WAR DEPARTMENT

Machine Gun Notes, No. 2. (from British sources).

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The following pamphlet "Machine Gun Notes No. 2" is published for the information of all concerned.

[062.1 A. G. O.]

BY ORDER OF THE SECRETARY OF WAR:

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The Adjutant General.

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LECTURE ON
MACHINE GUNS AND THEIR TACTICAL EMPLOYMENT.

By Colonel Applin, of the British Army.

Delivered at the U. S. Army War College, Washington, D. C., Tuesday, November 20, 1917.

My lecture this morning has usually taken seven lectures of forty-five minutes each when delivered at ———, and I do not see how it is possible to condense so large a subject into one lecture. I shall, therefore, have to leave out a very large number of things I should like to tell you. I shall have to skip, and I shall have to be very general. I make these remarks beforehand so that you will realize that I am not giving you anything more than really an outline of the subject.

The machine gun is the great life-taker; and our enemy realized that before the war. We only partially realized it. We relied more on our rifle, and the power of our men to develop that wonderfully accurate and rapid fire which was the great feature in the retreat from Mons, and which I do not think I am exaggerating when I say, probably saved the British army during that retreat. Then we discovered that we were up against masses of machine guns in the hands of the Germans. We discovered that they had learned how to use them tactically, how to group them, and we found that their machine gunners were not amateurs, but extremely expert and highly trained men; and we realized that the machine gun was what I have just told you, the great life-taker. I do not think I shall be contradicted if I say that the greatest number of our casualties in this war have been created by the machine gun.

This morning I hope not only to show you that the machine gun is a great life-taker, but I hope to show you also that the machine gun is a great life-saver; and it is in this category that I want you to look at it. If you will develop a very highly trained and organized body of machine gunners, if you have a discipline such as the Germans had in their machine guns, an iron discipline, men who can act

instantly, quickly, accurately, I have no hesitation in saying that you will find that my words are true—that the machine gun is a great life-saver.

All tactics are based on the characteristics of the arm with which we are dealing. I think that is quite obvious. Take the case of the cavalry: The tactics of the cavalry are based upon the fact that a man is mounted on a horse, that a horse moves at a certain speed, that he is capable of maneuvering with other horses in a certain method, and that the man is armed with a sword or a lance. The whole of the tactics are based on those facts, and nothing else. To take a better case, that of the artillery. Obviously, the tactics of each branch of the artillery are based on the weapon with which they are armed. It would be absurd to try to bombard a distant strong point, perhaps one of those huge dugouts, with an 18-pounder. It would be equally absurd to bring up your 15-inch Howitzer to repel an infantry attack, because you would be using the weapons against their characteristics. One is a high-velocity weapon which fires shrapnel; the other fires a heavy shell of low velocity, with a high-explosive; and they have to be used accordingly.

The machine gun is not peculiar in this respect, and we must base the tactics of our machine gun upon the characteristics of the weapon. That is the mistake which we all made at the beginning of the war. We left out the characteristics of the weapon. We said: "Here is a gun with a rifle caliber barrel. It fires the .303 British infantry cartridge. All right; then it is an infantry weapon. Stick it in the firing line and count it as 120 rifles, or whatever we chose to consider it. But there are certain characteristics of the machine gun which I shall tell you briefly this morning, and upon which the whole of its tactics are based.

Before I go into the question of characteristics, however, I want to impress upon you, as emphatically as possible, the difference between a machine gun and an automatic weapon.

By a machine gun or mitrailleuse, we mean an automatic weapon of rifle calibre capable of firing a great number of shots from one barrel with great rapidity—in our service it is 420 rounds, 420 bullets a minute; that is the rate of fire.—

Mounted on a fixed tripod from which it is fired with little effort on the part of the firer.

I wish to impress that, gentlemen, very strongly, because that is the main characteristic of the machine gun, and the way it differs from all ordinary automatic weapons. It is fired from a fixed mounting which holds it firmly without any effort on the part of the firer.

Secondly, the machine gun is a water-cooled weapon. That may seem trivial, but it is very important. If you own a motor-car I think you prefer the water-coolod motor-car to the air-cooled motor-car, because it is more efficient. In precisely the same way the machine gun is vastly more efficient when water-cooled than when air-cooled. It gives you sustained fire action. It does not heat. It will fire an almost unlimited number of rounds without cessation of fire.

To prove my point, at ——— we made that statement some twelve or eighteen months ago, and our General Staff did not agree. They said: "We cannot agree, until you prove that this weapon is capable of long continuous fire action. It may jam. When you fire a great number of rounds it may heat. We want proof of this." So we arranged for a test, and we got an ordinary Vickers gun, took it on to the short range, and we piled up ammunition to the ceiling behind. We had an expert firer and a No. 2, and they were not allowed to be changed. They had to fire right away through. We had two men to feed the ammunition to the gun. We had a table with three staff officers at it recording the result, and a stop-watch. The test was for the gun to open fire at zero and fire for exactly one hour. It was not to cease fire, except, of course, if it did so automatically.

The fire was opened and kept up continuously for one hour and five seconds, the five seconds being due to the fact that the firer was very nearly deaf by that time. The gun fired 13,728 rounds in that time, or about 228 rounds per minute, continuously. No allowance was made for any stoppage. There were several stoppages, small ones. The longest was on account of a broken lock spring, when the lock required changing. Possibly the longest stoppage was not a stoppage at all within the meaning of the machine gunner's vocabu-

lary, because it was due to refilling the barrel casing with water; and owing to firing 4,000 rounds without refilling, there was so much steam developed, that when the barrel casing was opened, the steam blew up, and it was a few moments before they dared pour the water in. That, I think, was the longest stoppage made.

The most interesting part of the experiment was the fact that at the end, the last shots were as accurately in the center of the target as the first. The target then had a hole about a foot in circumference cut out by the bullets. The last shots were as true in the center of that target as the first; and on examining the gun, with the exception of the muzzle-cup, which was practically blown away, the barrel was in perfect condition. It was nickeled slightly, it was somewhat worn, but it was in perfect condition, and could have gone on firing many thousands more rounds.

I have given that experiment at length because I want to emphasize the fact that the machine gun proper is capable of long-sustained fire action, and in the hands of an expert you can rely on it in war to cover your own advance or to protect you against the advance of the enemy.

Now, we must just look at the characteristics of this weapon as far as the fire is concerned. I am afraid this will bore you a little, but I hope you will bear with me while I discuss these few points, because the whole tactics are based on the firing of the weapon.

As you know, in the case of any weapon, any rifle, any small arm firing perfectly accurately, with perfect sights, from a vise, at a bull's-eye, if the first shot strikes the bull's-eye plumb in the center, the second, third, and fourth shots will not necessarily do the same. They will be "there or thereabouts," as we say; but we get what we call the "cone of dispersion," which I think you call the bullet sheaf here; and that dispersion alters with the range.

With the rifle, that dispersion is very big, because you have the idiosyncrasy of the man, the firer. The rifle is dependent entirely on the firer. It is dependent first of all on his power of aiming, which is really mechanical. If he can aim well, he always aims well. What it really depends

upon, however, is (1) his nervous system, (2) his muscles; that is to say, his physique.

A man who is tired, however great his energy may be, who is utterly weary, worn out with hard work, running, or whatever it may be, cannot hold his weapon sufficiently still to make accurate shooting. A man who is nervous, of course, will make no shooting at all. That is why I draw this great distinction between the machine gun proper, mounted on its fixed tripod, and the automatic weapon, which is dependent entirely on the firer for its accuracy.

With the machine gun mounted on its fixed tripod, given a man capable of aiming—and that, as I said before, is purely mechanical in a trained man—any trained gun-layer can always lay a gun equally well. Given the power to lay the gun, the fire will be just as accurate under the stress of war as it will be on the range in peace. You will get the same effect from a man who is nerve shaken, provided he can still see to aim, or a man who is completely fatigued and can barely lift his gun, provided he can still see to aim—you will get the same fire effect from him as you would from the fresh man, practically speaking. That is the great value of the machine gun over the automatic weapon in war, and that is due to its fixed mount.

There is one other point in the characteristics of this weapon, and that is the fact that the machine gun is recoil-operated. It is operated by the recoil, and not by using the gases, as in other automatic weapons. To this recoil action is due the reliability of the machine gun, with the water-cooling, which enables the gun to fire continuously without stoppages.

If you are firing at a target in an ordinary way, a bull's-eye target with the ordinary bull's-eye on it, and theoretically, your machine gun is aimed exactly at the bull's-eye, here, at 6 o'clock, as we call it in our service, and provided that you open fire at that spot with perfect aim, so that the first bullet will go through the center of the bull's eye, if you fire one hundred rounds, they will not all be in the center of the bull's-eye. The one hundred bullets will be more or less dispersed, according to the range, and will be dotted about in that sort of way (indicating on blackboard),

in which the nucleus of the shots will be in the center of the target, but there will be odd shots sprinkled high and low, and an odd shot to the right and to the left; but you will find that the cone of fire is dispersed more up and down than to the right and the left. You will find your target struck at the top or the bottom. You probably will not find shots on the outer edge, in that way (indicating).

Now, supposing we turn that target sidewise, and we imagine that the gun is firing at that target in that way. You have got your gun here. Here is your machine gun, and here is your bull's-eye. The cone of fire does something like that (indicating on blackboard), and the bullet sheaf strikes the ground between two points in which you get the nucleus of the fire.

We have found that if we take ninety per cent. of the bullets fired, that ninety per cent. is effective fire. I dare say with the rifle, in your service, 75 per cent. is considered to be the effective zone of fire; but owing to this fixed mounting which I spoke of just now, owing to the closeness of the grouping of the machine gun, we can take ninety per cent. as our effective zone. So we reckon on a ninety per cent. effective zone treatment by fire, and if we are firing at a range over 600 yards we have to consider that cone of fire, and not the actual target itself. In other words, we have not got to try to hit the target so much as to try to place the target somewhere within that effective zone. If the target is anywhere within that effective zone—that is to say, if we can play that effective zone, either the inner edge or the far edge or the center—it does not matter—on the enemy's line or trench or body of men, that body of men will be under an effective fire, and will be soqner or later wiped out.

If you look at it, you will find that that cone, as it strikes the ground, is very long and very narrow. It forms a much elongated vertical elipse. It is very long, but it is very, very narrow.

It is obvious that this gives us a certain characteristic which we must take into consideration when firing at the enemy. If, for instance, you wish to place machine guns for the defense of a trench line, and the enemy is likely to attack from this direction, supposing this to be roughly

your trench line here, and supposing you place your machine guns, however many you may have, in a line like this with a view of firing at the enemy, it is obvious that when the enemy attacks here, in this way, and when you fire those guns, you have only got a number of these very narrow cones in front of each gunner, and those cones are so narrow that they will only practically cover one man at a time; so that in order to get an effective fire on a line attacking you would have to traverse—in other words, move your gun so as to make this cone travel along in that way; and even then the cone can obviously only be hitting one or two men at a time. In other words, you would waste many thousands of rounds of ammunition to get a single hit. Furthermore, owing to traversing in that way, it is almost certain that a large number of those men will get home on your line.

The cone of fire or sheaf of fire of a machine gun has this peculiarity: It never rises above the plane to a greater height than that of a man, (six feet,) at ranges of six hundred yards and under. Of course, in your service I do not know the trajectory;—with your weapon possibly you may get eight hundred yards; I do not know; but with our gun the bullet never rises above the height of a man, above the plane, at six hundred yards and under. In other words, if we site our gun so as to insure that there are no dips in the ground, we may be perfectly certain that anywhere between the muzzle of the gun and six hundred yards, no living man standing on his feet, can cross. He must walk through at least 300 bullets a minute, which is about five bullets a second, in order to cross that zone.

Making use of this characteristic, instead of placing your guns as I showed you just now to defend a position, be it trench or anything else, supposing you place your guns in the salients, in this way (indicating) and instead of firing at the enemy at all, you take an aiming mark, under six hundred yards away. You ignore the enemy. Select an aiming mark under six hundred yards away, on the flanks, and order these guns to aim at these aiming marks.

What happens? If the enemy attacks—whether he is in mass or in open order, or in whatever way he attacks—every

gun at once opens fire, not at the enemy, gentlemen, but at its own aiming mark; and the result is you get a band of fire, 300 bullets a minute, from here on to this aiming mark, and in the same way you get a band of fire from here, and from here. Now, it is very obvious that when the enemy's men reach this point they have got to walk through this band of fire, and in almost every place they have got two bands of fire to walk through, and they must pass through these bands of fire at some period or another in order to reach your trench. We call these bands of fire, and we have found that that is the most effective way of using the characteristics of the machine gun, for a defensive purpose at ranges under six hundred yards.

Of course, as I pointed out to you, you have to be careful that you have no dead ground. If you happen to have a bit of dead ground here, where a man can go into the dip and escape the cone of fire, you have to fill up that bit of dead ground by one of our other weapons—either an automatic rifle, a Lewis gun, or whatever it may be, or a group of bombers. You have got to make good that dead ground.

Those bands of fire have been used by our allies, the French, with most extrordinary effect, and by going a step further they have solved the problem of how to use these bands of fire to the greatest effect. Those bands of fire originated with the Germans. That was the German method of defending his line, and it cost us many thousands of men; but with that military genius for which the French have always been celebrated, they took that idea and improved on it. In order to insure getting the enemy under these bands of fire, they ran out a light line of wire entanglement,—so very thin that it could not be seen easily, along the line of fire of each gun. When the enemy attacked he was held up by this wire, and then fire was opened while he was being held up in the wire. From every gun for five or six hundred yards ran this tactical wire, from the muzzle of one gun to here, and then back again to the muzzle of another gun. They withdrew their infantry altogether from the scene of action, behind, where they could rest in safety, away from shells; so that if the machine guns failed to hold up the attack, if the attack managed to break through, after severe losses, the enemy met a counter-attack from fresh troops, not in a line of trenches

—oh, no!—in the open, where it was most powerful and where it got the greatest effect.

According to the old way, if you will remember, the counter-attack always took place, against the enemy, after he had taken your trench. The only advantage you had was that perhaps he had not been able to turn the trench, and did not get quite as good shelter as he might have gotten; but there he was, in a trench. He had something to hold, and you had to attack him. With the French system of which I have spoken, you counter-attack him in the open, and it has proved to be most successful.

I have one little word of warning with reference to that tactical wire: Do not let it be seen. If the wire is seen, either from an airplane or by scouts or by intelligence men with telescopes, that wire will give away the exact position of your machine gun. The enemy has only to follow the wire down with his eye to know that at the end of the wire somewhere is the machine gun. When the French found that out, they did not begin the wire close to the machine gun; they began it somewhere away, and they ran it behind the machine gun, where there was nothing at all, so that you could not tell where the wire began or where it ended, with the result that the enemy bombarded the wire up and down, and generally managed to miss the concrete emplacement in which the gun was concealed.

These guns, four miles south of Ambarakoy, in Macedonia, were arranged in pairs—a very old system come back again,—in pairs, in concrete dugouts at least thirty feet underground; and the French made these concrete dugouts on one system. That is to say, they had boxes or frames made the size and shape of the dugout, and they very rapidly sunk these down, poured in the concrete, took out the frames again, and used them to make another one. They were all on one pattern, and very rapidly made. The gunners and the gun lived down in these concrete dugouts, and they had a concrete emplacement, a double emplacement for the two guns, on the top, from which the guns fired. In addition to that they had alternative positions outside, from which they could use their guns if they wanted to fire them at some minor attack and did not want to give away the position of the concrete emplacement.

