shell gas but thought nothing of it. Later on he felt a bit queer, and the regimental medical officer advised him to go down to the dressing station. He walked the length of the communication trench and then mounted a "push bicycle" for a mile's ride to the aid post. The exertion was too much, however, and he reached the aid post only to fall dead.

The danger of not treating gassed men as casualties and resting them for a couple of days, after which they would probably be fit for work again, is shown by a case where forty men were lost to the line for a considerable time, though fortunately none of them died. These men were part of a working party engaged in the construction of dugouts. They were caught in a surprise bom-

bardment, but were apparently not much affected. After completing their night's work they marched back to billets and turned in as usual. The next morning several of them were so ill—nearly to the point of collapse—and the remainder were so visibly affected that the medical officer ordered the whole party to be sent down to the casualty clearing station, where they were evacuated to the base.

In still another case I remember a sergeant and twenty men of a wiring party engaged in the consolidation of a recently captured position were similarly caught by a sudden and intense Green Cross bombardment. A number of the men were gassed and felt pretty seedy, but continued their work and then withdrew. The sergeant felt no ill effects until an hour after turning in, when he woke with a bad cough and internal pain and died two hours afterward. One private went to bed without complaining at all and was found dead next morning. Another died soon after getting up. A third reached headquarters complaining of shell shock and died three hours later. I mention these cases so that my reader will

realise why such great care is now taken with men who have been exposed to poison gas, and how by looking after them in this way it has been possible to reduce the number of delayed cases of death or serious illness to a minimum.

Talking of delayed effects of gas shell reminds me that at least two documents were captured during the Somme—one of them I got myself—which were obviously notes of lectures given to officers at a German gas school or staff course. In both of these sets of notes there were references to the Lusitania, showing that the German Higher Command was trying to explain that dastardly act to its own troops by making out that the Lusitania was sunk because it was carrying phosgene shell for the Allies. This lie can easily be nailed to the board, as not a single drop of phosgene—or any other poison gas or liquid, for that matter—was shipped from America before this year, 1918. Both of the paragraphs I refer to contained a double lie, for they each asserted that the French started the use of gas shell. One of them ran as follows: "The French first started the use of gas shell—

with great hopes, but with little success! The most striking result was that experienced by the passengers of the Lusitania, whose rescued mostly died later."

But to return to the Green Cross Shell. These were used during the Somme Battle in enormous numbers, far surpassing anything we had had before in the extent of the bombardment. There were a great many new features about these shell quite apart from the altered nature of the gas. First of all there was the size. Until then we had had gas shell of only two sizes—150-millimetre howitzer shell and the 105-millimetre howitzer shell. The former contained from five to eight pints of liquid according to the construction of the shell, and the latter about three pints. To these longer shell were now added shell from the ordinary field gun, or 77-millimetre gun—quite a small affair compared with the others and containing only two-thirds of a pint of liquid poison. But then, though so small, it could be fired more rapidly and accurately and could bring off an initial surprise in a way that the bigger guns could not do.

Shell of these three sizes were used then

on nearly all occasions and in very large quantities. One thing that made large numbers possible was the simplicity of the shell compared with the old pattern. There was no separate lead container and the "gas" was filled straight into the body of the shell, as the new material was unacted on by iron or steel. The head of the shell was screwed in and kept in position and perfectly gas-tight by means of a special cement.

As very little explosive was needed to open them up and spread the contents round the noise made by the burst of the Green Cross Shell was little more than a pop—at any rate when compared with the high-explosive shell or the old tear shell. The result was that at first men were apt to regard them as duds and to delay the putting on of respirators until it was too late.

These gas shell are supposed to make a peculiar wobbling noise in the passage through the air because of the liquid inside them, and in this way to be recognisable beforehand. Personally I cannot tell any difference in the noise compared with H. E. or shrapnel of the same calibre, though I have heard thousands of both kinds; but I

dare say some people can, as the belief is fairly widespread.

Of course Fritz's liberality with his gas shell caused us a lot of casualties, but not nearly so many as we might have had if he had known how to use them. The fact was he had not at that time got hold of the proper technic—developed later on by the French—of concentrating his gas shell on special targets. By now, of course, he has; but at that time he still clung to the idea of being able to poison big areas with his shell gas by putting down a series of barrages over the country to be attacked. Either he had not enough shell or he chose his areas too big, for he did not produce effective concentrations anywhere but locally. If he had, our losses might have been tremendous. As it was it became rather a hit-or-miss proposition, and I have seen hundreds and hundreds of these shell drop into absolutely unpopulated areas of the devastated Somme battlefield.

In one case a battery of field guns came in for its share of one such promiscuous bombardment while I was there. The number of shell coming over was so great that

it was like a magnified machine-gun shoot, but only a very few got on to the battery and the casualties were only two—both caused by a direct hit on one of the guns by a gas shell. If the boche had been able to concentrate his shell on and round the battery instead of giving it just the same amount as the unoccupied surrounding country the effect might have been very different.

One possible reason for the promiscuous and sometimes very casual shooting may have been the fact that the boche at that time had practically no air observation. Our flying fellows had temporarily chased his planes out of the skies and had shot down all his observation balloons. This made it impossible for him to pick his targets, and he either had to bombard the countryside or shoot "by the map," neither method being particularly conducive to good results with gas shell.

On the other hand, one or two places that he knew were pretty certain to be occupied by our troops were given their full dose. One such place was Caterpillar Wood—a big narrow spinney running off from the Fricourt Valley and so named because of

its shape and the fact that on the ordnance maps, on which the woods are colored green, it looks just like a green caterpillar crawling over to the shelter of Mametz Wood. This place was continually shelled with large numbers of the Green Cross Shell, and as it stood in the side of a valley the gas persisted longer there than elsewhere and built up a tidy concentration which caused a lot of trouble.

The gunners were among our chief sufferers from these gas shell, as their guns were so frequently placed in sunken roads and folds in the ground for protection against explosive shell and aërial observation, and these were just the kind of places that held the gas longest. In the open much less damage was done. I remember one night the first-line transport of a battalion of the Black Watch ran into a patch of country into which the boche was raining 77-millimetre Green Cross Shell, and came out with only three casualties, two of which were from a direct hit on one of the wagons, the driver being killed instantly.

It seems particularly bad luck to be killed by a direct hit from a gas shell, for the bits

of shell that fly about don't do much damage in the ordinary way and don't travel great distances. Indeed it is remarkable, even in the biggest gas-shell bombardments, how very few men are hurt by the fragments.

The first week or two after the advent of the Green Cross the toll of gas-shell casualties was considerable if not alarming, but steps were immediately taken to get the situation in hand. It is in a case like this, where a surprise had been brought off, that Discipline, with a very big "D," counts for so much. Fortunately the gas discipline of the British Army was pretty good, and it was not difficult to get new instructions carried out and orders obeyed. Once they got going their effect was most apparent and the gas-shell casualties dropped from week to week until they approached a minimum.

