

USE OF GAS AT THE FRONT.*

By W. B. Campbell.

THE Germans first used gas a year ago last spring. There was a feeling of horror, but there was also the impression that the Germans were very ingenious people to bring out this scheme. They are not!

If you read the Sunday papers, and I guess most everyone reads them at times, you will notice that it is quite a common habit for the writers to concoct wild stories of all kinds of inventions, especially inventions for killing people in warfare. The first mention that was made in those papers of the "tanks" showed a machine about 200 feet high. Well, the Germans' use of gas was somewhat along the line of these stories. It is not a new idea at all.

Perhaps the first time gas was actually used was the "stink bombs" of the Chinese. They were not poisonous but were intended to annoy the enemy as a cover for something more effective.

A popular story is that a great secret is locked up in the Tower of London, which, if the British government would only consent to use it, would wipe out all enemies wherever they are, but that the government is too humane to do that! The basis of that story, and it has a basis, is that about seventy years ago the use of chlorine as a weapon of warfare was actually proposed. It was Lord Dundonald, I think, who suggested it at that time, and the suggestion was turned down. The fact that gas could be used was quite well known. It was sufficiently well known to be taken up at one of the Hague conferences and they decided against it. However, the Germans did not mind that,—merely a scrap of paper.

As gas is used at the front to-day there are two forms of it, liable to confuse people when reading the newspapers. There is what is known as cloud gas, the poisonous kind, sent up in cylinders and released and sent across in the form of a cloud. Then there is what is known as shell gas, which is sent across in shells and released on the breaking of those shells. The cloud gas is the most important and the most deadly. It may seem a fairly convenient weapon, but if you will consider the gases that it is possible to use and the properties necessary to make them usable at all, you will see that it is not such an easy thing. First, as to the properties; the gas must be heavy; it must be at least twice as heavy as air. If not, it will diffuse too readily and be thinned out by the time it gets to the enemy trenches and be of very little use. The gas must be compressible to a liquid, so as to be transported, in cylinders, in bulk. It must not be a liquid of such a high boiling point that it will boil off with rapidity. It must be poisonous,—the more so the better.

Some of the gases ordinarily considered poisonous are not nearly poisonous enough to be used in this way. The arsine, AsH_3 , that compound of hydrogen and arsenic, which has a specific gravity of 2.7. This makes it plenty heavy enough. It can be liquefied. It has a convenient boiling point, but at $1/10$ of 1% it takes about two hours exposure to kill. Then there is sulphur dioxide. That is more poisonous than most people think. It has a fairly convenient specific gravity; its boiling point is 10 degrees below zero Centigrade. In comparing the toxicity

of these gases there are two terms used—the minimum effective concentration, that is the least concentration which will kill a man or knock him out in five minutes, and the maximum bearable concentration, that is the most that can be stood without danger for one hour. Sulphur dioxide has a minimum effective concentration of .05%, so it is a rather poisonous gas.

Some of the other gases that might be thought of are nitric oxide, boiling point of 26 deg. Cent., fairly heavy, and about as poisonous as sulphur dioxide. The high boiling point stops its use as cloud gas and it is not sufficiently poisonous to make it useful for shell gas.

Another one is hydrogen sulphide. That has a low boiling point but it is a little bit too light to use as a cloud gas, and it is only about half as poisonous as sulphur dioxide.

To come down to the ones really effective, first there is chlorine. That is the one the Germans used in the first gas attack. It has a boiling point of 36 deg. below zero Cent. It is two and a half times as heavy as air. It is very convenient. It can be liquefied and put into cylinders. It boils off rapidly and its minimum effective concentration is .01%, five times as poisonous as sulphur dioxide. The maximum concentration is about half of that.

Prussic acid is only three times as poisonous as chlorine. Another gas the Germans are making considerable use of is phosgene. That is not an ideal gas. It is twice as poisonous as chlorine, but it takes twice as long to kill. Another thing against it is that it has a boiling point of 8 degrees Cent. That is higher than the temperature you encounter on a fairly cold day in winter weather over there. There are a good many days when that gas would not come out of the cylinder at all. It is used mixed with chlorine. It is effective because it has serious after-effects on a man's heart. A man will get a small amount of it into his system, so small an amount that he will not think he has been gassed at all, but maybe two or three hours later he will be filling sand bags or doing some other work around the trenches and his heart will go back on him and he will drop exhausted or dead. The first time this gas was used the after-effects on the heart were not looked for and there was one party of men who had been slightly gassed but their officers did not consider them badly affected. They were sent to march out to the dressing station. None of them reached the dressing station. Now men have instructions that after being exposed to gas, they are not to move out of the trenches or do any more work than absolutely necessary for twenty-four hours. During that time the effect of the gas will wear off.

As to the quantity used, this is rather surprising. The effective concentration of chlorine is .01%, one part in ten thousand. Of course it is necessary in calculating the concentration for an attack to prepare to use more than that amount. Say you are figuring on using ten times that amount (the Germans in one attack sent over gas strong enough so that the men had to use helmets ten miles back of the line), that is, a concentration of $1/10$ of 1%, a wind of ten miles per hour (that is just a moderate breeze) and a cloud eight feet high at the enemy's trenches, if you figure that out you will get about 22,000 cubic feet of air passing over each yard of trench per minute, and this must be loaded up with chlorine. That requires about 22 cubic feet of chlorine, or $4\frac{1}{4}$ pounds, per minute per yard of trench. That does not sound much, but when you figure it by the mile, the way gas attacks are made, it mounts up.

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