I told you that the effective zone of the sheaf of fire from a machine gun, is very narrow and very long. The greater the

range, practically speaking, the shorter the depth of that effective zone. That being so, is that any use to us at all?

We found that it is, and we found that by using the guns in a certain method we can get effect. We have found that the dispersion laterally can be computed by a very simple rule of thumb. That is to say, the angle of descent in yards, of the bullet, multiplied arbitrarily by the figure 4, gives you the number of yards frontage which one gun can cover effectually. It averages about thirty-five yards per gun at medium range; and by working on that, we are able to put sufficient guns down to use distant fire effectively in that way. Of course, each gun traverses a little tiny bit, just a shade, to spread its fire and overlap the next gun. Usually the method of doing it is this: If you have a thirty-five yard front per gun, we let each gun traverse seventy yards, so that two guns are covering the same ground, then there is no space between unbeaten by fire.

I mentioned the fact that the fixed mounting gave you the enormous advantage that the gun had no nerves in action, that its fire was always reliable, no matter what happened. You may be heavily shelled; you may have everything around blown to pieces; but so long as the gun is intact and the gunner is still alive and able to fire, that fire will be almost as accurate when it opens, as if nothing had happened. This is a very important matter.

That being so, we are able to use our guns defensively to enormous advantage. I shall show you presently, through battle actions, an example of how they were used in that way. The fixed mounting enables the machine gun to do several other things which cannot be done with any automatic weapon, but only with a mitrailleuse or machine gun.

First, we can cover the advance of our own infantry by firing over their heads, with perfect safety. So we can do what we used to do in the past with our rifles in a different way: We can support an attack by covering fire.

Secondly, we can use indirect fire. We can fire over a hill or from behind a hill; and if we use certain rules, observe certain laws, we can fire as accurately by night as by day,—a very important thing in modern war. I cannot go into the details of that this morning; it would take too long; but it will be obvious to you, I think, that if you have a lantern, a light of any

sort, or even a luminous mark, placed ten yards from your gun on the ground, and if you get the ordinate between that mark and a certain range on your gun—perhaps an arbitrary range between 2,000 or 3,000 yards on your back sight,—you have only to aim at that mark at night, and you know that your gun is accurately aimed on a bridge or a road for any range you may wish. Another way is by compass, laying your gun with a compass bearing with a white mark to direct you at night. There are many ways of doing it; but the point I wish to bring out is that you can fire as accurately by night as you can by day. Now, you cannot do that with an automatic rifle. You may put it in a rest, you may do all sorts of things with it, but it is unreliable, while the machine gun is absolutely reliable because of its fixed mounting.

Having given you those points, we will come on to the tactics. How should a machine gun be used tactically?

The main principle of using machine guns may be summed up in three words: *Concealment; Flanks; Surprise.* It is essentially a weapon of surprise.

Concealment may be obtained in several ways. Originally, early in the war, in the trench warfare, we took the most elaborate pains to camouflage our emplacements. Emplacements were painted; emplacements were concealed with bushes; emplacements were concealed with chicken-wire and earth and all sorts of things. Everything possible was done to conceal the position of the machine gun, and in order to further conceal it, we used *"alternative positions."* That is to say, each machine gun had three or more positions, so that it could move from place to place and never fire twice in the same spot. That was concealment.

Now that we have given up trench warfare, now that we are attacking and moving forward over the open, the machine gun is even easier to conceal than it was in trench warfare. It is a very small weapon. It only occupies about five feet of space on the ground. I shall show you tomorrow, in my lecture on the Battle of Messines, how easily we concealed it from the Hun, although he was within fifteen hundred yards of it, and had powerful telescopes, and had been there for two years watching us most carefully,—how we concealed it on the front slopes of the hill facing him, while he was looking at us, and how we

had 166 machine guns in full view of him, absolutely in full view of him, within fifteen hundred yards, and he never saw one and never knocked out one. That is camouflage combined with use of the ground. The machine gun in the open is a most difficult weapon to locate; and having located it, as I shall show you when I come to the battle actions, it is a most difficult thing to knock it out.

In an emplacement it is a different matter. In an emplacement, probably the artillery have the range on it exactly. Once discovered, you cannot move a concrete emplacement; there it is; it is obvious, and it will be knocked out sooner or later.

I shall begin with defensive war, because we began with defensive war. I will end with the offensive,—the attack,—because we shall end this war with the offensive.

In defensive warfare, machine guns may be divided into two categories: The forward guns, using direct fire, bands of fire, as I showed you on the board, and the barrage guns, guns using indirect fire in the way I showed you, with such a frontage for each gun as to insure that there is no space along the front they are covering which is not swept by effective fire.

You may wonder why such an effective weapon should be used from a long range in this way. There are many reasons, but I think the principal reason is this: That at night, in particular, if the enemy can get through that short four or five hundred yards of ground, if by chance he gets through, there he is, with nothing to stop him. On the other hand, if you have placed your barrage guns correctly, you can bring down that fire exactly like a hailstorm, on a rocket being thrown up by the people who are attacked, and that fire will and can come down almost before the rocket has burst. Then, instead of having your guns " scuppered," as we say in English, if the enemy gets through that barrage your guns are still eight to fifteen hundred yards behind, and if properly sited in depth they turn inwards on aiming marks, as I explained before, and the enemy still has to meet their direct fire under six hundred yards, their bands of cross-fire. I hope I have made that quite clear.

That is what we mean by defense in depth—strong points, guns crossing each other, bands of fire, and each strong point checker-wise behind the other.

Gentlemen, that is impregnable. At the first battle for Passchaendale Ridge, on the 4th of October, I was in command of the Corps machine guns, and our troops were so successful in their advance that the New Zealanders and the Australians raced into Passchaendale, which was nearly a thousand yards beyond their objective—and had to retire again. I do not mean they were compelled to retire; they simply had to retire because we did not want them there. That was not the objective; but there was no enemy at all to be seen, except prisoners coming in by hundreds with their hands up. There was apparently complete and absolute disorganization of the German army behind. Officers commanding supports told me that they were astonished that within five minutes of the infantry going over they found masses of Germans coming back with their hands up. They could not understand it, they said—how these fellows were coming back so soon, utterly demoralized.

That was the 4th of October. We fought another battle on the 9th, and the third battle on the 12th, and we only had fifteen hundred yards to go to get that ridge. On the 12th a half-dozen German machine guns in concealed emplacements, which we had failed to locate and failed to knock out,—completely and absolutely held up two divisions, stopped the attack, and caused us the most appalling losses—twelve thousand casualties. I began by telling you that the machine gun is a great life-taker. Only a few days ago we read the good news that the Canadians had taken Passchaendale.

I want to emphasize the point that a single machine gun can hold up an unlimited number of troops on its front provided it is properly sited,—tactically correctly sited, and you have got men of iron discipline who will die rather than leave that position.

Now let us take a battle action or two, and see by example—because time is going very rapidly—what these guns can do.

Take one very early action in the war—October, 1914. I have chosen early actions in the war because they will be more interesting to you, who are going to have your early actions, than perhaps the later ones, which I deal with tomorrow. Here was an attack by the Black Watch. The Black Watch were marching on in

this direction at Vendresse (see chart with Appendix No. 24). This is the Vendresse road. There was a large wood here full of German troops. The Germans had guns somewhere back on the ridge, and when the advance guard of the Black Watch reached a point somewhere here, they were fired on from the wood, and artillery opened fire on them from the hill. They decided to attack. The advance guard, two companies, deployed for the attack, and they sent their two regimental machine guns, evidently in charge of an officer who had studied tactics, to support the attack.

How did he support the attack? This was before the days of overhead fire. His aim was to get to the flank. He pushed up this road, which was concealed, a sunken road, and he reconnoitered it himself, gentlemen. The first principle of tactical handling of a machine gun is *personal reconnaissance.* When I am lecturing to students, I always write a large "P. R." on the blackboard. I start on my lecture, and I never say anything about that "P. R." until everybody is talking about it. Then I tell them what it means, and they never forget it. That means "Personal Reconnaissance." That is your first and last duty before you attempt to go into action with a machine gun: See with your own eyes, hear with your own ears, trust no man.

This officer personally reconnoitered, and he found here a dip down into a quarry, and he said: "That is the place for me"; so he took his guns, and he placed the two guns in the quarry, like that (indicating), concealed in this quarry, on the flank. The attack then took place; and finding that he was in this quarry, and realizing that he was on an exposed flank, he did the next correct thing. We did not often do correct things in those days. He did the next correct thing, which was to send an escort of scouts, a small body of riflemen, half a dozen men with rifles, into this bit of a furze-brake here to protect the flank. He did the right thing, because a few shots were fired, and out of the furze-break ran fifty Germans and made for the woods. He opened fire with one gun, and as you see it was very oblique, almost flanking fire, and he killed practically the whole of those fifty Germans. Hardly one reached the woods.

Heavy fire was opened from the artillery on the advance, and the attack entirely held up. A very heavy artillery bar-

rage put down from the hill, and they could not move; and as soon as the artillery had become effective and held up our attack, the Germans advanced in masses out of the wood. They attacked in masses. An officer present described it as "masses of Germans coming out of the wood at the double," and they attacked these two small companies.

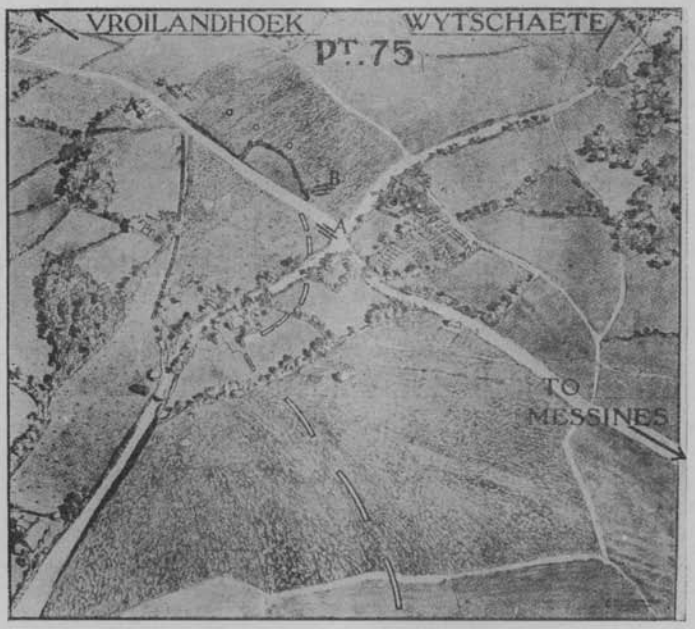
Did this officer with the machine guns open fire? No. He kept quiet, and he waited until the enemy had reached this fence; and when the enemy reached the fence he opened fire with both his guns, and he got them very nearly in enfilade. He searched back from 900 yards range with both guns to 1,200 yards as they fled back to the wood, leaving heaps of dead on the ground; and then, gentlemen, he searched the wood from end to end with his two guns, knowing that it was full of troops. The result was that from the wood debouched a stream of men making for this road. In the meantime, fearing that the artillery might find him, he moved the guns round into the cover here, into the furze-brake, with the result that when the Germans fled out of this wood, he got them in true enfilade.

That was an early but very successful action; and the lesson is that he did everything tactically correctly. He had *concealed* his guns so that the artillery could not find him and did not find him; otherwise they would have been knocked out at once. He got to a place on the *flank,* where he could support the advance. He could not have supported it from anywhere else. He got back on a flank, where he was in the best position to take on the Germans. He realized that being on a flank he must *protect* it, so he sent his scouts into that furze-break and drove out fifty Germans—otherwise, his guns would have been "scuppered" by those fifty Germans before he ever came into action—and he *reserved* his fire. I want to rub that in, if I may use such an expression to such an august assembly. I want to make that sink in very deeply. He *reserved his fire to the right moment.*

I think I may say that our failures in the past with machine guns have been very largely due to our anxiety to loose off our weapons on the enemy, instead of holding our fire. There is one moment when the fire will be more effective than at any other moment. That is the moment to fire;

and it takes a highly trained, highly disciplined man, to be able to keep his finger off that double button when he sees a good target, because he knows, or he thinks he knows, he is going to get a better one.

Here we have another case of concealment. This was a small action, early in the war, between Wyschaete and Messines. (See accompanying plate.) Messines is down here—that is the main road to Messines—and Wyschaete



is somewhere up here. A squadron of cavalry in our army, consisting of only four troops of thirty men each, 120 men with two machine guns, were ordered to cover a retirement of our main body, which was moving down the Messines road; and the officer in charge was told: "You have got to hold the cross-roads here at all costs until evening." He was put down there at night, and he had to hold it until the next evening at all costs.

Well, he disposed his troops, and he placed the two machine guns, one on the cross-roads, because it was night and he could command these roads, and troops are more or less confined to roads, as you know at night. He put the other gun in a turnip field—in the middle of the turnips—concealment! Now, he made a huge tactical mistake, and he did the right thing, both; and, as is always the case, they both came off. In other words, he suffered for his sins, and he was rewarded for his correct action.

His sin was that he had an excellent position for his gun by night, but he left it there during the next day; and as soon as the Germans attacked—and they did attack—and tried to get down this road, they came down on this hill here, and he opened fire at 1,800 yards and completely held them up. They went back; the staff came down, mounted, and they stood somewhere down here, and he opened fire on them, and they scattered; and then there was a pause in the day's occupations, and in about two minutes that gun, the unfortunate subaltern commanding it, and the gun-team, were no more. They rained shells on it, and they hit it almost the first time, and they blew it and the men and the officer away.

Why did they hit it the first time? Because it was in the one place that the artillery always has the range on, the cross-roads, and the one place that artillery always fire at if they have nothing better to shoot at. You ask a gunner what he is going to fire at. He says: "I think I will fire at the cross-roads," because he thinks there must be something coming along.

Now, that is the lesson. He went out minus a gun, with one gun lost; and the Germans, in attack, came down the hill, and the gun in the turnips opened fire and got them in enfilade, knocked them out and stopped the attack. Then every gun the enemy had opened fire on that turnip field, and almost every turnip was blown up, but the gun was not. It was never hit; and that, gentlemen, is another peculiarity about the machine gun. If you conceal a machine gun really well, you can hit every single thing in the neighborhood, but it is only through very bad luck that you get hit yourself. That gun lasted out the whole day; and, to make a

long story short, the Hun was unable to move down the Messines road until the evening, when the cavalry withdrew.

I have told you about the enormous effect of direct fire at close range, and here at the beginning of the war, before we knew a great deal about it, is an incident of the enormous effect of direct fire.

The illustration was furnished by Coldstream Guards at Landrecies. (See diagram with Appendix No. 22.) They were ordered to hold the bridge-head. The village was one of those little, long, narrow French villages with all the houses on the main street, and just where the last houses came were the two main roads leading away. The officer who had to defend that had two machine guns and a company of infantry. He dug two trenches where you see the mark here in white, a trench there and a trench across the road; he put a gun behind each one, filled them up with men, put his sentries out and all the rest of it, and was perfectly happy—felt that he had mastered the situation. But presently he heard a sound of singing and marching feet, and a regiment came down the road singing a French song. So the officer said: "Hello! These are our Allies coming;" and he got out of his trench, and the others got out of their trenches, and an officer dressed as a French officer came up, and spoke French, "Bon jour, Monsieur," and put his sword through him. At the same moment two men dressed in French uniform on either side of him bayonetted the men opposite them, and the corporal in charge of the gun leaped back into the trench and opened fire. Well, unfortunately, the rest of the enemy were massed on the road, and it took a long time to clear the road afterwards.