Among the important steps that were taken were a revision of the methods of spreading the alarm, and the protection and clearing out of dugouts into which the gas had penetrated.

Mention has already been made of the slight noise caused by the explosion of the gas shell, and instructions were accordingly

issued that all shell that sounded like duds were to be regarded as gas shell, and the respirators adjusted accordingly. This got over one of the elements of surprise.

A great many men, especially those in battery positions, had been gassed in their dugouts before warning of the gas bombardment had been spread. Numbers of these men were actually gassed in their sleep and were awakened too late by the choking fumes themselves. What was done was to post a gas sentry at every battery in just the same way that it was done in the trenches. Special local-alarm signals were arranged so that the sentry could wake every one in the neighbourhood without having the alarm spread beyond the limit of the gassed area. These alarms generally took the form of bells or of gongs made from big shell cases; but later on policemen's large rattles were found to be the most effective "weapon" for the purpose, and numbers of these were distributed up and down the line and in the battery positions. It was feared at first that the noise of the rattles would be mistaken for machine-gun fire and no attention be paid to it, but this did not ma-

terialise and the rattles have done good service.

The only thing about them is that they are made of wood—and nicely pickled, easily burning wood at that. In the trenches kindling chips of any kind are eagerly sought after to make a miniature fire to warm tea or cook an egg. When men will go the length of shaving the handles of their entrenching tools to obtain dry wood it could hardly be expected that policemen's rattles would always be respected. I am afraid a number of them disappeared. With the artillery things are not so bad as fuel is easier to obtain and the rattles are therefore less liable to get lost

CHAPTER VIII

The gas-proof dugout—First-aid methods of alarm—Von Buelow improves German gas tactics—Popular errors about gas—Effectiveness of new British repirators—Vomiting gas—Germans speed up their manufacture—Gas as a neutraliser of artillery fire—As a neutraliser of work behind the trenches—Raw recruits ashamed to wear the mask—Casualties resulting.

PROBABLY the most important thing that was done as the result of the Somme Battle experience was to insist on there being at least one protected or gas-proof dugout at every headquarters, battery position, signal station, aid post, or wherever gas shell were particularly likely to drop.

I have deferred describing these protected shelters until now, but as a matter of fact they had been devised and adopted nearly a year previously, though not many of them had got into actual use. The protection consists essentially of a damp blanket fitting closely over the entrance to the cellar or dugout or emplacement, which-

ever it may happen to be. The value of the blanket depends on the fact that if you prevent the movement of air you prevent the movement of gas. That is all there is to it. Stop any possible draft and you will keep out the gas. In practice the blankets are kept rolled up out of the way and are let down only when the alarm is sounded or when gas is about. In order to get an air-tight joint the blanket is made to rest on a sloping framework set into the entrance to the dugout. To make sure that the blanket really does remain stretched out over the frame and does not gape at all, two or three wooden battens are fastened across it at intervals.

Where space is available two such sloping blankets are used, at least two feet apart and preferably far enough apart to allow a stretcher in between. This forms an "air lock"—you must go into the lock and close the outer blanket before going through the inner one—and not only makes protection of the interior doubly sure but makes it possible to enter the dugout even in the middle of an attack or bombardment. In the old days the blankets used to be sprayed

with the Vermorel sprayer solution, but anything that will keep them damp and flexible will do. In the early days, too, the companies or batteries used to do all their own work on protecting dugouts, and it was always possible in cold weather to obtain an extra supply of blankets on the plea that they were required for making gas-proof shelters. Nowadays a close eye is kept on these supplies, which are doled out by the engineers, and it is seen that if blanket material is supplied for protected dugouts it is going to be used for protected dugouts, and for nothing else.

Gradually all dugouts, cellars and buildings within the gas-shell area—let us say up to three miles from the front line—are being provided with blanket protection, which means a big decrease in casualties, for once inside such shelters men can sleep in more or less comfort until they again have to don their respirators and face their tour of duty in the poisoned air outside.

It practically came then to this—that protection against the poison-gas shell was a question of gas-proof dugouts on the one hand and rapidity of spreading the alarm

and quickness of getting protected on the other. At the gas schools and in the regiments and batteries men are trained to be so quick in their movements that they can get on their masks in six seconds. They are also taught on the burst of a gas shell in their neighbourhood to hold their breath at once. It sounds easy enough to do this, but it must come to a man automatically in any circumstances he may happen to find himself—and you can find yourself in some queer circumstances in war—and to assure this a great deal of training is needed. Anybody, however, can hold his breath for thirty seconds, and with practice it is possible to go well over a minute. During this time it is possible to make a fool of oneself in half a dozen different ways in putting on a respirator, and yet get it on in time in the end. But drill sergeants will stand for nothing less than the standard time and the most meticulous accuracy. God bless these tyrants—they must have saved a lot of lives! One of the difficulties we began to encounter with regard to gas shell was the spreading of the alarm among men on the march or in communication trenches where no alarm de-

vices are installed. In some battalions it was the custom to teach men to spread the glad tidings by taking off their steel helmets and beating them with their bayonets. This certainly makes a good old noise, but unfortunately it is just when gas shell are coming over that shrapnel is also likely to be in the air, and to deprive a man of this tin hat at this time in order to provide him with a gas alarm is rather robbing Peter to pay Paul.

The best way undoubtedly, and the one now taught throughout the British and American forces, is to hold the breath, then put on the respirator, and finally spread the news to everyone else by shouting "Gas shell!" as loudly as possible with the mask on. In this way the information can be spread throughout a big working party or from front to rear of a column of infantry on the march in a remarkably short space of time. Even in the trenches it is well to give word-of-mouth warning as well as by means of the local alarm devices, for a second or two of absolutely invaluable time may be saved in this way. One soldier questioned by an officer going the rounds as to what he

would do in the event of a gas shell bombardment replied nervously: "Put on my gas mask and shout 'Rattles!' "

For the remainder of 1916 the boche treated us with gradually increasing numbers of Green Cross Shell. His tactics, too, got a bit better—I mean for him—for he began to make more concentrated bombardments on particular targets. Possibly this was because of special orders that were issued on the subject. One of these was by General von Buelow to the artillery of his army, in which he said: "There have been many instances of Green Cross Shell being fired in small quantities. This is a waste of ammunition, as with all gas shell good effects are only obtained by using them in large quantities. The firing of small quantities of gas shell has also the disadvantage that the enemy is practiced in the use of his anti-gas appliances and attains a higher degree of gas preparedness. For this reason the effect produced by larger quantities will be reduced."

This showed the increasing interest in the use of gas shell taken by the German General Staff, and heavier and more concen-

trated bombardments based on the above orders became more frequent. One of these, brought off in unusual circumstances, occurred at Arras in December, 1916. I say "unusual" because the weather was so cold at the time that the Green Cross liquid did not evaporate so quickly as usual but hung about in some places for long periods. The bombardment occurred at night and about three thousand shell must have been fired into one corner of the town—in fact, all round the old gateway through which the whole of the transport from the St. Pol road would have to pass. The surrounding houses and cellars got filled with gas, and in such billets, especially where shell had actually burst inside a room, the liquid soaked into the walls and floors and only evaporated the next morning when the air grew warmer. A lot of men were gassed in this manner on the following day, as they naturally thought the gas had vanished, and were gradually overcome as things warmed up.

In the open, gas disappeared more at its usual rate, though it hung about all during the bombardment and for several hours after, thus forcing men in the neighbourhood

to wear respirators for long periods. Some of these men, overcome by fatigue, actually slept in their respirators. I think this was the first time I had heard of its being done, though it has been done often enough since.

By this time the British Army had been fitted out with the celebrated box respirator—a respirator of particular interest to Americans, as it was the type adopted for and at present in use in the American Army. A short description of it will not be out of place. The principle of the respirator is to have a box filled with chemicals and attached by a flexible tube to a face piece or mask, which fits closely to the face. All air breathed by a man must therefore pass through the chemicals, and these are so chosen that they will absorb any and every poison that may be present in the atmosphere at the time. In order to keep the air pure in the mask and to have a double line of protection a man breathes through a special mouthpiece and has his nose clipped. So even if the face piece, which is made of rubber cloth, should be torn or damaged in any way the soldier is perfectly safe as long as he does not attempt to talk—that is, if

he keeps his nose clipped and does not remove the mouthpiece from his mouth.

The respirator is not only active against a diversity of poisonous gases but it will keep out very high concentrations of gas for many hours.

One of the most misleading statements made about gas masks—sometimes by newspaper men and consequently given wide publicity—is that such and such a mask will stand up for so many hours against gas. It is a very natural thing to want to know or to state how long your respirator will last, but without stating what concentration of gas is being talked of it is impossible to give such definite information about any mask. It simply depends on the amount of gas there is in the air. But the box respirator if kept in good condition and properly used is guaranteed to keep out German gas continuously for many hours, even in concentrations which it is quite impossible for the boche to maintain in the field. In the American modification of the box respirator the absorptive power of the chemicals used is even greater than in the British box, and this makes it the best respirator in the

world, which is very reassuring for those who have to make use of it.

The box respirator is contained in a haversack and is carried slung on the shoulder until such time as the soldier comes into the forward areas, where it must be carried tied up on the chest ready for instant adjustment in case of need. As I mentioned before, it can be put on in six seconds from the word "go," and once a man is practiced in wearing it he can walk, run, shoot, dig, speak or do anything but eat and smoke in it; and this for long stretches at a time. I know many cases where men have been forced to wear masks literally continuously for more than eight hours; and much longer periods than this, with perhaps short intervals of rest in protected dugouts or in unaffected areas, are common.

Of course the soldier has to be practiced in putting the mask on quickly. It is not quite so simple as the old "gas bag," about which a drill sergeant said to a squad: "You just whops it out and you whops it on." But it does not take long to make men proficient with the respirator, at any rate on the parade ground. It is making him proficient under

conditions of war that counts and all his instruction is now aimed toward this end.

With the mask in position and a tin hat on top of his head a soldier has a peculiar beetlelike appearance, which is not very improving, though the following conversation was reported to have been overheard by an officer about to enter a dugout:

" 'Ere, mate, take yer gas mask off."

"It is off."

"Then for Gawd's sake put it on!"

The Germans were much interested in our new respirators and their development, and apparently had great difficulty in obtaining specimens for examination. During the winter of 1916-17 German soldiers were being offered a reward of ten marks for every British box respirator that they brought in; but as we were doing most of the shooting at that time I can hardly think that Fritz made a fortune out of his chance.

But to return to the gas shell. During 1917, it became apparent that the Germans were placing more and more reliance on the use of gas shell and were manufacturing them in enormous numbers. For a whole year after the introduction of the Green

Cross there was only one modification of the chemicals used and that was the admixture with the diphosgene of a material which has been called "vomiting gas." This substance is a chemical named chloropicrin, and it certainly lives up to its pet name if you take a real good breath of it. The boche mixed it with his diphosgene in order to make the latter more potent if possible, or else because he was running short of diphosgene; but he still calls the mixture Green Cross and uses the gas for its killing power.

The chief development, however, was rather in the tactics than in the chemicals used. Gas shell were no longer thrown away; each target or area was apparently considered separately and was given enough shell to make certain of putting up a very high concentration of gas on it. At this time the boche divided his gas-shell shoots into two classes—those for "destructive" effect, and those for "harassing" purposes.

The destructive fire was intended to take on big targets, which were not only definite but were known to contain living targets—for example, concentration points where

troops were bound to be gathered; billeting areas, including well-known villages or towns; areas known to have a number of batteries collected in them, and so on; in the latter case the batteries themselves would be taken on individually if their positions were known.

Apart from a number of fairly big bombardments, like that at Arras, mentioned above, the destructive shoots were chiefly counter-battery ones, intended if possible to "neutralise" our artillery while it should be actively engaged in putting down a barrage, either to prevent a German attack or in preparing the way for our own infantry when we were attacking, which, of course, was much more frequently the case in 1916 and the first half of 1917.

This neutralisation business wants a bit of explaining. It will have been realised that the Germans were and still are using two very distinct kinds of gas shell—those which kill, like the Green Cross, and those which only temporarily put a man out of action, like the lachrymators and nowadays the mustard gas. Of course, the idea underlying the use of gas shell in general—and

the whole war for that matter—is to put men out of action. The most effective way of doing this is to kill, as that puts a man out of action for good and he doesn't return. But you can kill men with gas only by taking them by surprise, because of the excellence of the gas masks.

After the surprise has been effected the chief use of the gas shell is to force the opposing side to continue wearing their gas masks and in that way to hamper them and reduce their fighting efficiency for considerable lengths of time. This is where the lachrymators and mustard gas and similar stuffs come in, because they are very persistent, and a little goes a long way in forcing a man to keep his respirator on. The quick-killing gases, like phosgene and the Green Cross, are not very persistent, and it would be waste of material to continue shooting them when you could effect the same thing with another stuff, which would hang about for hours or perhaps for days.

Now see how this affected the German "fire for effect," or destructive shooting, as applied to a battery, and why the gas shell are so particularly suited for taking on

targets of this kind, which used to be engaged only by high-explosive shell. Imagine a battery of, let us say, field howitzers. Our men are making an attack. The howitzers are busy pounding the German trenches to bits, and then they are going to "lift" on to the support trenches when our men go in. The whole of the success of the infantry assault may rest on the guns' keeping up to the program with the requisite amount of fire. The boche business then is to try to put our guns out of action. If he can do this he has the infantry—I won't say at his mercy, but at any rate at such a serious disadvantage that their losses will be tremendous compared with what they would be under cover of a good barrage from the guns.