That stopped the first attack. Night fell, and after many severe attacks he had to withdraw; so he decided to withdraw from these cross-roads and put his guns, one in the main street of the village, beyond the houses, and the other one here at the side, to prevent the enemy coming down here, as they threatened to attack from there. This gun was knocked out early in the day. They rushed the gun and shot the gunners. One gun remained; and the lesson was, that he concealed his gun, although it was in the middle of a single road, the main street of the village, and he concealed it in this way:—

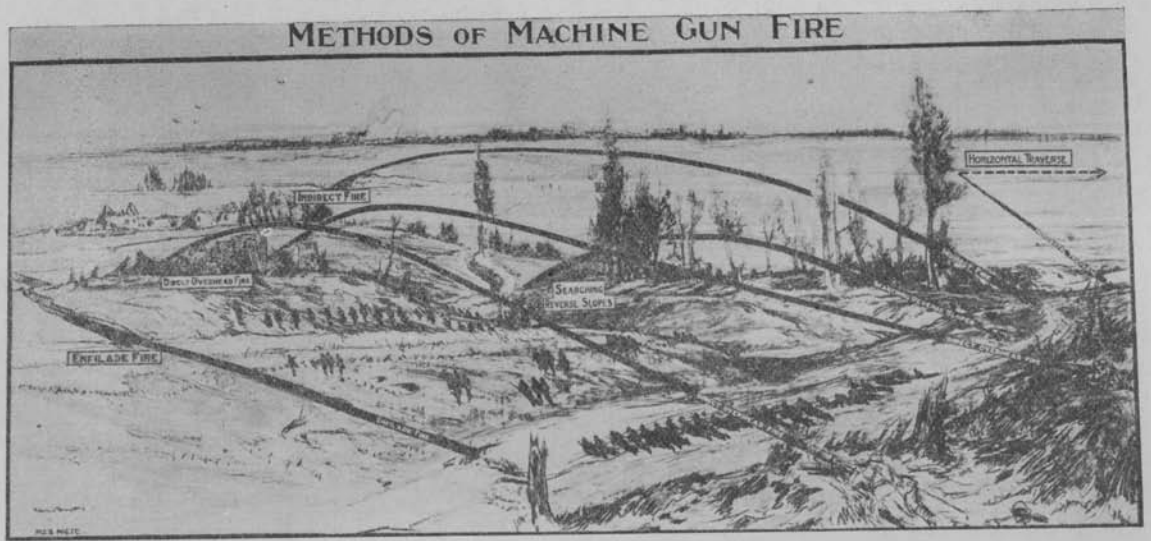
He put his men into a hastily constructed trench in the road, and he put the gun back, behind the trench, about 100 yards, and his orders were, "The gun is never to fire except when the men are firing:" and whenever the attack took place down that street, whenever anybody attempted to attack that barricade, the men opened rapid fire, and when they opened rapid fire the machine gun opened, and the machine gun ceased fire when the men ceased fire, with the result that the enemy were unable to locate the gun. They brought field guns up and they fired down the main street of the village, and they blew houses down on the right and on the left; they made an awful mess of things, but they never hit that gun, because they did not know where it was. Afterwards, later in the day, I think the Grenadiers—I am not sure—brought up another gun across the bridge; and under cover of the fire from that gun the party withdrew across the bridge in due time.

Now, gentlemen, I have been very, very long; but I hope you will bear with me for one moment more. I just want to show you this diagram, because it shows so very clearly the various methods of fire. It is not intended for an institute of this kind. It is intended for teaching the young idea in the machine-gun school.

Here we have a picture of France, "somewhere in France," and we have machine guns and troops attacking, showing the various kinds of fire which the machine gun does, diagramatically.

For instance, we say enfilade is the most effective kind of fire. There is a machine gunner lying down nicely concealed, who is enfilading a company. Now, the enemy had to come up from the farm and occupy this cutting, with our troops behind this hill thinking that they are safe. This gun that is pushed round on the flank fires enfilade fire along this line, and you see it goes down the cutting, and will kill everybody in that cutting. That is enfilade fire.

The next is direct overhead fire. Here is the gunner on a little bit of a hill. Here is the valley between where the men are, and he is on a bit of a hill. The gun is firing over the heads of his own men in the valley, and also the men going up the next hill, and it has direct fire, because from this position he can see all his troops. He can also see his target—the target he is firing


METHODS OF MACHINE GUN FIRE
INDIRECT FIRE
HORIZONTAL TRAVERSE
SEARCHING
REVERSE SLOPES
ENFILADE FIRE

at. That is what we call direct overhead fire. It is over the heads of his attacking troops. Here are the front men, here. He can see them. He can see when it is safe and when it is not safe, and he can see the target he is firing at. That is direct overhead fire.

Here we have another example of the same thing—direct overhead fire. The gunner is on a hill, where he gets full observation, and directs his fire down into that building.

Then we get searching a reverse slope. Here is a gun laid with a clinometer. He cannot see his target. He has laid it by the map. He wants to search the slope of this hill leading down to the yellow area here, and he has laid his gun for a range which will enable that fire to sweep that reverse slope.

Now we come to indirect fire—firing on a target the gunner cannot see, with the clinometer. Here is a gun behind the wood. The gunner cannot see anything. He is going to shoot over the top of the wood, and the fire goes over the top of the wood and comes down behind a hill on this side here, into a trench or something that he has spotted on the map.

Here we have traversing fire. Here is a road, and the gunner wants to traverse that road. Perhaps the enemy are going to pass along it, and you see the "taps." Each "tap" of the gun gives you the group of fire shown on the dotted line.

Of course, gentlemen, that is only intended to illustrate the methods of fire to recruits.

Finally, I am sure you will allow me to say a word on the subject of the machine gunner. We cannot do any good with machine guns, and we did not do any good—that is the lesson I want to impress upon you—we did not do any good; we failed, until we realized that you must organize these gunners, and they must be commanded by a senior trained officer, and they must be used collectively for a collective purpose. To-morrow, in my lecture, I shall give you the details of that.

We realize at the training center at home that the best, and nothing but the best, is necessary for machine gunners. It is a very difficult thing to create a new arm, if I may say so, and make it the *corps d'elite* from the beginning. It is a very difficult thing to get the *esprit d'corps* which we of the old army have for our own regiments. The authorities decided that

the main thing to be desired above everything else, the main qualification, should be discipline. We found at the front that without the most perfect barracks square discipline, unless our men polish their buttons, unless our men spring to attention, unless they march like Guardsmen marching to Buckingham Palace, unless they do all those things, they cannot fight well, they cannot fight so well as we are doing. Really, they cannot. So when the officer or man arrived at Grantham, he was gone over by a surgeon who saw that he was physically, and as far as he could tell mentally, fit. If there was any physical or mental disability found, he never got farther than that doctor's room. If he passed that, he went up, and he was placed in a drill school which we specially created. We got a Guard's officer, we got Guards sergeants, and we had Guards methods; and people used to be astonished, and say: "We can't tell why your machine gunners want to do all this clicking of heels and saluting and presenting arms, and all this sort of thing."

Well, a man went into that school, and he was there for anywhere from a week to three weeks; but he never left that school until he was as smart as his instructor in every detail. I have seen officers with two medals on them doing right-hand salute, left-hand salute, all around that drill-field, and going on doing it until they could do it like a Guardsman. It was necessary, gentlemen, and it has made the Machine Gun Corps what it is; and it was not until that was done that they went on to the other branches of the machine gun education.

I tell you that because I am convinced myself, and I am quite sure I am speaking for every one of us who has been through what we have been through, that if a trench has to be taken it is the best disciplined regiment that takes it with the least loss and with the most prisoners; and if a trench has to be defended, it is the best disciplined regiment that holds that trench with the least loss and the least number of prisoners lost. I can prove that to you, not once, but a dozen times. When we see an undisciplined regiment slouching into the trenches, we say: "Well, the Huns will have some out of them," and they do. They come over, and they take them away in bunches. We put in a very smart

regiment, and you see them marching out, and you say: "By George, that is a smart body of men," and you hear that the Hun has raided them, and you hear that he has gone back very badly beaten, perhaps with one prisoner.

I hope you will forgive me for pointing this out—that if a machine-gun corps or a machine-gun company or whatever you like to call it is going to be formed, if it is not formed of those men, I have no hesitation in saying that it will be a failure. When the machine gunner has to do something, he has to do it very quickly, very smartly, and above all very accurately. If he is not smart enough to keep himself clean, if he cannot clean his buttons, if he cannot put his boots in proper position under his bed-cot, if he cannot salute in the proper manner, you may be perfectly certain that he will not be able to manage that gun smartly when the psychological moment comes. In one case it merely means a slight reprimand; in the other case it may mean the loss of hundreds of lives.

With that I finish my lecture this morning.

LECTURE ON THE MACHINE GUNS AT THE BATTLE OF MESSINES.

By Colonel Applin, of the British Army.

Delivered at the U. S. Army War College, Washington, D. C., November 21, 1917.

My lecture this morning is on the subject of "The Machine Guns at the Battle of Messines." Before I come to the question of the use of machine guns at that battle, I want to describe, just briefly, the strategical situation that led up to that battle. (See plates accompanying Appendixes Nos. 27 and 28.)

In 1915 and the spring of 1916 it was found that the deep salient was becoming a nuisance to the British Army. In other words, we found that the continual hammering of heavy guns by the Hun into our positions there was more than we could stand, and we decided to push him back and straighten out that salient. All preparations were made for an attack on the Messines-Ypres ridge—to be more correct

I should say the Messines-Wytschate ridge, because the ridge ends almost at Wytschate, and it goes back to Ypres practically on a level plain. There is only one little bump on the level plain, which is the hill known as Hill 60, with a little thing in front of it called "The Caterpillar."

The strategical situation did not permit of that battle taking place, however, and the straightening out of the salient was postponed until a later date. Early in 1917 the Germans decided to withdraw to the Hindenburg Line, and they did not give us any notice of their intention, with the result that the plans which we had made had to be altered; and it was decided by the great general staff of the French Army in conjunction with our own, that we should make a united effort to put a final end to the occupation of Belgium by a concerted attack. The plan was for us, the British, to attack the Hindenburg Line from the front, roughly on the line from Arras to Vimy, while our French Allies made the real attack. Ours was to be a holding attack. We were only going to thrust into the line and hold them, fight hard, strike hard, and compel the Germans to concentrate all their troops and prevent them from moving, while the French came up from the south and came in behind the Hindenburg Line and cut off the German Army from the Rhine.

Had that plan succeeded, gentlemen, I probably should not be talking to you this morning. The plan, however, did not succeed. Circumstances were too strong for us; and, to make a long story short, the British took the Vimy ridge, they pushed the enemy back from Arras and held the ridge in front of Arras. I was in Arras in January, February and March, and at that time we were under very severe shell fire night and day. We had shells falling in the garden of my billet while I was there, and we were so close to the front line that we even had a machine-gun bullet from the enemy come into the mess through where the windows ought to have been while we were sitting there one evening after dinner. I mention that to show you how near we were to the front line.

That push pushed the Hun back practically out of range, and he now can no longer shell Arras except with a long naval

gun, and it is not worth his while. He practically does not shell Arras at all. It is shell-free, and the population have returned. You all know the heroic story of the taking of Vimy Ridge by the Canadians; and that success undoubtedly did much to console us for our disappointment in not finishing the war.

After this the great general staff decided to straighten out the Ypres salient; and we had notice of this intention as early as April, so that we had two months of preparation. The Germans knew for twelve months that we were going to straighten out this salient; and the position of the Germans on that ridge was such that they looked straight down from a really big ridge into our trenches. We looked straight up at them on the ridge. It was a most impossible situation, and it appeared that Messines would be impregnable. They had fortified it for over two years; and Messines itself lent itself particularly to fortification, because it contained some wonderful old buildings—an Institute and a Cathedral or church—which had most wonderful cellars, cellars forty feet underground, made of concrete, and, with the big building on top, practically shell-proof to anything. Tunnelling out from these into the hillside, the enemy was able to push out machine guns and observation posts. On our side, our jumping-off point was our little Hill 63, in front of Plugstreet Wood. It is really Ploeugsterdt Wood, but our soldiers corrupted it into "Plugstreet," and it has been shelled until the wood is nothing but matchwood. The whole place, the village of Ploeugsterdt, is simply a pile of ruined masonry. All the villages in the neighborhood are simply piles of masonry, merely indications that they had been human habitations once. That, as I say, was our jumping-off point; and, as you may see, the problem was an extraordinarily difficult one.

I had two months for preparation. I was Corps machine-gun officer of the Second Anzac Corps, and the Second Anzac Corps had the task of taking the Messines Ridge itself; and as Corps machine-gun officer it fell to me to advise, and finally, under instructions from my Corps Commander, to issue the orders for the use of the machine guns in that battle.

I had the privilege of being at Arras when the preparations for the Battle of Arras took place, in February and March; and there we had one of our crack machine-gun officers, who had decided to try a barrage fire of machine guns to support the attack. I had the privilege of hearing what went on at all his meetings with his divisional machine-gun officers and his company commanders; I had the privilege of seeing all his plans drawn up for that. It was on a comparatively small scale, and it was quite a new thing. It had only been tried originally on the Somme, and had been more or less successful—this form of barrage fire with machine guns. It was really put into practice for the first time at Arras on a small scale; but even there they were afraid to do what we call a creeping barrage. They were afraid to creep right in front of our infantry, all the way, slowly, in front of them, and it was done by lifts. The fire was put five hundred yards in front of the infantry line, and when they went over the top the fire was lifted by perhaps two hundred yards at a time until it reached the final protective barrage. That was in its simplest form.

At Vimy, the Canadian Corps machine-gun officer, perhaps one of the greatest machine gunners to-day, arranged an elaborate and probably the first really great barrage, in his attack on the Vimy Ridge; and after the Battle of Vimy, rumors reached me of the success of this. There was great talk of the tremendous support it gave the infantry. They said that it saved thousands of lives by beating down the enemy's small-arm fire after the big bombardment had passed. The Hun was in the habit of placing his men not in the front-line trench or even in the supporting trench, but in switch trenches and reserve trenches, and they lay there in deep dugouts, free from shell-fire; and then, when the heavy stuff had passed over, when the eight-inch and the five-inch shell barrage had passed over, and the eighteen-pounder barrage, the small stuff, had not yet reached it, they popped up out of their dugouts, lined the trench, and fired rapid-fire both with machine-guns and with rifles through the eighteen-pounder barrage, knowing full well that up against the eighteen-pounder barrage was a line of our lads, bayonets fixed, charging forward to meet them. In

that way they wiped out large numbers of our men, caused enormous casualties to the line, and then, when we arrived, "Kamerad! Kamerad!" They lined up and held up their hands and pretended that they had not been fighting at all.