Now if the enemy uses high-explosive shell to take on our batteries he can put them out of action only by registering a direct hit. If the guns are well dug in in good emplacements with head cover it will be possible for high-explosive shell to drop within a dozen yards without doing anything but scare the gunners. Not so, however, with the gas shell. Drop enough gas shell within a dozen or

twenty yards of the battery position and the gas will float down with the wind and penetrate every nook and cranny. If the gunners are not quick some of them may be gassed; and if, as is sometimes the case, the gun has been worked short-handed this alone may throw down the rate of fire to a very considerable extent. Add to this the fact that the remainder of the crew will have to don their respirators in order to fight their gun at all, and it can be seen that the rate of fire may be reduced to such a low limit as to make it of little value for the time being; or the gun may even be put out of action completely.

Once the first surprise is over and no more immediate killing can be counted on, the bombardment may be continued with persistent gas shell, which are just as effective in making the men wear masks.

From our point of view it all comes down to the ability of the gunners to be quick enough at first in preventing themselves from being gassed; and then later of their being capable of carrying on with their firing while wearing masks. It means that gas training and discipline are, if possible,

more important for the artillerymen even than for other branches of the service. This is realised to the full in all their training and practice, for if they are not able to respond to an S O S call from the infantry an otherwise abortive German attack may be turned into a disaster. It is like everything else in this war—a question of training and discipline.

The neutralisation of the infantry or the transport is conducted on similar lines, and though it rarely reaches the point of being complete a partial neutralisation of reserves which prevents their getting up in sufficient numbers or in time, either for reinforcement or attack, may have most serious consequences in an operation. The partial neutralisation is attempted, just as for the artillery, by killing as many as possible by heavy surprise bombardments with the lethal shell and then continuing with persistent gas in order to force the remainder to wear their gas masks.

Let me describe as an example a particular way in which the infantry may be partially neutralised if they they are not thoroughly steady, well-disciplined and

trained up to the final dot in gas-defensive measures and the use of their respirators. Troops in the front line, whether they are in settled lines of trenches or merely in temporary positions, are absolutely dependent on their supplies. Supplies of ammunition, barbed wire and, above all, rations must be brought up to them constantly; otherwise they cannot continue to fight. All these things are brought up at night. The motor lorries of the Army Service Corps take the supplies up to selected points, where they are taken over by the first-line transport—that is, the regimental transport, which consists of horse or mule drawn general service or limber wagons.

As night approaches everything is loaded up and departure timed so that the trysting place with the infantry carrying parties is reached after dark. These meeting places are very frequently crossroads immediately below the lines, and in position warfare are usually situated close to the entrances of the communication trenches. Pass by such a place by day and you will find it deserted, but as soon as darkness has fallen it becomes a hive of activity—as busy a crossroads as

you might find in the centre of a big city. There is a constant movement in and out of men, animals and vehicles. Unloading and taking over of the supplies alternate with checking off the goods and the moving off of the carrying parties. Military policemen direct the traffic and relieve the ever-threatened congestion. Altogether it is one of the busiest and most important phases of the routine side of war, and anybody there without a special job is a nuisance and is not wanted.

Places like this of course are apt to be well known to the boche, and every now and again he will drop in some high-explosive shell or put over some shrapnel in the hope of catching the crossroads at its busy hour. But even if he is lucky and manages to get on to the spot it hardly holds up the work at all. I have seen a big shell drop into just such a place and make a huge hole in the road, killing men and horses and smashing up a wagon. Half an hour later there was hardly a sign that anything had happened. The hole had been filled in and the material debris cleared away. The wounded of course had been looked after first.

Now imagine instead of ordinary shell that a number of gas shell had been dropped into this busy centre. On a dark night, probably very muddy underfoot and with all the excitement of kicking mules, flares going up and anything from machine-gun bullets at long range to shell of every size dropping in or expected, things are difficult enough. But with the advent of the gas shell every man must get himself protected. It is now that the "hold the breath, and mask on in six seconds" stunt is going to be of value. With well-trained troops the losses from the gas may be negligible, and it is equally true that they will be heavy if the discipline is poor. But whether one way or the other it means that all the frightened horses and mules must next be fixed with their respirators and the work in hand must be proceeded with by everybody while wearing gas masks. This is the real test.

If the men are well trained the carrying parties—perhaps with loads of barbed wire on their backs—will get away as before and proceed up the filthy communication trench to the front line; swearing probably, uncomfortable certainly, but safe. Similarly

the drivers will be able to get their teams away from the gassed area as soon as they are unloaded, and the serving out of the supplies will go on as before, though at a reduced rate. But if the soldiers were not able to carry on in these terrific circumstances—could not wear masks for long periods and could not do anything in them—confusion would undoubtedly supervene and the work be brought to a standstill. If this happened the men in the front line next day would be short of rations, of ammunition, of wire. They would, in fact, be neutralised.

It is attempted neutralisation of artillery and infantry by methods such as these, carried out over large selected areas and generally as a preface to an attack—either their own or ours—which constitutes the German "fire for effect." The "harassing fire" is simply the same thing on a smaller scale and with no immediate tactical reason at the back of it except that of killing and general annoyance. As a rule a sudden burst of a few shell will be landed on some likely place, such as the entrance to a communication trench, a sunken road, a bridge or an observation post. These small shoots were al-

ways causing us a few casualties. There was no warning, or somebody was not quick enough, or did not get his respirator on, or took it off too soon. There would always be some reason—but in the end it would generally come down to something that the disciplinary thumbscrew could cure.

It is almost unbelievable nowadays that at one time one of the chief sources of these constantly occurring casualties was shamefacedness at being seen in a mask. Men would not protect themselves until absolutely forced to do so, for fear others would regard them as being too easily frightened. This was especially the case with new comers, who did not want to drop in the estimation of the older hands.

One case was reported where a corporal in charge of a small party of men in passing along a communication trench ran into some pockets of gas from a bombardment that had just stopped. He ordered his party to don their masks and proceeded up the trench. A few yards farther on they passed through the support line, which happened to be fairly free from gas, and here they were met by jeers from some of the supporting troops

who shouted "Hello, got the wind up?" and in this way induced the corporal, really against his better judgment, to order masks off. Not more than twenty or thirty yards farther along the party ran into a particularly bad pocket of Green Cross and the corporal and several of his men were so badly gassed that they had to be sent to the rear.

The attitude of the officers is always reflected in the attitude of the men. At that time you would sometimes meet young officers who had either been on the outer fringe of a gas-shell shoot or had merely smelled tear gas thinking they knew all about it and refusing to believe in the extreme deadliness of the poison gas and the need for enhanced discipline. They would damn the gas and the need for taking precautions, and their men would consequently damn the gas and the need for taking precautions. This of course would mean another batch of casualties when Fritz did treat them to the real article.

Just to show how a small matter of indiscipline may result in disaster I would instance the case of two men who took off their respirators in a front-line trench. Their

battalion was going to be relieved that night and they took off their webbing equipment for the purpose of fastening on the haversack and pack. Absolutely against orders they also removed their box respirators, and of course it was just that moment that the boche chose for dropping in half a dozen small trench-mortar bombs filled with phosgene. These vicious little guns are very accurate and most of the shell landed on or near the parapet and filled the fire bay with gas. Both men dived at once for their respirators and in so doing upset three other men in the bay. All five were gassed and three of them died later.

CHAPTER IX

Mustard or Yellow Cross gas—Not deadly but a danperous pest—Its troublesome persistence—Cleaning it out by fires—Sneezing or Blue Cross gas—Another pest—Its violent effect—The limit of gas shell effectiveness—The need for constant vigilance and disciplinary training.

THIS was pretty well the position of things in July of last year, when the German use of gas shell underwent a radical development due to the advent of the so-called mustard gas. So much has been written about this gas and so many mis-statements have been made concerning it that it is as well for the public to understand what mustard gas is, what it can do and what it cannot do. On the one hand, it has been credited with such impossible potency as would make it wonderful that any Allied soldiers remain at all. On the other hand, it should be realised that in mustard gas the Germans possess a very powerful weapon of war and one which they are using to a very considerable extent.

In the first place let it be said that mustard gas is not a killing gas like Green Cross, but that it is of the persistent type, like the older lachrymators. Unlike the lachrymators, however, its effects are not transitory and a man put out of action by mustard gas is going to be a casualty for several weeks and perhaps longer. Mustard gas principally affects the eyes and the lungs, but in a very strong vapour or in contact with any of the actual liquid from the shell a man's skin may be burned very severely—even through his clothes. More attention has been turned to this blistering effect of the gas than to anything else, but as a matter of fact the blistering is of secondary importance and in itself does not result in the loss of many men to the line. Of course one has to be very careful. It is foolish, for example, to lean up against sandbags that have been spattered with the liquid or to sit in a mustard-gas shell crater. Sooner or later the skin underneath will develop a severe and possibly extensive blister, which is very painful and certain to last some time.

These burns are not dangerous, but they are most uncomfortable, to say the least,

especially as they are most easily produced on the more tender parts of the skin.

Great excitement was caused at first among the Highland regiments because the story was spread about that the Scots were particularly susceptible to the mustard gas because of their attentuated clothing. As a matter of fact the kilt doesn't seem to be a source of danger at all, and Highlanders are burned no more frequently than others. Possibly the continued exposure of their legs hardens them.

The chief effects of the mustard gas are on the eyes and lungs. The first thing you notice is the smell—which is slightly of garlic or mustard—and irritation of the nose and throat. Neither effect is enough to make you feel gassed, and the chief symptoms develop later on. When the gas is strong it is apt to cause sickness and sometimes actual vomiting. Later on the eyes inflame and get very sore, the lids swell and blister, but no permanent injury to the eyes takes place, though the victim may be temporarily blinded. The effects developed in the lungs are equally painful and consist of severe inflammation and bronchitis, which

may take some time to get better and if not well looked after may develop into pneumonia.

It will thus be seen that for a persistent gas, though not deadly poisonous, mustard gas is a nasty proposition. First the gas does not of itself force a man to protect himself. With the old lachrymators a man either put on his mask or his eyes would smart and water so badly that he could not keep them open. With the Green Cross and similar gases a man either protects himself or dies. But with the mustard gas, though the smell and irritation may be perfectly apparent, the effect is not such as to force a man to don his mask. Yet if he does not do so and continues to live in the vapour unprotected he will certainly become a casualty. It may take half an hour, it may take several hours to come on, but come on it will.

Another particular disadvantage of the mustard gas is its persistence. It will hang about in shell holes for many hours and even for days. If it gets into a dugout it is very difficult to get rid of it, and as long as there is enough to produce the faintest smell or irritation of the nose there is enough to bring

on serious symptoms eventually. This means that when it is used our fellows are forced to wear their masks for very long stretches of time.

The mustard gas is known officially by the Germans as Yellow Cross gas, and the shells are marked on the sides with bright yellow crosses and bands. The paint used for these bands changes colour in contact with the mustard-gas liquid, so that if a shell should leak it at once becomes apparent and can be taken away and buried.

The Yellow Cross gas was first used at Ypres and bombardments there were quickly followed by similar ones at Nieuport and Armentières. Enormous numbers of shell of all calibres were employed, including a new and larger size—the 8.3-inch howitzer shell, which holds nearly three gallons of the liquid and can be fired a distance of six miles.

At Nieuport more than fifty thousand shell were fired in one night, and equally large numbers were used in deluging the other towns. Since then the numbers used have continually increased, especially when

the boche was preparing for an attack or expecting one of ours.

Duds that were collected showed that the mustard-gas liquid was a chemical called dichlorethyl sulphide, a liquid that gives off its vapour only slowly. The shell themselves were similar to the previous gas shell except that the small one have a new type of fuse—a very simple and quick-acting fuse which bursts the shell before it can get into the ground, and consequently produces a very little crater. This of course helps to spread the gas round more than if a big hole were formed. The respirators keep out the Yellow Cross gas completely, and the blanket protection of dugouts will also keep out the gas splendidly. Of course if a dugout gets a direct hit with a mustard shell there is nothing for it but to leave it empty for some days, as the liquid cannot be removed by ventilation with either fans or fires.

A case that will illustrate what I mean was one in which a three-inch mustard-gas shell got a direct hit on a doctor's dugout and gassed him and his orderlies. Some time afterward the remaining orderlies thought they ought to send the doctor's things down

the line and went in and got them out of the dugout. They noticed a faint smell but did not worry about it, and soon afterward found themselves gassed in consequence.

A fire was then placed in the dugout to clear it. In the meantime the medical sergeant secured another dugout by clearing out some infantrymen. In the evening the infantry felt soul-sick and wanted somewhere to sleep, so they went into the original gassed dugout and slept there. In the morning they all went down, gassed.

Where there has been no direct hit and the mustard-gas vapour gets into the dugout, it can be cleared out just like ordinary gas, by ventilation either with fans or by means of fires. For clearing dugouts a great deal of reliance is placed nowadays on building small fires inside. A dugout with two entrances can be very quickly cleared by means of fires, as a through draft is produced, which carries the gas away with it; but difficulty is frequently found in getting the necessary fuel for the fire and in keeping the stuff handy. Bundles of firewood and kindling material are supposed to be kept in the dugouts ready for use; but, as has

already been explained, the Tommies are always on the lookout for combustible materials for their own fires, and continual inspection has to be made to see that the special supplies for ventilation are kept available. One officer told me that he always had the supplies of wood, paper and kerosene kept in an army-biscuit tin which was closed and sealed; because, as he said, no Tommy would ever investigate the contents of a biscuit tin unless absolutely forced to do so for lack of other food.

It should be realised, however, that properly protected dugouts have given perfect immunity from the mustard gas as long as the protection has remained intact, and a great deal of attention is being paid to increasing the number of the protected shelters in order to give the men the necessary rest from wearing their respirators occasioned by the extensive use by the boche of his Yellow Cross Shell. In Nieuport a special gas patrol was instituted for going the round of the town to see that blanket protection of cellars and shelters was kept in good condition, as there was always a chance that they would not be well looked after or that the

blankets had been taken down by some enterprising Tommy for his own personal use.