That is what we were up against. This machine-gun barrage just met them, just came down on to their heads at the moment when they popped them over the parapet to shoot; and the result at Vimy was that trench after trench, back trenches, switch trenches, communicating trenches, were found full of dead Germans, and those dead Germans were found with rifle bullets in the breast, nothing down by their feet, always in the breast, showing that they were breast-high over their intrenchments when hit. Now, not a single rifle was fired by our men in the attack; they go over the top in silence with the bayonet; so that that was all done by machine gun fire.

Knowing that in two months hence I was to command the machine guns at Messines, I went and saw my Army commander, commanding the Second Army, and I asked him if it would be possible for me to go down to Vimy, to go over the battlefield, and particularly to consult the Canadian Corps Machine Gun Officer. He allowed me to do so. I went down there for three days, and I went all over Vimy Ridge, and I came back absolutely convinced of the potency of this barrage. But he told me something more: He told me that he did not bother much about creeping barrage. What he was convinced of, was that the real role of the machine gun was the protective or S. O. S. barrage, over the heads of his own infantry, while they were consolidating, to meet the immediate counter-attack; and he pinned everything on this. He worked everything to get his guns in position to put down an impenetrable, impassable screen of machine-gun fire right along his whole front on the S. O. S. signal going up. He told me how successful it had been, how attack after attack had been beaten back. I spoke to other officers, infantry officers, and they were all talking of absolutely nothing but this machine-gun barrage, and how the Huns melted away before it; and I came back convinced that I had two great tasks to do at Messines: (1) To support the attack by covering the advance of my infantry from the moment they left the trench until they reached their objective; (2) to put down a protective barrage when they had

reached their objective, and prevent the counter-attack pushing them out again.

I have gone into that rather at length because I want to make it quite clear.

Incidentally, while I am talking of this barrage, I should like to mention the fact that after the Battle of Messines every one was absolutely convinced throughout the British Army of the importance, the vital importance, of this barrage fire—so much so that Sir Douglas Haig himself, the Commander in Chief, asked Colonel C———, who is with you here today, to arrange a demonstration for himself; and he ordered all his Army commanders, all his corps commanders, and as many divisional generals as possible, to be present at that demonstration. It was held down on the coast; and when my Corps commander got that order to go over he sent for me and said: "Applin, I want you to come down with me." I went down with him, although I ought not to have gone there, because it was intended only for the senior officers. There were only two other corps machine-gun officers there; but I was very glad indeed that I was included, because I had an ocular demonstration of what I had done at Messines but what I had not seen, because you canont see a barrage in a battle. You can see nothing but dust. You can see nothing but bursting shells.

There I saw the guns laid out, I saw the drill, I saw the methods which they had improved. Mine were very rough and ready at Messines, but the school at ——— took it up and improved it; they turned what was a rough-and-ready way of doing it into a drill; they made actual rules for this barrage; they evolved scientifically all the principles of what we had done roughly, roughly hewn; and I saw what I had done at Messines carried out as it ought to have been carried out. Then I had the privilege of going down and sitting in a dugout on the beach; my feet were just outside, and I was asked to take them in, because the bullets would drop very close to my toes; and Sir Douglas Haig and all these great generals were there sitting in these dugouts, and then the guns that we had seen already laid, opened fire; and on the wet sand of the beach in front of us we heard the soft patter of hail—for that is what it sounded like—and we saw the sand go up in little spurts, like this, in a line all the way along, deep—a very deep, long line—the whole

sand going up in little spurts as though there were a heavy shower of hail, a heavy hail-storm, only each one of those hail-stones was a .303 bullet. When that demonstration was over, there was not a General there, however prejudiced he may have been before, that was not convinced of one thing, and that was that he himself under no circumstances would have dashed across that space.

After the Battle of Messines, gentlemen, the French, who had heard of the success of this barrage fire, approached our General Staff and asked if all their school commandants could come to ——— to learn the barrage work, see it done and learn it; and they had the same demonstration given them. Thereupon they said: "That is what we will do," and they went away.

Gentlemen, the proof of the pudding is always the eating. What did the French General Staff do? On the report of those officers, who had seen that demonstration, they themselves at once set up a school, and they set up that school within a few miles of ———, so as to be in touch with it and near it, and they have set up that school for the purpose of teaching machine-gun barrage fire to the French Army. Now, there we have, perhaps, the closest touch of comradeship in Arms between the two allies that we have had yet in the war. They have come and sat down with us, and they are adopting that method; and not only did they adopt it, but they rapidly put it in practice. On the 20th of August, when the Morocco division attacked on both banks of the Meuse, they attacked under cover of barrage fire done by French machine-gunners "on their own"; and the report was that it was a complete and absolute success.

Now to return to our "muttons":—

The problem of the Battle of Messines was the problem of (1) how to get our infantry out of a trench which they had been in for two years, up the side of a very steep hill, a very steep ridge, crowned by the ruins of Messines, crowded with machine guns, with batteries of every calibre of artillery, knowing the range to an inch, with fortifications in depth, great, big, deep dugouts that no gun in the world could knock out, miles and miles of the most elaborate trenches, and the whole thing looking down on us and watching our preparation. The problem was how to get our infantry up into Messines to take that ridge with a minimum of loss.

My Corps commander sent for me and said: "Applin, how do you propose that the machine-gun shall be used at the Battle of Messines?" I said: "Sir, I propose that we shall do a barrage, a creeping barrage, in front of our infantry from the moment they leave the trench until the moment they occupy the position."

Now, gentlemen, that was not done in a day. I had highly trained machine-gun companies. Every officer, every man, had graduated at the training-school at ———, and had probably gone through a second tactical course at the machine-gun school at ———, and was in every sense of the word an expert. You must remember that the men who fired those guns were in every way experts; and yet how did I begin?

I began by pulling those companies out of the line and sending them ten, fifteen or twenty miles behind the line to train; and they trained in the following ways: First, physical training. Every man of those companies did a hard course of physical training until his muscles were iron, because I realized the fact that we were not going to put those guns in a wagon and jump on the horses and wheel that wagon up the Messines' Ridge. I realized the fact that those guns and that ammunition, every round of it, would have to be carried on a man's back. I realized the fact that by the time we had done with our artillery fire the Messines Ridge would be a honeycomb of deep shell-holes, and that the whole of the bottoms, the Steenbeck valley, where there was a straggling river, a stream overflowing its banks in mud, would be a huge bog up to the waist; and so I physically trained my men.

Next, I trained my officers and non-commissioned officers in the methods that they were going to adopt for this battle. They practiced barrage fire, as I say, a very rough-and-ready drill; I issued orders as to how the thing was to be done, and they practiced it continuously. Every single gunner—not "No. 1" only, but every single man in the team —fired the actual barrage that he was going to fire on the short range, over and over again until he was sick of it, and could do it in the dark; he practiced his lifts on a map of Messines made to scale, and he went over the actual lifts

on this short range that he would do in the battle, with aiming marks, until he was tired of it, and knew it backward.

Then came the question of material. I found that we had one hundred spare barrels, and I said I wanted two spare barrels per gun, and I had two hundred and sixty guns; and I was told that it was quite unnecessary; the spare barrels were not required. I ventured to differ. I pointed out that we were going to fire rather more rounds than we were accustomed to fire. They asked me how many rounds I proposed to fire. I said: "About five million rounds."

The life of a barrel for overhead indirect fire is about fifteen thousand rounds. The life of a barrel altogether is about twenty-five thousand rounds—that is, in our Service. So you will see the necessity for having those barrels. Well, gentlemen, I dreamed of those barrels. Those barrels got on my brain; and it was not until the evening before the battle that I got the last of those barrels up by special train.

I wanted clinometers. I was told that clinometers were no longer an issue for machine guns, and I again had the same up-hill fight to get those clinometers. The reason I am giving you all of this is that we want to save you, if possible, from what we have gone through ourselves. We fought for those clinometers, and we finally got, not what I asked for, but we got one clinometer to two guns. We got those just in time for the battle.

Then, in order to make it absolutely safe, foolproof—because, mind you, this was the very first time that a creeping barrage had been used, it was the very first time of my doing a thing of this kind at all, and I was naturally a little bit nervous about it—I decided to put stops on every gun; and I got stops made in the Second Army workshops for every gun, to put on the gun, to prevent the gunner from elevating or depressing his gun when doing the S. O. S. barrage. We put that stop on the gun, and there it was, locked on the barrage line, so that nothing short of kicking the thing over could make the gunner fire at his own people.

Now for the details of how we do a barrage. It will be impossible for me this morning, in a tactical lecture on a

big battle like this, to do more than very briefly explain how the thing is done. It is done in the following way:

In the first place, you have to decide by personal reconnaissance the position for your guns; and it is very obvious that as I proposed to have about one hundred and sixty-six guns in the first barrage firing over the heads of my own people—that was the number required for the frontage; my frontage of the barrage was roughly about three thousand yards—I wanted one hundred and forty-four guns to do that creeping barrage; and it took some reconnoitering to find the positions for each of those guns, as you may imagine.

I decided, first of all, that I would go on the top of Hill 63, or even the reverse slope. This is Hill 63. (See large map in back.) I thought I would come up a good distance back, because if you went over the top you looked straight into the telescope of a Hun sitting in Messines. He looked straight at you. When I got up there and looked at them, I found the range was too great. It could not be done. Also, I met an officer who said: "My dear fellow, you don't think you are going to put your beastly little machine-guns there, do you? There is where the eighteen-pounders are going;" and so that was knocked on the head. So we went on down over the slope; and after a great deal of reconnoitering all along the bottom slope I decided that the best place was to go a bit down the slope into the valley. I will tell you that while reconnoitering there we were very constantly harassed by our friends the enemy, who used to fire at us with everything they possibly could.

One of my divisional officers one day went down; I wanted him to go and have a look and see if he could not alter a position I had chosen. He went down there, and he got outside a bit of barbed wire put there and was walking along when a "whiz-bang" came and pitched three or four hundred yards away—"whiz-bang" being a soldier's term for a high-velocity field-gun shell that comes with a whiz, and you do not hear the whiz much before you hear or feel the bang, so they call it a "whiz-bang." They are very nasty things; they scatter the stuff about all over the place. The man who was with him said: "Look out"—they were in full view—"We had better get out;" so the other fellow

doubled away, found a gap, and jumped into the trench. This fellow ran the wrong way, and the "whiz-bangs" followed him all the way, until presently one plumped up close to him and knocked him over. He saw a tub of water standing by this place, and he crawled under the tub of water, and he remained there for about two minutes until it got so very hot—he was covered with mud and stuff—that he felt he was bound to be hit, so he leaped up, and as he ran they pitched one into the tub of water and blew it to pieces. He luckily found the trench, and as he jumped into the trench, another one burst on the parapet of the trench.

I saw him, I think, four hours afterwards, with his report. He was a very brave and gallant officer, who got the D. S. O. at Messines, but I can assure you, gentlemen, that that officer was still trembling from the shock, when he came to me four hours afterwards. It was a very nerve-shaking experience, and it is not realized by people who have not gone through it what strain it throws on the nerves.

To show you how close we were, and how difficult it was to conceal one hundred and forty-four machine guns on the face of that hill, one day when I was up there with a general commanding one of our divisions; he was looking over the parapet on the top of this hill here, from one of these communication trenches. It was a very beautiful day. He was looking over the parapet, as I say, and I was standing by the side of him, when I heard a vicious little spit, and I looked down, and I saw the earth knocked up about twenty or thirty yards away. I did not say anything; I thought I might have been mistaken. I waited, and again, presently, there was another one; so I got down on the bottom of the trench, and I said: "You had better get down, sir; they are sniping you." He said: "Look here, I am busy now; don't talk to me; I want to finish my reconnaissance," and he finished it; but it shows you that even a man showing his head and shoulders over the top of a communication trench there, was fired at with a rifle from Messines. I mention this to show you the difficulties we had in arranging where those guns were to be.

We finally decided on our gun positions, gentlemen. I personally, as corps machine-gun officer, reconnoitered the

areas, and I allotted those areas to my gunners. Then I found a new difficulty, and that was that the organization of the British company did not suit barrage fire. A company consists of sixteen guns under a Major or a Captain, and no man can command sixteen guns at once. It is an impossibility. He can direct them, possibly, but command them he cannot. For barrage fire you want direct command of your guns; I had not had any experience, but I decided that eight guns would be the most one man could command, and so we were forced to break our companies up into batteries of eight guns.

There was another reason for that, as well, and that is that a certain number of machine guns have to go forward with the brigades to consolidate, and perhaps in the first instance to assist in breaking down resistance at strong points with the attackers; and the number of guns had to be decided.

Well, we had a battle royal over that, as to the number of guns. Naturally a Brigadier wanted all his sixteen guns, and a few more if he could get them, and a Divisional General naturally wanted to support his Brigadier, and the Corps Commander naturally did not want to interfere with his Divisional Generals, and so it met with a great deal of discussion. The end of the thing was that the Corps Commander laid down definitely the rule that four machine guns per brigade should accompany the attack. Now, when I say, "accompany the attack," I do not mean in the firing-line, gentlemen, or with the firing-line, but I mean in such a position that they can arrive at the point and consolidate at the right moment. They were to be under the Brigadiers—four guns per brigade. Four guns per brigade were to be held in Divisional Reserve, in the hands of the Divisional Commander, and the Divisional Commander was at full liberty to give those four guns to his brigades if he liked.

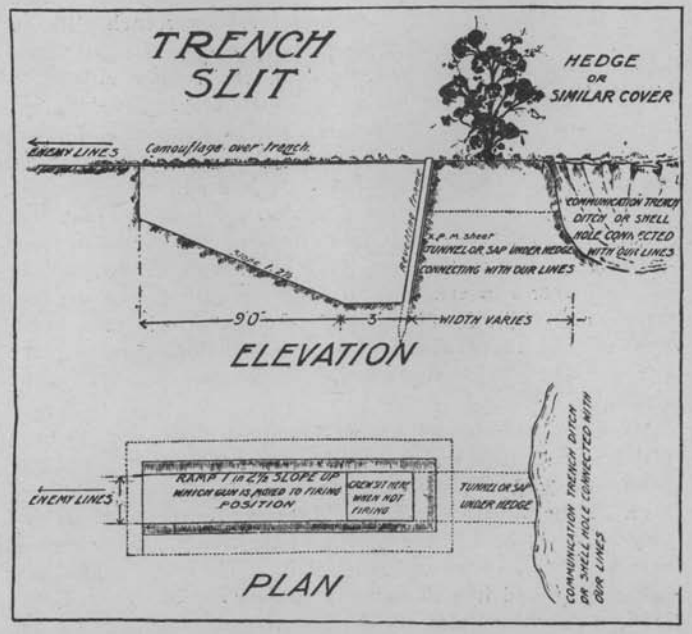
Now, one Brigadier demanded all eight guns—I shall tell you what happened to him presently—and the Divisional General gave him the whole eight. I bagged the rest for the barrage, and we had one Division in Reserve; so that I was able to have the Divisional guns, the guns of the Reserve Division, more or less to play with.