Round about battery positions the most annoying feature of the mustard gas is the length of time it persists. In the shell holes it can at any rate be partly destroyed by sprinkling with chloride of lime. It is rather interesting to find that in some captured German instructions great secrecy was laid on the use of chloride of lime for getting rid of the effects of mustard gas. The boche kept boxes of chloride of lime in all positions where the gas shell were stored, and issued instructions to his own troops that "the use of chloride of lime for the protection of our own troops against Yellow Cross liquid must not become known to the enemy. Observation of the strictest secrecy is a matter of duty just as much now as it was previously. The troops will be thoroughly instructed in these precautionary measures, but nothing will be taught them as regards the nature or composition of the antidote employed."

During the present offensive the Germans have used very large quantities of mustard gas, generally for holding purposes and

against our rear lines, battery positions, communications and reserves. This is kept up for many hours in order to wear out the patience of our fellows and weaken them for the coming assault.

Strong points that the boche does not wish to attack are also swamped with the gas, and when Armentières were evacuated by the British, Yellow Cross liquid was actually running down the gutters. But in places that he intends to assault he will complete the mustard-gas bombardment against our troops some considerable time before he advances; otherwise his own troops would run into it and be forced to don their respirators.

The quantities of shell used in this preparation are enormous and supplies of the mustard gas must have been accumulated during the winter to an unexpected extent and their manufacture proceeded with to full capacity.

Take it altogether, Yellow Cross gas is very much more than an annoyance, but there is no question that good discipline and thorough appreciation and carrying out of the orders laid down for the protection of troops have reduced the losses in very much

the same way that the screwed-up discipline reduced the losses after the first introduction of Green Cross Shell. One of the most objectionable features of the mustard gas is the continual care that has to be exercised to prevent casualties. It is so easy for a man whose clothing is slightly contaminated with gas to enter a dugout and contaminate the whole of the interior and all its occupants. Sentries also have to be posted to warn troops passing through or into an area that has been bombarded with mustard gas, so that respirators can be put on. After a cold night the officers must be continually on the watch to see whether the vapours that rise from the warming of the earth by the morning sun are charged with mustard gas, and to take the necessary precautions on the slightest detection of the characteristic smell. This smell to my mind is much more like garlic than mustard, and the use of the term "mustard gas" is purely the origination of the Tommies themselves. As a matter of fact, so as not to confuse the Yellow Cross liquid with true mustard oil, efforts were made at first to prevent the stuff from being called mustard gas. But

once the British Tommy decides on a name for anything, that name it is bound to have, and as he adopted the name "mustard gas" for it mustard gas it will remain for all time.

The other new material that was introduced by the Germans in the summer of 1917 and which, like mustard gas, has been in use ever since is the German "sneezing gas." For a long time high-explosive bombardments were reported on many occasions to be accompanied with violent sneezing, which at the time was laid down to the presence in the air of undecomposed explosive from the shell. As a matter of fact the sneezing was due to the presence inside the high-explosive shell of bottles containing chemicals the chief effect of which is to cause violent sneezing when small quantities get into the air. This sneezing material, or sternutator, to give it its scientific name, in this case was a solid which is atomised into tiny particles when the shell bursts. Chemically speaking, it is called diphenylchlorarsine. This material is used embedded in the trinitrotoluene of the explosive shell in most cases, and such shells are called Blue Cross Shell, and are marked accord-

ingly. This is the third of the present trilogy of the German coloured-cross gas shell. The sneezing gas is also sometimes mixed in with the contents of the Green Cross Shell in considerable proportions.

The idea underlying the use of this sneezing gas by the Germans was apparently partly that of getting a gas which they thought might go through our masks. In this of course they were disappointed, as the respirator keeps out sneezing gas perfectly well. The other idea underlying its use was apparently to cause such violent sneezing as to prevent men from getting their masks quickly adjusted or to cause them to sneeze them off if they had been put on.

This and all sorts of other tricks of the gas-shell business have been tried out at various times by the Germans. While putting over Green Cross or Blue Cross Shell, or both, they will suddenly accompany them with violent bursts of shrapnel, the idea being that men will be so busily occupied in putting on their masks or in sneezing that they will not take the usual care in finding immediate cover from the shrapnel; or that, on the other hand, in taking cover from the

shrapnel they will not get their masks on in the minimum time or will displace them in their efforts to get away.

The sneezing caused by the Blue Cross Shell is a most peculiar and violent kind. If you get the smallest dose of this stuff into your lungs you start sneezing at once. You seem to sneeze from the very bottom of your stomach upward, and feel as if the whole of your chest were going to come out with it. This may continue almost continuously for a short time; but there are apparently no after effects unless the gas has been very strong indeed, in which case there is very painful irritation of the whole of the throat and lungs which will produce bronchitis.

This is the present stage of development of the German gas shell. Whether they will add another colour to their lot of Green, Yellow and Blue Cross Shell we do not know, but we are prepared for it when it does come, and in the meantime he is getting as good as he gives.

It will be news to most people to realise how the gas shell are gradually dominating the field. Some bombardments are composed entirely of gas shell. As many as a quarter

of a million have been fired on the attacking front during twenty-four hours, and probably at least one-quarter of all German shell of all calibres are gas shell.

It must be remembered that there are certain things that gas shell cannot do. They cannot replace high-explosive shell for the demolition of fortified works, for example. Nor can they be used for cutting barbed wire previous to an advance; and the creeping barrage that preceded the assaulting infantry cannot be made up by gas shell. An S O S barrage in No Man's Land, to cut up an attack, also would have to be shrapnel and H. E. so as not to gas the defending troops. When all these are cut out it will be realised that the proportion of gas shell that are used against living targets must be very big indeed. It is hardly too much to assert that at the present day, of the actual methods of attacking men direct gas is the most important. It must be realised also that it can become, and is likely to become, still more important, and that the fight between the offence and the defence on both sides will continue until the end of the war.

Since December of last year the boche has

been copying a method invented by the British for firing a large number of big drums of gas simultaneously. These drums are used chiefly against the front-line troops and are generally filled with pure phosgene. As each bomb contains a gallon and a half of liquid and many hundreds are fired at the same moment a good high concentration of gas is produced. Warning is given by the tremendous roar from behind the German lines when the flock of canister or rum-jar bombs starts on its way. Every man who hears the noise gets his mask on at once, even before there is any sign of gas; and if he does this there is little danger, as the respirators are quite capable of dealing with even the very high concentrations of phosgene produced. If a man keeps his head and obeys orders there is little to fear from gas. But discipline must be high. As one Tommy said: "You must be so well disciplined that when the gas alarm goes you will even drop the rum ration so as to get your respirator on in time." Beyond that it is simply a question of carrying on the work in hand while wearing a respirator, and this is entirely a matter of practice.

CHAPTER X

Liquid Fire—First used by Germans in July, 1915—A great surprise and success—German hopes from it—Construction of a flame projector—Flammenwerfer companies—Their perilous duties and incidents of desertion from them—Improved types of projectors—Co-operation of machine-gun fire—Failure of liquid fire—Its short duration and short range—Ease of escape from it.