The problem of concealing those guns in full view of the enemy was, as you may imagine, a difficult one. We had trained our men before hand to dig the kind of trenches in which I proposed to conceal the guns, in their training area, and the whole of the gun-teams had practiced digging these things at night, in the dark, so that they could do them on the ground; and they dug what we call a trench slit, which is not my invention, but the invention of another corps machine gun officer. I got it from him. We used these trench slits, and I had one hundred and forty-six trench slits on the face of Messines Hill 63 in full view of the Germans, right away round to Wulverghem, the ruined village of Wulverghem, which is on a continuation of this hill, but goes down into the valley there where you see the river, and then runs up against a steep hill on this side; and the trench slit is what you see here. It is a slit, a narrow slit, cut in the ground, five feet deep by five feet to eight feet long. Some of them made them longer; some of them went to ten and even twelve feet. We left it to the idiosyncrasy of the officer concerned as to what he wanted, but we recommended eight feet long, with a slope one in two and a half, up like that, to the level, which enabled you to place the gun there with the muzzle of the gun just above the ground.

When this trench was dug we improved it, and we put up a platform on which the gun could rest. During the bombardment, and when the gun was not in action, the men sat down here. They pulled their gun a little way down the slope, and they sat down here in the bottom of the trench. The trench is very narrow; and we camouflaged it. This is the camouflage. We camouflaged it with ordinary chicken-netting, covered with stuff to represent grass, which was originally made brown, and then gradually green as the summer came on, until it was bright green, the color of the grass; and that was unrolled and rolled over this trench, so that there was not the faintest sign, with the best telescopes they had in Messines, of anything on the ground. The whole thing looked like grass.

Twenty-four hours before the attack our men had to get into that trench slit. Now, here is a point: If you were asked to sit for twenty-four hours in a beastly little slit like that, and

you were asked not to smoke, and you were asked not to stand up, you probably would not do it; but if you have got the iron discipline that the machine-gunner in the British Army has, and you say to him: "You are not to do that," it is a point of honor with them not to do it, and they did not. When the battle was over it was my pleasure to go round and see as many of those machine-gunners as I could, and thank them for the magnificent way in which they had behaved in those trench slits. Not one



single gun was discovered, and those guns opened fire at zero an absolute and complete surprise to the Hun. Not one single trench slit was knocked out with the intense barrage that the Hun put down on them, and the casualties in those particular trench slits were extraordinarily light. I cannot tell you exactly what they were, because it was difficult to find out, after the battle, who had been hit in the trench slits and who had been hit going forward; but I do not think the casualties were more

than ten out of a hundred and forty-four guns—ten killed and wounded in those trench slits—and practically the whole of the Hun's barrage came down, more or less in their area.

In other words, a trench slit will absolutely protect you against the high explosive shell if you do not get a direct hit. There was one case of a team being buried. They were quite unhurt, however, and they were dug out in a few minutes. Later on, on Messines Ridge, when the guns moved forward for the second barrage, there was a case, two days afterwards or three days afterwards, of a direct hit in a trench slit; and when the officer reported it to me. an Australian officer, he told me that this was a direct hit, and he had lost his gun. I said: "Well, I am sorry. How many of the poor chaps went West?" He said: "Well, nobody was hurt, sir." I said: "How is that possible?" He said: "Well, you know, the boys had gone out of the trench slit into another one to have a pipe and the trench slit got hit while they were away."

Of course, that is neither here nor there.

Now, to come to the details of this battle:

When the infantry left the trench, we were to open fire over their heads—that is, at zero—and in order to insure the safety of the infantry, certain elaborate precautions had to be taken; and they were, roughly, as follows:

In the first place, we had to convince the infantry that we were not going to shoot them; because if you have ever had a machine gun fired over your head, you will know that there is what we call the "crack" of the bullet. That is to say, every bullet as it passes over your head, even if it is three hundred feet up above you, makes a loud, a most alarming, crack, and it sounds exactly as if it had struck the ground or a rock close beside you. In fact, a man hearing that for the first time will make you a bet—you can win money on it—that the bullet hit a rock close to him, whereas really it was merely the crack of the bullet in the air, perhaps three hundred feet over his head. The reason for that crack is a very simple one. It is exactly the same as thunder. It is a momentary vacuum caused in the air by the passing of the bullet, and you only hear it at the exact place where that vacuum is filled up when it is in a certain relation to your ear. That is why you hear it as a crack. If you could get in an airplane and follow the bullet at the

same muzzle velocity, you would hear a continuous crack all the way along—at least, so I am told.

Another thing we had in this battle was what we called the "baby elephant" emplacement. This was used on the Wulverghem ridge, where we were on the reverse slope of the ridge, and would have been in full view of the enemy on the top, and it was not a suitable place to put the guns on the top. The Twenty-fifth Division of the British Army were on that ridge, and the ground was so unsuitable for a creeping barrage that it was decided not to do a creeping barrage for the Twenty-fifth Division at all. They put down a standing barrage, and no creeping barrage at all; and their infantry were hidden from the Hun for the greatest part of their advance, until they got really almost up to the ridge itself; so there was not the same reason for the creeping barrage there. So the Twenty-fifth Division did not have a creeping barrage; they had a direct and indirect barrage on to the points which they were going to take, and they pushed forward a large majority of their guns behind the front wave. They followed the front wave at about five minutes' interval, got over just before the Hun barrage came down, and used their guns forward.

Now, the reason for that was, first, they could not do the barrage; secondly, they had a very peculiar ground, with a series of ridges, and they wanted to make each ridge good, and the system was that of "leap-frog." They sent thirty guns forward under cover of the fire of thirty guns, putting a barrage over the first ridge. When those guns had gotten forward and were ready to put a barrage on the next ridge, the other guns ceased fire and leap-frogged through them while they put their barrage on the ridge, so that the ground in front of the infantry was always covered by a barrage.

Incidentally, their flank was in the air. The Ninth Corps, on our left flank, had something like two or three thousand more yards to go. They were further back, as I shall show you on the map in a moment, so that it was a case of a wheel. Consequently, the outer edge of the wheel had much farther to go than the inner edge; so that the Ninth Corps had much farther to go than our corps. For that reason they wanted to have guns which could not only barrage the ridge in front but which could instantly swing around like that (indicating) and protect their flank in the event of the Ninth Corps being held up.

I want to point that out because it shows you what a tremendous lot of things you have to consider before you can arrange machine-gun co-operation with infantry.

This "baby elephant" (see accompanying diagram) of which I spoke, consists merely of a double piece of bent steel, locked in the middle, which is more or less shrapnel-proof. I say "more or less": Anyway, it is some protection, and by putting a layer of sandbags on the top it is absolutely shrapnel-proof. A pit is sunk in the ground, and this device is laid on the ground, camouflaged, so that it cannot be seen from the air. The gun is in the pit here, and fires through that little slit. The reason for that was that on the reverse slope of Wulverghem Ridge the Hun was always bursting high shrapnel, so that it was one of the most unpleasant places to visit. There was not very much doing, barring that, but that was nearly always doing, and it is a very unpleasant thing; and, therefore, we gave them head-cover because they wanted head-cover. At another point they did not want head-cover; there was no shrapnel.

I have here a reproduction of the map of Messines Ridge. (See large map in back.) It is really a reproduction of my original tracing on a larger scale, so that you can see it. I submitted this for my Corps Commander's approval, and then this was sent to every Brigade and Divisional Commander, with a copy of the orders.

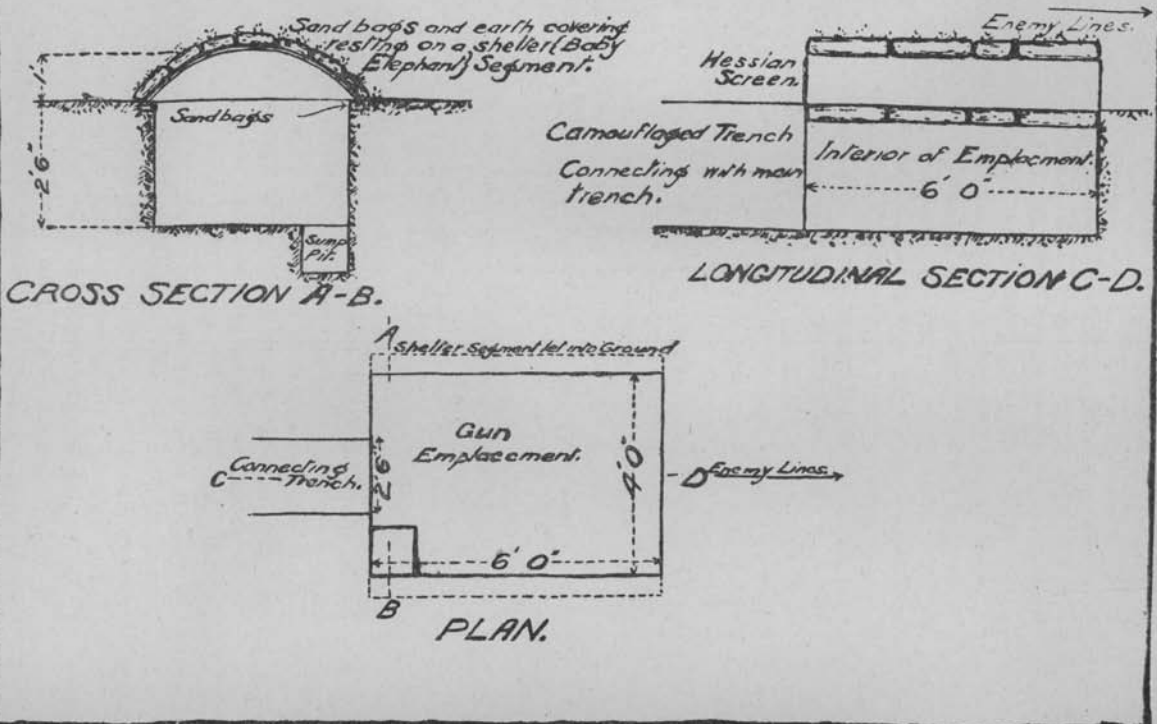
Now I want to describe this as briefly as possible, because I could lecture here for a week on this subject.

Here is the front-line British trench. The blue irregular line is the front-line British trench; and by the look of the river—it is the Steenbeck River—you will be able to realize the fact that this hill runs down to the river, which is in a deep valley, and then the ridge runs up again to the Messines Ridge. Messines is right on the top of the ridge, absolutely on the top or pinnacle of the ridge, here, and is higher than the top of Hill 63. It looks down on to the top of Hill 63, so that when you are on the top of Hill 63 the first thing you realize is that you are looking up at the Hun.

The divisions went over the top in the following way:

On the left was the Twenty-fifth Division, with a very short front, narrowed out to a still narrower front. The front there was barely one thousand yards across, about eight hundred yards

M.G. EMPLACEMENT.



across, and their final objective was barely one thousand yards away, and the lay of the ground was such that they could not do a creeping barrage, so they put down a standing barrage. Their barrage is shown in blue. The guns were arranged in batteries of eight, each battery under a battery commander, and each group of batteries under a group commander, and each division under the divisional machine-gun officer, and the whole show under the Corps machine-gun officer. I want to make that clear first.

You will see here that the guns are lettered A, B, C, D, E, F, G, H, down to W, each one representing a battery. In some cases batteries of eight were not required or could not be put in, owing to the narrowness of the ground, and there we reduced them, either to two fours, or in one case to two sixes, with a four back here. We could not make arbitrary eight-gun batteries because of the peculiar nature of the ground; but you will see there is nothing over eight guns. That is the biggest unit we could manage, and it is the biggest unit that ought to exist in any formation of machine guns, in my opinion; and that opinion is the result of practical experience in the field.

You can see here, on this, exactly where each battery was. Here are the batteries, shown in this way. You can see each battery, where they were situated, how they were broken up according to the ground; and those were up on the high reverse slope of Wulverghem Ridge in those "baby elephants."

Communication was arranged by buried cable from the Divisional officers to their headquarters, and from the Divisional officers to the Group Commanders; and from the Group Commanders to the Battery Commanders, armored wire was used—a word about our armored wire in a minute,—and in certain cases forward, when the guns went forward for the second barrage, ordinary telephone wire was used.

The buried cables were successful, and were never cut. The armored wire was partially successful, but was often cut. The telephone wire was an entire failure, and was always cut. But we foresaw all that, and we arranged two other forms of communication: One, signallers with "Flappers"—that is, the shutter signaller; it is a little shutter which shows red and white, and he operates it and does the Morse code—and the other, and the most successful of all, was runners. Now, gentlemen, runners

have to be trained, and very highly trained. It is a very dangerous game, and you want a man of very high discipline and very highly trained as an athlete to be able to run over shell-swept ground, and particularly over mud and shell-holes.

The plan for doing this creeping barrage for the safety of the infantry was as follows:

In the first place, you cannot see a machine-gun barrage, so your infantry may run into it. To prevent the possibility of your infantry running into the barrage, the barrage was placed four hundred yards beyond the eighteen-pounder barrage, and worked with the artillery. First, note that the machine-gunner must know something of artillery, and must work with the artillery commander. I worked with our Corps Artillery General, the general commanding the artillery of the Army Corps. I used to go to his office and get his plans, his timings, his lifts, his gun positions, and I used to go and make up mine and submit them to him and say: "That is what I propose to do," and we worked together, the two kinds of guns, the machine guns and the big guns; and the place for the barrage is four hundred yards in front of the eighteen-pounder barrage.

When the infantry go over the top, their job is to get up as close as possible, fifty yards, to the shells of our eighteen-pounder barrage, and they have got to sit down under that eighteen-pounder barrage until it starts to creep forward, and when it creeps forward they have got to run forward or march forward—it may be a fast walk; it is usually a fast walk—underneath that barrage. They have always got to keep up to that barrage, because their safety depends upon their being under our barrage.

Four hundred yards beyond that was the machine-gun barrage. Now, when the Hun pushed up his machine-guns and his rifles to fire through the eighteen-pounder barrage, knowing that our men were fifty yards behind that barrage, walking in a line, he was met with the machine-gun barrage that came down and blotted him out. That is the protection that was given to our infantry as they advanced. That barrage crept forward at the same rate as the eighteen-pounder barrage, always keeping four hundred yards in front, until the final objective was reached.

The peculiarity of this battle was that we were on the

right flank, and we did not advance one single pace on this flank. It ended here. We pivoted. We pivoted in that way, forward. Of course the people away over here came forward a great deal farther than that. They were still farther back. It was a pivot movement, because it was a salient, and we were one arc of the salient. Therefore the problem was a different one for each of these Divisions.

The Third Australian Division was the pivot division. Their machine-gun barrage is represented on this map by yellow. These yellow bands represent to the exact scale of this map, to the right scale, the effective zone of fire when the guns were first fired. That is the effective zone of fire, in depth and range, in that way.

Those represent zones of fire placed one on another for a special purpose. There, again, is the zone, in depth, to scale. The depth of that zone is about one hundred and twenty yards, something of that kind—one hundred and twenty to one hundred and eighty.

Here, you see, the zones are one over the other, and double, and an arrow indicates that they were moved back and forth. There is a special reason for that. That was our extreme flank, and naturally the most dangerous place, because if the Hun wanted to counter-attack, he probably would have counter-attacked from here, and would have tried to push up that way; so we put down a double protective barrage on that flank.

Gentlemen, since I have been to ——— and seen that flank barrage put down on the sand and looked at it, I said to myself: "I believe that I could get through that," and I do not think it is really effective. When I did it at Messines, however, we thought it was effective. As the result of the experiment, we find it is not as effective as we thought; and personally I shall never do one again. Next time I shall concentrate eight guns on one point, when I shall get a complete and impenetrable barrage two hundred and sixty yards long by sixty yards broad, that nothing can get through. I point that out because Messines only happened on the seventh of June, and we have learned that much since.