When the German Army entered on its policy of frightfulness there was none of its new and unprincipled methods which had more immediate and striking success than the use of liquid fire. And there is now none of all its methods of frightfulness which has fallen more into disrepute, and which has had less success when once the first surprise was over.

A great deal of attention has been drawn in the newspapers to the use of liquid fire, but the average man, even in the fighting forces, knows very little about the German methods and the appliances for its use. Yet Germany still has special troops trained in

the use of liquid fire, and seeks continually to alter and develop the fire weapons and their tactical employment in order to take advantage of the undoubtedly terrible appearance and destructive power of the high temperature flames which can be emitted. This article is intended to show the stage to which the development has attained and the reasons for the relatively innocuous character of what is probably the most terror-inspiring method of modern warfare.

Throughout 1915 England was pouring new divisions of its National army into France. As with all new troops the procedure adopted at the time was to bring these divisions by easy stages to within a short distance of the front line, and then send them in by companies for a four day "instructional tour" in the trenches to pick up all the wrinkles and habits from the seasoned troops holding the line. After the whole formation had been put through it in this way the division would be allotted a definite part of the line, taking it over possibly from the troops with whom it had been in for instruction and allowing the latter to get out for a much needed rest, or to get

"fattened up" for some impending or progressing show elsewhere.

One such new division, absolutely fresh from England and with no war experience whatever, was the target selected by the boche for his new deviltry. The portion of line allotted to this division was on the outermost part of the Ypres salient and included the ruins of the little village of Hooge right at the point of the salient. This position had always been a hot corner—"unhealthy" in the British army parlance—and had changed hands several times. The trenches there were poor as it was almost impossible to get effective work done on them owing to their exposed position. Indeed there were many parts of the line where no movement was possible by day and the men on the posts had to lie "doggo" until night. The two lines were very close together—in many places less than twenty yards—and it was quite possible to hurl hand grenades from one set of trenches to the other. It was on this position of the line, over a front held by two battalions, that the attack was made.

After a bombardment of several days, a mine was exploded under the front line and

then immediately afterward, at 3:20 A. M. on the morning of the 29th of July and without the slightest warning, the front line troops were enveloped in flames. Where the flames came from could not be seen. All that the men knew was that they seemed surrounded by fierce curling flames which were accompanied by a loud roaring noise and dense clouds of black smoke. Here and there a big blob of burning oil would fall into a trench or a saphead. Shouts and yells rent the air as individual men, rising up in the trenches or attempting to move in the open, felt the force of the flames. The only way to safety appeared to be to the rear. This direction the men that were left took. For a short space the flames pursued them, and the local retirement became a local rout. Then the flames stopped and machine guns began to take toll of the fugitives. Only one man from the front trenches is known to have returned. German infantry following up, poured into the breach in the line, widened it, took our positions as far back as Sanctuary Wood, and then consolidated.

Ten days afterward we counter attacked and won back the whole of the line concerned

but at very considerable cost. Incidentally, we captured two of the German flame projectors, one of them complete, and they proved to be of the greatest possible use to us subsequently for educating the army in the new warfare, and for inspection by our own experts with a view to their duplication for retaliation.

Any one attempting to blame the troops attacked for their retirement can hardly appreciate the circumstances, and, I am convinced, over-estimates his own capacity for resistance. This attack was an utter surprise—the kind of warfare was unknown and and unheard of. Imagine being faced by a spread of flame exactly similar to that used for the oil burners under the biggest boilers, but with a jet nearly sixty feet in length and capable of being sprayed round as one might spray water with a fire hose. Personally, I am pretty sure, had I been there, that I should have hopped it if I had not been fried by the heat or frozen with terror. Later, when we knew the limitations of these things it was different, though even then it is a pretty good test of a man's nerve.

The flame projectors taken by the 14th Division in the counter attack were simple but very interesting in construction. The main part was a cylindrical vessel of steel about two feet in height and fifteen inches in diameter provided with straps so that it could be carried on a man's back. At one side about two-thirds of the way up was a filling hole for oil, closed by a screw cap. Near the top was a pressure gauge attachment and toward the base was a lock closed by a lever handle and to which could be attached a long length of flexible hose ending in a peculiar shaped nozzle.

On examination it was found that the body of the projector was divided internally into two compartments which could be connected by opening another tap. The upper compartment was the compressor and the lower the oil reservoir. The compressor chamber was filled to a pressure of twenty-three atmospheres with deoxygenated air or nitrogen. Air itself cannot be used because of its oxygen content forming an explosive mixture with the vapours from the oil, and any heating on compression, or back-flash from the flame or fuse, might make things

very unpleasant for the operator. The nitrogen required for the flame projectors is carried into the field in large cylinders about 4 feet 6 inches in length and 6 inches in diameter. Several of these cylinders have been captured from the enemy since. These cylinders are actually taken into the trenches and the flame projectors charged from them there.

The combustible liquid used in the flame throwers has varied in source and composition from time to time, but it invariably has one characteristic which appears to be essential for good results—it must have light or easily volatile and heavy and less volatile fractions mixed in carefully graded proportions. The heavy oil has sometimes been a petroleum product and sometimes a tarry residual oil from the distillation of wood. The light portion, which insures the jet's keeping alight was originally a light gasolene, but at one period, whether from shortage of petrol or not I do not know, the place of the latter in the mixture was taken by ordinary commercial ether.

The lighting device, fixed at the end of the flexible hose, is the most ingenious part

of the whole contrivance and is so made that the oil ignites spontaneously the minute the jet is turned on, and is kept alight by a fiercely burning mixture which lasts throughout the discharge.

The nozzle is about 9 inches long and detachable so that replacement is easy. It clips into the end of the tube and is held in position by an annular ring. When the oil with its twenty-three atmospheres pressure behind it is rushed out of the jet, it forces up the plunger of a friction lighter and ignites a core of a fierce burning fuse mixture which fills the whole of the space between the central tube and an outer casing. The latter consists of a thick wick soaked in paraffin wax and fitting loosely into a thin brass case.

When the nozzle is in position all that is necessary is to turn on the tap, and the stream of flame issues from the tube and can be directed at will.

The official name for this instrument we discovered was the *"Flammenwerfer"* (flame thrower) and it is now never known in the British army by anything else than its German name. Indeed this is one of the

very few German words we have adopted as an outcome of the war, the only others I can remember being *"strafe"* and *"Kamerad."*

Flammenwerfer attacks are made by the 3rd and 4th Guard Pioneer Battalions and by the Guard Reserve Pioneer Regiment—all of which troops are specially trained in flame tactics. Each battalion is composed of six companies and each company is equipped with 18 small or portable projectors similar to that described above, and with 20-22 large projectors of greater range. The latter larger flammenwerfer are built on the same principle as the former, but are too heavy to be used as mobile weapons. They are consequently built in to the trenches at about 27 yards from the opposing lines, and, if the trenches are not close enough together for the purpose, special saps are pushed out and the flammenwerfer installed at the end. The range of these large projectors is 33-44 yards and they can cover a front of 55 yards with flames.