The green represents the frontage and the barrage of the New Zealand division who had the honor of actually taking

Messines itself. Owing to the 25th Division being unable to do a creeping barrage, we put down a barrage on a very bad piece of ground here. I want you to look at that, because that was co-operation. It was not on our ground. Here is our ground. It was not on our front, but on somebody else's front. That is co-operation with the Corps or the Divisions or the Brigades on your right and left—the old story, co-operation. If you do not co-operate, you cannot operate.

Here is the standing barrage of the 25th Division themselves, and you will notice a red barrage overlapping, coming away from the distance up here. That is the co-operation of the Ninth Corps with my Corps. I personally arranged that with the Ninth Corps officer, and I took mine down to overlap his by fifty yards, and he overlapped me by fifty yards, making a total of one hundred yards that we overlapped to insure there being no gap.

Now, you will see several curious barrages here. Here is a double enfilade barrage behind Messines, the zones being put one over another, and covering a depth of about one thousand yards, and doubled.

Behind Messines there was a deep and long communication trench which branched off into switch trenches all down here. All these red lines are communication trenches. Those were the main entrances into Messines. I put that barrage down on that, to block Messines to the enemy. He could not reinforce Messines, nor could he leave Messines, without passing through this barrage. Two days after the battle I went up and I walked over those trenches. Some hundreds of bodies had been buried, but it was very soft walking, because there was only about an inch of soil on most of them. There were quite a large number, quite a good bag, there alone. The "Morning Post" correspondent was up in these trenches a few days afterwards, and there was an article in the "Morning Post" on the enfilading machine guns. Some officer or other gave it away to him, evidently, and he described these trenches as being full of dead Germans; and a group of officers who had evidently run out of the trench and run up the hill here, trying to get away, were lying in a circle, all killed by machine-gun bullets.

This is a very interesting thing, because this battery of eight guns are concentrated, one over the other, and they tapped down here. There ought to be eight, but the man has only drawn four. There were eight guns overlapping, and they "tapped" in "five-minute" taps. The times were written down—45 to 50, 50 to 55, 55 to 60, and so on. They tapped on those times right across these trenches and back again, with the result that they swept the trenches for five minutes on each aim, which meant that a complete, heavy hail-storm for a duration of five minutes from each gun swept the whole of these trenches from end to end. I have no hesitation in saying that the majority of the enemy killed at Messines were killed in those trenches.

Now, gentlemen, I did not do that. That is the only bit of work in the whole thing that I did not do. That was done by an Australian divisional machine-gun officer who drew that up and put it in under my barrage. I sent for him, and I said: "What the —— do you mean by interfering with my barrage and putting that in?" He said: "Sir, that is going to be a splendid thing. You had better leave it in.'" I said: "Certainly not; I won't have it in my barrage." He was one of those persistent people, and he kept coming in to talk about this, and finally I said: "Oh, well, very well, then; let it stand." Well, gentlemen, that was the most skillful thing we had done in the whole barrage.

On taking the black line, which was our first objective, we rested there and consolidated. We rested there for four hours and dug in and consolidated, and then we went on to this green dotted line; the idea being that we were not going to get Messines very easily, and that if we had had a pretty tough fight to get this, and lost very heavily, as we expected to do—we expected to lose a great many thousands of men in taking that ridge—if that had happened, we probably should not have gone on to the green line. We probably should have stayed where we were, and been happy. But if we were successful, in four hours we were to go on to the green line; and, as you can see by the map, we can reach the black line all right from back here, but we cannot reach the green line. So we had the problem of having to move guns forward during the battle.

With the first barrage, for the first twenty-four hours, we did harassing fire. We did harassing fire for a week on the Hun. We fired at him all night and nearly all day. That required an immense amount of organization alone; and the result of it was—I cannot read it to you; I have not time—but the result of it was that the prisoners who came in stated that in Messines for forty-eight hours they had not had a bite to eat except their "iron ration." They had been unable to get the rations up. They said: "Every road and every trench we tried was blocked with machine-gun fire, and the carriers refused to go forward." They would not go up. The artillery kept certain places under fire, and we kept the other places under fire, and that harassing fire came down at odd moments, a half hour at a time and a quarter hour at a time, in odd moments, so as to terrify the drivers and prevent them from moving up.

The second barrage, 130 minutes fire, was the creeping barrage.

The third barrage was the most important of all. I am going to show you next the S. O. S. barrage, to meet the enemy's counter-attack when consolidating. There were ninety-two guns firing, forty-six guns supporting. It is necessary, for an S. O. S. barrage, always to have one in two guns supporting—not firing, but laid, aimed, ready to press the double button, so that should a stoppage, a prolonged stoppage, occur in any gun, there is always a gun waiting to press the buttons and take up that fire. That is a very important point. You have always got to reserve one gun in two, not in reserve in cotton-wool behind, but actually on the ground, laid, loaded, aimed, ready to fire.

Those guns for forty-eight hours remained in position, ready to press the double buttons at any moment, laid on their objective. That was one of the objects of having your one-in-two guns in reserve. You could always haul one-third of your guns out of the line and let them rest without lessening your barrage—a very important point.

That was done with the prismatic compass for direction, the map, and the clinometer; and in order to make the thing foolproof, in addition to the clinometer there was an aiming mark on which the gunner himself aimed when the gun had

been set by the clinometer, so that should the gun shift even in the slightest degree, the aim shifts, and he at once corrects it and gets it back on the aiming mark. I want to point that out, because it is a very important point. As long as that man keeps his gun on the aiming mark, so long is the gun firing with the correct quadrant elevation by the clinometer.

Now, to make certain, to make doubly certain—because, mind you, we were shooting over the heads of our own infantry, and a single mistake on the part of one of those gunners meant death to our people, firing into their backs 300 rounds a minute, something like a million rounds of ammunition, like hail; a single mistake meant wiping out a whole line of our own people—to make doubly certain, between every 250 rounds (that is, each belt) a non-commissioned officer placed the clinometer on each gun and shouted out the reading, so that if the gun had shifted, or the aiming mark had shifted, between every 250 rounds, that reading was checked. He shouted out the reading, "Four degrees ten minutes," or whatever it was "Three degrees twenty-five minutes," and the man who had it there written up in front of him said: "Right!" or if it was wrong he again adjusted the gun. That was the safety precaution taken.

The exact rate of fire was laid down for each gun, and it was not to be exceeded under any circumstances, keeping every area under effective fire. If a gun was knocked out, the battery commander was responsible for seeing that a fresh gun took up the fire.

The battery commander was also responsible for the supply of ammunition. That alone was an enormous problem. He was also responsible for the moving of his gun, for the time of moving it. He selected the moment to move, because no one else could judge when to move, and no one else could judge how to move. He had to watch the enemy's barrage, and when he thought the barrage had lifted he had to move, and he had to move in the direction that he thought was safest for his team. All that he had to do was to reach his second objective on the hill at the schedule time.

The quadrant elevation and safety angles were checked, put on paper on an army form and again checked by the Divisional Officer, and then sent in to be checked by me, as far as I could check such a large number, at headquarters; so there was a complete check; and each form was signed by the officers checking it, so that if anybody had been shot, we could go through those and see that no mistake had been made, as far as calculating the angles went.

The map error is a very serious one. You find that your map shrinks when wet, and you get completely different readings on a wet map, a map that has been exposed to the weather, than you do on a new, dry map.

Calibration is probably the most important safety precaution of all. Unless you calibrate your guns you cannot all be shooting at the same spot. There is an enormous difference in the idiosyncrasies of each gun, and they must be calibrated. The easiest way is to do it on the twenty-five yard range.

Extra oil-cans had to be purchased by me locally, as the Government did not supply cans sufficiently large to enable me to carry the oil required.

Now, while our infantry were digging in on the black line, we had to put down our S. O. S. barrage. We also had to arrange to assist our infantry in moving forward on to the green line, and we had to arrange for a barrage on the green line, while they were digging in on the green line. I will show you that S. O. S. barrage on this second drawing.

You will notice that whereas the guns on Hill 63 were able to stand in position where they were, the guns that were here have all moved forward to these new positions, and in some cases they made three moves. We tried to avoid three moves. Here a battery has made three moves. Where they moved they were called by their letter with the figure "2." For instance, "S-2" is S's second position. He was originally there. "S-3" is S's third position. But they had to make two moves to get forward, and those moves were made in this way:

A gun was to be in position by a certain time, and the officers were allowed to move after a certain time. Roughly from twenty-five minutes to half an hour was allowed, and it was at the discretion of the battery commander and no one else when to move his guns; and it was most successful, because they moved with practically small losses.

The first barrage that was to come down was this barrage here, which you see is a complete barrage right away down to our flanking barrage here. These guns were behind Plugstreet Wood, which you will see on that map in a minute, and were firing over the top of Plugstreet Wood. Now, that barrage never came down, because the Hun never attacked.

We then moved forward to this green line, and in doing so we were able to do a little creeping barrage here. That was a creeping barrage forward at the times set—10:10, 11, 12, 13, 14, 15, and so on—to here. Then that remained down for ten minutes and ceased fire. That barrage, as you see, joins the old barrage here, so that the old barrage joined up with the new barrage in that way and formed one complete belt of fire four hundred yards in front of our consolidation. To get co-operation, we had the Ninth Corps put their barrage down overlapping ours by fifty yards in that way.

At 7:25 on the seventh of June, 7:25 in the evening, the Hun launched his great counter-attack, and he came over in masses, and as soon as he was seen coming, the infantry put up their rockets. That is the S. O. S. signal. On that, the artillery officer runs to the telephone and telephones down to the batteries "S. O. S." The batteries fall in on their guns and load and fire; and as the guns are some three or four miles back, it takes some time, generally about four to five minutes, before the artillery barrage can actually come down thick. Well, I was told by officers at the front—an artillery observer in the front-line trench told me —that on the S. O. S. going up, the machine gun barrage came down instantly, while the rocket was still in the air, exactly like a heavy shower of hail, and he said it was the most curious sight he had ever seen. This barrage came down, the weather was dry, and the dust flew, and the masses of Germans, he said, seemed to eddy and then melt away, and there was nothing left —nothing left; and then the artillery barrage came down and blotted it all out.

What really happened was this: They walked straight into that barrage, and it simply staggered them. The front lines went down. and the back lines disappeared. Every man who was not hit disappeared into a shell-hole, with which the ground was covered. The whole country was full of shell-holes, and all the shell-holes were full of Huns, except the dead ones and at that moment down came the artil-

lery barrage, and there they were, pinned into their shell-holes, and they had to endure the artillery barrage.

I mention that because I want you to realize the enormous importance of this S. O. S. barrage.

Our guns were so far back that under normal circumstances they would have been perfectly safe. As it happened, the barrage was so successful that at the end of forty-eight hours two out of the three Divisional Commanders asked that the barrage might remain on longer, and the barrage actually remained on for another thirty-eight hours, by their request, because they were so pleased with it.

The result of this was that the guns for which we had selected these positions—we had to select these positions off the map; we could not walk up there before the Battle of Messines; it had to be done on the map—were exposed to shell-fire, and this particular flank of Messines was shelled very heavily, and I am sorry to say the machine-gunners in those trench slits were pretty badly knocked about. Practically the heaviest of all our casualties occurred there. It was unavoidable, but it teaches the lesson that if you are going to select positions on a map you will not necessarily select the safest positions. I have often felt rather sad to think that I was responsible for that loss of life through possibly an error of judgment on my part; but one had to do the thing, and there it is. But they did suffer very heavily, and they did not forget to let me know.

Now I propose to tell you the results of the Battle of Messines, and then to quickly run through some very interesting photographs of the battlefield itself.

The ammunition expended is rather an interesting thing.

The Twenty-fifth Division fired 345,000 rounds before the battle in harassing fire.

The Third Australian Division fired 264,000 rounds before the battle in harassing fire.

The Fourth Australians fired 30,000 rounds; and they were in reserve, you will remember.

The New Zealand Division fired 110,000 rounds.

Total, 749,000 rounds fired in harassing fire before the battle.

Incidentally, La Petit Douvre, or what we call La Douvre farm, was a very strong point, very strongly defended, and was a difficult nut to crack. It was surrounded by barbed

wire; and when our artillery had cut it, the artillery commander said: "Now, can you keep that wire open? We have cut the wire; can you keep it open? We cannot waste any more ammunition on it." I said: "Yes"; and we had special machine gun batteries told off to keep that wire open. That wire was kept open, and we took La Douvre farm with no loss. We kept the wire open with machine guns only. I shall show you a picture of it presently. I mention it only so that you will realize what the picture means.

In Barrage No. 1 we fired 944,000 rounds—practically a million rounds.

In the S. O. S. barrage, which of course came down very often, we fired 1,714,000 rounds. Now, there is a very interesting thing about that S. O. S. barrage. It used to go up about five or six times a day, or oftener, and of course led to an awful waste of ammunition. Finally I wanted to know what it meant, because of course we knew there was nothing very great going on. We wanted to know what it meant, and the reply was: "The Hun is sending up the S. O. S. signal." He sent up the S. O. S. signal, saw it the first time, got similar rockets, sent up the S. O. S., and our boys back behind here, where of course they could not see what was going on, naturally thought it was the attack. So you are up against all those little things with our friend the enemy.

Our losses—I am speaking only of the machine guns, gentlemen—were as follows:

The Twenty-fifth Division lost three officers killed and fifteen men; nine officers wounded and ninety men; two men missing; total, 129.

The Third Australian Division lost no officers killed, twenty men killed, eleven officers wounded, ninety-five men wounded, and ten missing; total, 136.

The Fourth Australian Division lost two officers killed, eleven men killed, four officers wounded, and fifty-four men wounded; four missing; total, 75.

The New Zealand Division lost three officers killed, thirty men killed, eleven officers wounded, and one hundred and fifty-one men wounded; five missing; total, 200.

The total losses of my Corps in the battle, as far as machine gunners were concerned, were eight officers killed and

seventy-six men, thirty-five officers wounded and three hundred and ninety men; twenty-one missing; total casualties, 530 out of my Corps of machine-gunners. I do not think that was a heavy price to pay for what we did.

The losses in those divisions in taking that ridge, gentlemen, I think I am right in saying—I will not give you this as gospel—were less than in any other great battle that we have fought in this war. They were the lightest losses we have ever had; and it was said that those light losses were largely due to that machine-gun barrage, which prevented the Hun doing what he usually does, and that is shooting down our men with rifles and machine guns after the heavy artillery barrage has passed over.

The losses in material were very large. We lost thirteen guns, fifteen tripods, two hundred and twenty-nine boxes of ammunition, three belt filling machines, eight spare-part boxes complete, three first-aid cases, and one range-finder; and most of those stores were lost by the brigade that took forward eight guns to consolidate. The officer said: "Those guns are going forward with my line. They are going into the trenches with my line, and I am going to have them really protect me from my line." I saw the machine-gun officer afterwards, and he told me what his losses were—they were nearly all his losses; he lost men and material frightfully from shell-fire—and when asked what firing he did, he said: "One gun fired a little, but we practically did not fire a shot. There was nothing to fire at."

That shows you the danger of allowing an infantry officer to take forward machine guns unless he understands their tactical handling; and for that reason, gentlemen, let me beg, whether you be a Divisional Commander or whether you be a humbler commander of a platoon, for God's sake learn all about machine-gun tactics, not only your own, but the enemy's.

It may be interesting for you to know that at the Battle of Messines—I got this from the general officer, the chief staff officer of the Second Army, so I know it is absolutely correct—for ammunition alone we used eleven trains a day, and we fired twenty-two thousand tons of ammunition in the Battle of Messines—twenty-two thousand tons of ammunition! That is, during the six days of the battle.

That concludes my lecture, gentlemen; and I shall be very pleased to answer any questions that I can on the subject.

(Great applause.)

AN OFFICER. Colonel, I should like to ask you how many men you had serving all of your guns—how many men you had in your machine-gun organization.

COLONEL APPLIN. How many men to each machine-gun?

THE OFFICER. No; your whole organization.

COLONEL APPLIN. In the whole organization, the whole corps?

THE OFFICER. Yes.

COLONEL APPLIN. I cannot answer that off the reel, but I shall be very glad to give you the figures. I had two hundred and forty guns, and each gun had an average of ten men. That is just a rough statement of the number.

ANOTHER OFFICER. Colonel, you spoke of the administrative general on the staff. What are his particular functions?

COLONEL APPLIN. He does all movements, all quarterings and material, ammunition-supply, roads so far as they affect the movement of troops—not the repair of roads, but movements and quarters; practically what we used to call, in the old days, the Quartermaster General. He also does adjutant general's work. He has a deputy assistant adjutant general under him who does promotions and orders. He does the whole of the administrative side of the army corps.

ANOTHER OFFICER. You spoke of the Hun imitating your S. O. S. signal.

COLONEL APPLIN. Yes.

THE OFFICER. Would it not be possible to arrange a schedule of alternating colors of rockets which he could not imitate?

COLONEL APPLIN. I have no doubt that it would be quite easy; but we are a very simple people, and we have kept the same S. O. S. signal for some time now. The S. O. S. signal, ever since I can remember, has been a red rocket, and it is a very easy thing to imitate. Of course the Hun did not do us any harm by doing it. We found it out very quickly, and it did not do us any harm. It just wasted a little ammunition.

ANOTHER OFFICER. Colonel, you spoke about a lesson you had learned in regard to the flanking barrage. I did not understand the difference between what you said was a failure and what you intimated would be done in the future. You spoke of having

seen this flanking barrage tested, and you thought you could improve on it.

COLONEL APPLIN. The flanking barrage theoretically is done by placing the cones one over the other. That is to say, the first gun fires at eight hundred yards, the next gun fires at nine hundred yards, the next gun fires at one thousand yards, and all on the same line, so that you get the cones one over the other, and the ends overlapping. Is that clear?

THE OFFICER. Yes.

COLONEL APPLIN. Right; but owing to the rigid mounting of the gun, and to the fact that it does not lose anything in direction—that is to say, the bullets follow each other out in a straight line—you get a very thin line of bullets. The depth of that may be six hundred yards of ground completely swept, but it is only swept about five or six feet across; so that if you can jump across six feet you have got the barrage behind you; so the troops who want to pass through it have only to leap through a few feet, and they are clear of it. In other words, you would only make about ten per cent. of casualties with that barrage instead of about eighty or ninety per cent., as with an ordinary barrage.

Have I made that clear?

THE OFFICER. Yes. Then the alternative means is a frontal fire barrage?

COLONEL APPLIN. No; not necessarily. Our tests in France proved to me very conclusively that a concentration of eight guns on one aiming mark gives you two hundred and sixty yards depth by sixty yards breadth of absolutely concentrated hell. That was put down to show General Sir Douglas Haig; and he, realizing its importance, at once said to Colonel C———: "Yes, but can you put that down somewhere else? Put it down over on that white flag. How long will that take?" Colonel C———said: "Well, sir, they are students up there, and we will have to telephone up. It will take probably four or five minutes." General Haig said: "Do it." It came down, I think I am right in saying, in one minute five seconds.

COLONEL C———. Yes.

COLONEL APPLIN. In one minute five seconds from the order being given, and the guns were more than two thousand yards behind where we were sitting, it came down perfectly accurately

on that white flag. The depth of it on the sand, the length of it, was roughly two hundred and sixty paces—I paced it myself—and the breadth of it was roughly sixty paces, and nothing living could get through. The fire of those eight guns was concentrated on one aiming mark, and the spread was the natural spread due to the various errors that must creep in, the difference between each gun, the tiny difference in aiming or laying each gun, etc., etc.

ANOTHER OFFICER. What was the opening range of your fire there, sir?

COLONEL APPLIN. The opening range differed according to the position of the guns. Some guns were close, and some guns were further off. We may take it that the average range was about from eight hundred to twelve hundred yards.

THE OFFICER. What would be the effective range for such ...age?

COLONEL APPLIN. For a good barrage?

THE OFFICER. For a creeping barrage.

COLONEL APPLIN. You can creep with a barrage more or less ...tively to two thousand eight hundred yards, but at that ...nce the angle of descent of the bullet is very great, and ...s not kill. It wounds, but it does not kill. It is not very ...ve; but the moral effect of a creeping barrage at that ... is very great. The moral effect is very great of having ... bullets raining down on your head. We consider that up ...o thousand eight hundred yards you get moral effect; up ...o thousand five hundred yards you get actual effect; and ... get perhaps the best effect between eighteen hundred and ... thousand two hundred. I am speaking very generally.

THE STRATEGICAL AND TACTICAL VALUE OF MACHINE GUNS.

By Maj. Lindsay, Senior Instructor, British Machine Gun Training Center.

1. To enable the value of machine guns in war to be thoroughly appreciated, it is essential that sound ideas are held on the subject of what constitutes the fighting value of any body of troops.

The strength of a force is frequently judged by the number of the individuals of which it is composed. This point is fundamentally wrong, and the strength of any force lies not in numbers, but the volume of fire which that force is capable of producing.

It has been said that *"In War Fire is Everything"* and to-day this fact has been proved more conclusively than at any period in the history of war.

Were the combatants armed with stones, or archers at Crecy, or an army of to-day with its heavy guns, quick-firing artillery, machine guns and rifles, the basis of success has been always the same, and victory secured to that side which has been able to pour on to its adversary the greatest number of accurately directed stones, arrows, shells, or bullets in the shortest time.

If this fact is fully appreciated, there can be only one conclusion reached, namely: that it is not numbers of individuals that make for victory, but the amount of fire which those individuals can produce.

2. Even before the outbreak of the present war it was admitted that one machine gun could produce a volume of fire equal to at least 50 rifles, but subsequent experience has proved that even when machine guns have been used, either singly or in pairs, without the advantage of "higher direction" or even very highly trained teams, the effect produced on the enemy has been far greater than that of 50 rifles.

By the collective employment of machine guns in large numbers, under supervision, on a definite tactical plan, their powers as compared to that of the rifle increase out of all proportion to any figure that may be arrived at by a mathematical calculation based on the bullet-producing power of the two weapons.

Every officer of experience in the use of machine guns will agree that their power is underestimated when it is affirmed that employed collectively under these conditions one machine gun is equal to 100 rifles.

3. The establishment* of a machine gun company is

*This establishment is not sufficient to keep 16 guns in action. See Suggested Establishment, which has been found, by experience to be the *smallest* number of all ranks with which it is possible to "carry on."—G. L.

laid down as 150 of all ranks and 16 machine guns. Thus 150 individuals when armed with 16 machine guns are capable of producing a volume of fire equal to that of 1,600 rifles.

According to the establishment of the company it is seen that approximately 10 men are required for each gun, consequently when the machine gun is the weapon in use it may be said that 10 machine gunners are equal to 100 men armed with rifles.

4. Once these facts are clearly appreciated the value of the machine gun from a strategical standpoint forms an interesting study.

Most military operations of a strategic nature on a large scale consist in a defensive along one portion of the front while the offensive is being taken along another. Unless the army desiring to take the offensive is immeasurably superior in numbers over the defender the danger arises that, having massed troops for his offensive, he may have so weakened some portion of his defensive line that the enemy may be enabled to break through. Therefore, he must ensure that he only withdraws for his offensive such forces that the remainder of his line is not liable to be broken and defeated before that offensive has sufficiently developed to ensure a decisive victory against the enemy's main army.

5. It is admitted that for a decisive attack on any portion of the enemy's line large numbers of infantry are necessary, and so far as the British Army is concerned it is impossible to mass the required number of infantry on any one portion without the withdrawal from the remaining portions of considerable numbers.

Therefore some means of maintaining or even of increasing the fire power of that portion of the force which is acting on the strategic defensive must be secured while the infantry is massing for the offensive.

It is here that the value of machine guns does not appear to have been fully realized.

A machine gun company of 150 men, at any rate when acting on the defensive, is equal to 1,600 infantry in its power of resistance to attack.

Thus two machine gun companies would be roughly equal to 3,000 infantry.

Now, machine guns require a certain proportion of riflemen and bombers for their own local protection.

Therefore a force of two machine gun companies supported by 1,000 infantry would be a most efficient substitute in a defensive line for 4,000 infantry; that is to say, the line which had previously required 4,000 men will be held equally well, if not better, by 1,300 men.

6. Let this calculation be applied on a much larger scale. A certain front A.....D is held with 12 divisions.

It is decided to attack the enemy on that portion of the front marked A.....B, consequently it is necessary to mass on, or immediately in the rear, of the line A.....B all the available infantry which can be secured without dangerously weakening B.....D.

Now, 1,000 riflemen and bombers, i. e., one battalion of infantry with two machine gun companies, can hold a line of equal length to 4,000 infantry, i. e., one infantry brigade, but these 4,000 infantry have with them, on their own present establishment, 32 Lewis guns, so that to ensure a sufficient margin of safety let us add two extra machine gun companies per division to replace these regimental machine guns which will of course accompany their battalions to other portions of the line.

On the front B.....D are eight divisions; that is to say, 24 brigades, or 96,000 infantry.

To replace each division withdrawn from these lines 8 machine gun companies and 3* battalions will be required.

Consequently to hold B.....D 64 machine gun companies and 24 battalions will be necessary.

Since 24 battalions equal 2 divisions, 6 of the 8 divisions can be withdrawn from B.....D and placed on or behind A.....B. Thus 72,000 infantry are released for the offensive, and have been replaced by 9,600 machine gunners; in this manner a saving of 62,400 infantry has been effected on the front on which it is intended to remain on the defensive.

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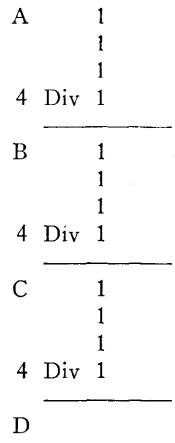
*These will have their 8 Lewis guns apiece, *i e.*, 24 Lewis guns.—G. L.



The majority of experienced machine gun officers will say that this calculation much overestimates the number of machine guns required to replace the divisions withdrawn from the line B.....D; but the argument must be the more convincing if, having erred on the side of safety, the power of the machine gun has been under rather than overestimated.

Needless to say, an efficient system of field fortifications in conjunction with these calculations is taken for granted.

7. They can also be applied on a still greater scale; this is to say, that they can be used to determine the number of troops that can with safety be removed from one theatre of war to another. As long as the strength of any military body is calculated on the number of individuals it contains, no true value of its strength can be obtained.

The only reliable way of deciding the relative strength of armies is by calculating the volume of fire that the armies in question are capable of producing.

8. The great tactical value of the machine gun both in defensive and offensive action is a subject of too great a scope to deal with in the present paper. A few points for consideration however are put forward:

(*a*) Assume that it was desired to send to the Balkans all the

troops that could be spared from other theatres of the war. Owing to the comparatively small numbers that were immediately available for this purpose, it was necessary for those troops that arrived to act principally on the defensive until further reinforcements could have been sent to them.

Let the above calculations be applied and it will be found that for defensive purposes two infantry divisions accompanied by 64 machine gun companies would have obtained a result equal to, if not greater, than 8 infantry divisions. In other words the machine gun force numbering 33,600 men could have obtained as great a result as that by 8 divisions of 96,000 infantry.

(*b*) Next take the case of a small cavalry force, say one brigade pushed forward rapidly to seize some tactical point which it is desired to deny to the enemy and hold until further bodies of troops can be pushed to their support.

Repeating that the Machine Gun Company is equal in fire power to about 1,600 rifles, therefore it follows that it is considerably greater than that of a cavalry brigade.

Thus if the cavalry brigade which was pushed forward had been accompanied by a machine gun company, the fighting power of the brigade would have been more than doubled by the 150 men composing that company.

Therefore the most economical way to employ cavalry for work of this nature is more or less as an escort for a number of machine gun companies.

Once the desired position has been occupied by the cavalry they can be replaced by machine guns and concentrated once more for further action if necessary.

(*c*) In attacks such as those which took place September 25th and 26th it is a noticeable fact that if the artillery have done their work thoroughly the infantry is instantly successful; in fact, as a rule, the assault is either completely successful in a very short space of time or it fails altogether.*

After breaking through the enemy's defensive line it is necessary for the infantry to press forward with the utmost vigor with the object, amongst other things, of capturing his artillery.

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*NOTE.—If 1,000 men can take a position, in 9 cases out of 10, 100 men could do so equally well. For you either succeed or fail according to the effect of your preliminary bombardment, and covering fire.—G. L.

By the time the infantry have got through they are much weakened by casualties, and probably somewhat scattered. The artillery is probably unable to support them, and they have to move forward to a new position itself.

It is then that the infantry, weakened by losses and unsupported by artillery, is brought to a halt by the enemy's reserve machine guns, and the weakened firing line has not sufficient fire power to overcome them.

Now is the time for pushing forward to their support formed machine gun units employed on a definite tactical plan.

These units will enable the infantry either to:—

(1) Consolidate and retain the line gained until supports and reserves arrive,

(2) Secure the superiority of fire necessary for a further advance,

or, if any portion of the attacking line has pushed forward beyond the troops on its right and left, these units will themselves be able to protect the exposed flanks.

(*d*) The value of the machine gun when used as a reserve of power to hold up and drive back infantry that have succeeded in breaking through the defensive line has been so amply demonstrated by the Germans that to draw further attention to it is superfluous.

(*e*) Lastly the mobility of a force composed of machine guns is definitely greater than that of a force composed of infantry equivalent in fire power.

It is obvious that it is far easier to move from one part of a battlefield to another, or from one theatre of war to another, 150 individuals and 16 machine guns than their equivalent of 1,600 infantry.

Furthermore, not only is it in itself more mobile but consider for a moment in the example above mentioned the difference between the numbers of reserves required for the force of 8 divisions of infantry, i. e., 96,000 infantry, and those of the machine gun force numbering only 33,600. Not only that, but an enormous saving in transport and supply is effected, as for example: Assuming the daily rations per man at 31 lbs. each, it only required 450 lbs. to be transported per machine gun company against 4,800 lbs. to its equivalent in infantry, or rather less than 1/10th.

A saving is also effected in forage in the proportion of 5 to 8.

Surely these advantages are worthy of very serious consideration, and the saving in personnel thus effected would tend towards a great reduction in the total casualties sustained by the armies in the field.

9. It is said that Great Britain has difficulty in obtaining under present conditions sufficient men to maintain armies of the required size in the field. If this is so there is greater need than ever for clear thinking on the machine gun question.