It is probable that in the attack at Hooge that both large and small flammenwerfer were employed.

It is possible with the above equipment for a flame company to cover a total front of 1100-1600 yards.

Service in the Guard Reserve Pioneers is apparently a form of punishment. Men convicted of offences in other regiments are transferred either for a time or permanently, and are forced under threat of death to engage in the most hazardous enterprises and carry out the most dangerous work. The following incident will serve to show how the German soldiers are hounded to their death in these engagements.

In the summer of last year a small flammenwerfer attack was made against our line at a point near Monchy, south of Arras. Two boches armed with flame projectors of a modified pattern were instructed to attack one of our advanced posts which was at the head of a sap running out toward the German trenches. In broad daylight and with no covering fire worth talking about these two poor devils were forced over the top with revolvers pressed into their backs. One was shot down immediately. The other managed to get clear of his own barbed wire and then discarded his apparatus, with the intention

of crawling over to us and deserting. By this time, however, he had been badly shot up—whether by his own people as well as by us, I cannot say. His left arm and his right thigh were both smashed, and he had two bullets in his abdomen. Nevertheless this man managed to crawl into our lines and was taken care of. He was sent down to a Casualty Clearing Station in a perilous condition, but despite his terrible injuries I understand the doctors managed to patch him up, and that he recovered completely.

The portable flammenwerfer used in the attack just described was brought in by our patrols the following night, the spot where he had left it being accurately described by the wounded prisoner. It was found to be of a new pattern and other specimens of the same construction have since been captured, chiefly in the neighbourhood of Lens where they were employed by the boche in the course of abortive counter attacks against the Canadians.

In this pattern, which is shown in detail in the photograph, the compressed nitrogen is contained in a spherical-vessel which is contained inside a ring-shaped oil container.

The whole thing looks like a life preserver and is mounted on a light frame so that it can be comfortably carried on the back. For a man who may suddenly have to get down on his stomach and crawl, the apparatus is much more compact and better fitting to the body than the original type, but it has no advantage over the older varieties as regards range or duration.

The flexible hose which carries the lighting nozzle is made of canvas and rubber, and enemy documents which have been captured show that only one tube is provided for each three reservoirs. After the discharge of one apparatus the long tube is supposed to be fitted with a new nozzle and handed on to the others in succession.

The flammenwerfer companies are divided into squads. Following the German army habit of adopting contractions—a habit presumably forced on them by their cumbersome word-building language, the squads are designated *Groftruppe* or *Kleiftruppe,* according as they are armed with large or small projectors. The former is a contraction for *Grosser-flammerwerfertrupp* (large flame projector squad), and the

latter for *Kleiner-flammenwerfertrupp* (small flame projector squad).

In the case of attacks with the large projectors, or a combined attack with both sizes, the chief thing is secrecy of installation in the trenches. If it was ascertained or suspected that flammenwerfer were being put in, our gunners would open on the position in no time and blow the apparatus sky-high. As it is necessary to sap out to within 27 yards of our lines in order to get in a "shot," it can readily be seen that the possibilities of using the large projectors are very limited, and as a matter of fact little use has been made of them.

Attacks with the portable projectors are more possible owing to their greater mobility. But here again the essential part of the tactics and the most difficult thing to do is to get near enough the target to make the shot effective. The range is only fifty to sixty feet. The German idea is to cover the advance of the *"Kleif"* men by protecting machine gun fire.

In an attack, the advance of the company is covered by machine gun fire from each side, converging at a point on the opposing

trenches. In the triangle thus formed the attacking force, the *"Kleiftruppe"* in front, then a party of bombers, and finally the raiding or attacking party take up their positions in No Man's Land and crawl as far forward as possible in the "protected area." As soon as the flame projectors are within range, the machine guns switch outward to each side, the flame is discharged and the bombers rush in and try their luck in the trench. If things go well, the infantry follows the bombing party and proceeds to its objective.

In an attack of this kind, or a less well-supported attack such as that at Arras, mentioned above, the attackers suffer from two such severe disadvantages that against well disciplined troops they stand little chance. These disadvantages are (1) the flammerwerfer carriers have to get so near their objective that they are almost certain to be shot, and they then become a source of danger to their own side; (2) men in trenches know they are perfectly safe from frontal flame attack if they keep well down and hug the parapet side of the trench. The reason for this is that the flame will not sink

down into a trench, but having little force behind it at the end of its journey is curled *upward* by the rising currents of hot air. The result is that any sort of head cover (unless made of wood) makes perfect protection, and a man crouching in a trench or even lying prone in a shell hole, is very unlikely to be more than slightly scorched at the very worst. I can vouch for this, for I have lain at the bottom of a trench with the flames playing over my head and have not been injured in the slightest, though I confess to being very much relieved when the flame stopped. The only danger in trenches to men who keep their heads is that of "blobs" of burning oil falling from the end of the fiery stream, but this is not a very serious chance.

Another serious disability in the German liquid fire is its very short duration. The stream of flame from the portable flammenwerfer lasts rather less than one minute. It is impossible to charge up again on the spot, and the result is that once the flame stops the whole game is finished and the operators are at our mercy. Without making the apparatus of a prohibitive weight, the duration

of the flame cannot be increased. Even the heavy projectors give only a flame lasting at the best one minute and a quarter.

It must be realised that it is discipline and coolness (if one may use the word) which count, and that the moral effect on unsteady troops, unaware of the fact that the appalling flames have little destructive value, may be very great indeed. When men have bolted from the trenches into the open they are an easy prey.

An enfilade attack, i.e., one made from a flank, would be much more dangerous were it not for the difficulty of approach and the fact that the traverses of a fire-trench are as good protection against flame as the parapet. Only where the *"Kleif"* squad can approach under cover and get in its shot at an exposed target is the flammenwerfer likely to have much success nowadays.

A certain amount of value was obtained from their use in this way in the attack on Verdun for reducing isolated strong-points, notably fortified farmhouses and broken down cottages in the ruined villages. In certain cases the flame projector carriers were enabled to approach under cover or by crawling among the ruins and heaps of

debris, to within striking distance of the otherwise well protected machine gun emplacements and positions. By suddenly playing the fire jet into the loopholes, enough flame penetrated into the interior of the emplacement to put the machine gun and its crew out of action—either temporarily or permanently. This was the opportunity awaited by the covering party of bombers who would rush the post the minute the flame ceased, having made their approach while the projectors were in action.

But even for special cases like these the circumstances must be so favourable and the inherent disadvantages are so great that the flammenwerfer cannot be counted on to attain the required result.

The low value placed by the Allies on the German flame attack can be realised from the fact that no special form of cover is provided against it. There is no special form of fireproof clothing or other protection issued to the troops, and the instructions for meeting the attack may be summarised as "Shoot the man carrying the apparatus before he gets in his shot if possible. If this cannot be done take cover from the flames and shoot him afterward."