As it can be seen that 10 trained machine gunners are the equivalent in fighting value of 100 trained riflemen, it therefore appears to be a bad policy to continue piling up division after division of infantry until every machine gun that can possibly be acquired by next spring is assured of its full complement of trained machine gunners.

The reason ascribed by some for the delay in providing the large numbers of men required during the next few months in order that the machine guns which will become available during that time may be manned, is the lack of men for the infantry. Surely it is better that the infantry should go short than that a single machine gun should remain without its proper proportion of trained personnel. The training of men to use rifles, while there is lack of men to use machine guns, would appear to be like unto a commander, who, having a force, some armed with wooden clubs and some with rifles, continued to train men in the use of clubs, thereby neglecting to increase the numbers of his force who were armed with the more efficient weapon.

Or again, like unto a force, armed partly with magazine rifles and partly with "Brown Besses,' to which (both magazine rifles and "Brown Besses" being available) drafts armed with the "Brown Bess" were sent instead of drafts armed with magazine rifles.

Yet there is a greater difference between the "killing power" of the machine gun and the magazine rifle than between that of the magazine rifle and the "Brown Bess."

10. If it is by now decided, that the creation of a great machine gun force for strategic and tactical purposes is the

most urgent need of the moment, what means exist for its creation and growth?

Up to a few months ago there were no such means, for the machine gun strength both in the field, and as regards training at home, was split up into a number of isolated units, guided by no "higher direction" either in thought or action. But in the new Machine Gun Corps, if it is properly developed, there is the organization which will supply all needs in this direction.

It is, however, absolutely essential that the work and future policy of this Corps should be immediately considered and definitely decided upon.

A few suggestions are therefore put forward as to the lines on which the Corps should be developed.

It must first be remembered that the supply of machine guns no longer represents the difficulty. It is the supply of trained machine gunners to man these guns that is the difficulty.

Let it be decided at once that machine gunnery is the most important branch of infantry work, and that the men must be secured at all costs, even if it requires the decision to maintain a smaller number of infantry divisions in the field, and necessitates the breaking up of many formations now under training, and the conversion of them into machine gunners. Even then the machine gun corps will be faced with a stupendous task, and will need every help from those in authority to enable it to carry that task to a successful conclusion.

11. The following represents the broad lines on which the machine gun corps should work, and the order in which it should tackle its respective tasks:—

(*a*) (*i*) Train a sufficient number of machine gun companies to enable one of these to be attached to every brigade of the armies in the field.

(*ii*) Train a further number of machine gun companies so as to provide a fourth company for each division.

(*iii*) Create a reserve of trained personnel to replenish wastage in (*i*) and (*ii*).

(*b*) Train a further number of machine gun companies to be formed into larger units, say battalions of 4 companies each,

which may eventually be grouped together in still larger formations for strategical and higher tactical purposes.*

(*c*) Absorb into the corps all machine gunners of every kind, whether belonging to regimental sections, machine gun companies, machine gun squadrons or machine gun regiments. These men would be trained in every kind of machine gun in use with the army in the field.

A large reserve should be kept in England, and smaller reserves with each army in the field; it being the duty of the reserve in England to keep up the reserves abroad to some number to be decided upon, by this means all machine gunners, being members of the corps available for general service, and specialists trained in all the adapted types of machine guns, can be drafted in this indiscriminately to any unit that requires them at the moment.

Thus will efficiency be increased tenfold, and drafting be made a far less difficult matter.

12. In conclusion, the whole machine gun question must be fully and carefully considered, and a definite policy as to the creation and development of a machine gun force of great magnitude decided upon.

This question goes to the root of the difficulties of the supply of men for the army, for a number of men armed with a more effective weapon are of far greater value in war than a much larger number less efficiently armed.

In proportion of fire power there is also a saving in officers and N. C. O.'s when the machine gun company with its 9 officers and 11 N. C. O.'s is compared with the numbers required for its equivalent in infantry.

Therefore, if the total numbers of the British Armies are limited, it must be ensured that what there are can make up for lack of numbers by superiority of fire power.

The only way that this can be done is by developing the machine gun service to the utmost limit.

Therefore without one moment's delay the greatest machine gun service possible for this purpose should be created. For this purpose every machine gun is required, and it is necessary to train gunners to man them by every possible means, and in the shortest possible time compatible with efficiency.

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*A "Machine Gun Force," as advocated in Paragraph 6.—G. L.

MISCELLANEOUS NOTES FROM THE BRITISH MACHINE GUN TRAINING CENTER.

Sweeping Reverse Slopes.

Occasions may arise when the reverse slope of a hill can be swept by machine-gun fire. The following method is based on the fact that if machine guns are placed so that the angle of descent of the bullets conforms as nearly as possible to that of the slope of the ground, the maximum effect will be obtained.

The principle underlying this method is to note the angle which the reverse slope makes with the horizontal plane, and then add or deduct the angle of sight between the gun and crest of hill or visible horizon.

Method.

1. From a contoured map determine the angle of descent of the reverse slope.
2. Examine the angle of descent table, and find which range corresponds to this angle of descent.
3. Select a gun position on the map at the range determined, and calculate the angle of sight from the gun position to the crest.
4. Take the sum of these two angles, or, in the case of a negative angle of sight the difference and again determine the final range for this total angle of descent.
5. Place the gun at this distance from the crest corresponding to the range found above.
6. Adjust the sights for the range with an extra elevation of 100 yards for ranges up to 1,000, and 50 yards for ranges over 1,000, and aim at the crest. This extra elevation will ensure that the lower half of the cone is also assisting to sweep the slope.

As the angle of sight to the crest line may be considerably altered when moving the gun forward or backward to the desired position particularly on uneven ground, it may be desirable to calculate the angle of sight again.

The guiding principle of machine-gun fire, which is based on the characteristics of the weapon, is to produce and apply fire in groups, varying in volume according to the nature of the target.

The application of fire is to a great extent dependent on correct appreciation of climatic conditions, the permissible and probable errors in ranging and accurate observation of the strike of the bullets.

When the greatest volume of fire is required the groups fired will vary from 30 to 50 rounds, according to the proficiency of the firer. The firer pauses momentarily between each group to ensure that the sights are correctly aligned, and continues until ordered to cease fire or until he considers it necessary to do so.

When firing for the purpose of correcting ranging errors, groups of from 10 to 20 rounds are used. The word "Ranging" should precede the order or signal to fire. Ranging fire should never be used when surprise is of importance.

Permissible and Probable Errors in Ranging.

Fire will not as a rule produce results commensurate with the amount of ammunition expended, or fulfill the purpose for which it is used unless the target is included within the area beaten by 75 per cent. of the bullets directed upon it.

If an error in ranging is made which causes the nucleus of the cone to strike at a distance short of, or beyond the target, equal to more than half the depth measurement of the effective zone the target will not be included in this zone, and the fire will be ineffective.

The permissible error in ranging, if fire is to be effective, is therefore half the depth of the effective zone, e. g., at 1,000 yards the effective zone is 140 yards in depth; the permissible error is therefore 70 yards.

The probability of error in ranging increases with the distance. That is, the probable error in ranging increases at the same time as the permissible error decreases.

The probable error in ranging may be taken as 5 per cent. of the distance when a range finder is used; 15 per cent. when judging distance is the only means available; 10 per cent. when a combination of the two is possible. To this may have to be added errors due to climatic conditions.

The figures above are given only as a guide, and allowances must be made for indifferent rangetakers, etc.

To give a satisfactory degree of assurance of fire effect, it

becomes necessary, unless the situation permits of errors being corrected by observation of results, to increase the depth of the effective zone. The depth of the effective zone can be increased by the use of "Combined Sights" or "Searching."

Combined Sights.

When two or more guns are working together the depth of the effective zone can be increased by ordering different elevations to be used by each gun, while each uses the same aiming mark. By this means while the effective zone is increased, the density of fire is considerably reduced. The difference in elevation between guns depends on the number of guns available, the probable error in ranging to be allowed for, and the depth of the effective zone for one gun at the particular distance. The extreme difference in elevation must be limited so as to ensure that no gaps are left between the 75 per cent. cones of the different guns.

For general guidance, combined sights differing by 100 yards should be used at and beyond 800 yards and up to 1,200 yards, inclusive; beyond 1,200 yards the difference in elevation should not exceed 50 yards between guns. When two guns of a subsection are sighted to the same elevation "Combined Sights by Subsections" differing by 100 or 50 yards, according to the distance, may be used.

A Machine Gun Commander should use his judgment in modifying the application of the above in accordance with the facilities that may be available for accurate ranging, and thus gain the tactical end in view with less expenditure of ammunition, and less exposure of guns and personnel.

Combined sights should at once be discontinued if accurate obervation of the strike of the bullets can be obtained.

Machine Gun Commanders when ordering combined sights will give out the lowest range and the difference in sighting to be used. The lowest range will always be taken by the left hand gun of the section or sections as the case may be. The No. 1 of that gun will pass to the No. 1 of the gun on his right the range he himself is using and the difference ordered, and so on down the line.

When the target to be engaged is a narrow one, and all guns

are using the same aiming mark, it will generally be impossible for the firers to observe their own particular cones of fire. In these circumstances no alteration in sighting is permissible except under the orders of the Machine Gun Commander. If as a result of his observations or for other reasons, the Machine Gun Commander wishes to alter the sighting, the quickest method is to bring the elevation of the left hand gun above that of the right hand gun or to lower the elevation of the right hand gun below that of the left hand gun according as to whether he wishes to increase or decrease the elevation. To ascertain the amount up or down multiply the difference in sighting between guns by the number of guns used, *e. g.*, 4 guns 50 yards difference; amount necessary 200 yards.

When the guns are laid on different points of aim, each firer should endeavor to correct his elevation from observation of the bullet strike. In such cases the effect may be increased by traversing from the flanks inwards or from the center outwards.

Searching.

The principles of searching are taught in Part I of the Annual and General Course for Vickers, Maxim and Colt guns.

It is used when only one or two guns are available and combined sights will not overcome ranging errors. It requires much skill on the part of the firer to avoid gaps. The size of the groups will depend on the nature of the target engaged. When one gun is being employed for "Searching" the sights are adjusted so that the first group will include the lowest limit to be searched which is dependent on the probable error in ranging expected.

The gun is now laid on the aiming mark, and the sights adjusted without relaying so that the last group will include the highest limit to be searched. The line of sight will now strike the ground short of the aiming mark. A group is now fired, after which the elevating wheel is turned to cause the next group to strike sufficiently far beyond the first to ensure an overlap. This is continued until the line of sight is again brought on to the aiming mark.

When using two guns the left gun will act as described above; the sights of the right gun will be adjusted in the first instance to the highest limit to be searched, and will work down to the lowest limit.

Searching will be discontinued when observation of results is obtained.

The effect of ground rising with respect to the line of sight must be considered when combined sights or searching is employed.

Combined sights and searching can be used for engaging targets of great depth, such as roads, bridges, etc.

Traversing.

The principles of traversing are taught during elementary gun drill and during the Annual and General Machine Gun Courses.

This method of distributing fire laterally is employed against a linear target.

The normal method of traversing is by means of a series of small groups, with the object of covering as wide a front as possible with only sufficient volume to ensure effect. In this case a group should consist of from 5 to 10 rounds only, because against a linear target greater volume will not produce greater effect.

Traversing may be either horizontal or diagonal.

This method of engaging a linear target possesses certain disadvantages. It is a slow method and requires careful training, and the regularity of the groups may possibly detract from the effect produced on the target. The former can be remedied to a great extent by seeking opportunities for oblique fire thus reducing traversing to a minimum. Loss of effect due to the regularity of the groups, can be overcome by teaching the gunner when ordered to apply each group to a different portion of the target.

Up to ranges of about 1,000 yards experiments show that machine guns firing 250 rounds in a minute can distribute fire over about 25 yards of front.

An alternative method is the "Swinging Traverse," the traversing clamp being kept fairly loose, and the gun swung evenly and smoothly from side to side. This method may sometimes be found necessary against dense targets at close range, when the normal method would be too slow.

Using this method a gun can distribute fire over approximately 30 yards of front in 5 seconds at close ranges.

Night Firing.

If the gun position is not exposed to the enemy's fire, the gun, if not otherwise required, can be mounted and laid by day and left till night. At night some kind of auxiliary aiming mark is placed in front of the gun in line with the target. This auxiliary aiming mark can be a screen secured to the open side of a box in which is placed an ordinary siege lantern, or an electric torch. This screen is marked with lines to permit of searching and traversing within definite limits. The horizontal lines on the screen are 1 inch apart, which will give a difference of angle of 10 minutes from the center line if the screen is placed 10 yards from the gun. The amount that 10 minutes represents in range can be readily ascertained from the table showing the angles of elevation for the gun. The vertical lines are 2½ inches apart, which will give deflection of about 2 feet per 100 yards of range, when the screen is placed 10 yards from the gun.

Some searching is necessary at night to overcome any errors in laying, holding, or other factors.

When the gun position is exposed, or several lines of fire are required, it will often be possible for arrangements to be made by day, so that the gun and tripod can be brought up under cover of darkness and placed in position to open fire when required.

By day, an observer selects the gun position and also the target he wishes to engage. He places a stick (L) in the ground about 10 yards from his gun position and in rough alignment between the target and gun position. He then crawls back to the gun position and places a stick (G) in exact alignment with his first stick (L) and the target. If it is probable that more than one target is to be engaged other sticks (L^1, L^2) can be placed between the stick (G) and the different targets (T, T^1, T^2). To do this an assistant is required to place the sticks in position while the observer dresses them from (G). It is necessary to place the sticks vertically in the ground, and the stick (G) should not be more than 6 inches above the ground to avoid being knocked over by the crosshead of the tripod, when it is placed over it.

Ranges and angles of sight to the target must also be taken.

Should it be found impossible to place the stick (L) in position owing to the proximity of the enemy the stick (G) should first be placed in position and a second stick (M) placed in rear of it and in alignment with (G) and the target.

Under cover of darkness the position of (L) can be easily ascertained by an observer at (M) directing an assistant to place a stick in alignment with (M) and (G).

At night, the auxiliary aiming mark is placed in the exact position of the stick L, L^1, L^2, according to the target it is desired to engage.

The gun and tripod are brought up and the crosshead is taken from the socket. The tripod will then be placed over the stick (G) so that the intersection of the "Webs" in the socket is exactly over it. The crosshead and gun are then mounted and aligned on the lamp.

After the required angle of quadrant elevation has been placed on the gun, the tangent sight slide should be adjusted so that the line of sight is directed at the intersection of the central vertical and horizontal lines on the night firing screen. Allowance for any side wind blowing must now be made by using the vertical lines on the screen.

When the conditions are such as to render the placing of the night firing screen in front of the gun impossible, use may be made of mirrors to allow of it being placed in rear or to a flank.

Overhead Fire.

Direct overhead fire with machine guns may be employed under certain limited conditions. The following factors, all of which tend to increase the difficulty and risk in employing fire of this nature, necessitate the working out of a reasonable margin of safety.

1. The state of the barrel.
2. The condition of the tripod and the nature of the ground on which mounted.
3. The degree of visibility of the target.
4. Errors due to ranging and climatic conditions.
5. Accuracy of laying and holding by the firer.

The flat trajectory of modern ammunition necessarily restricts overhead fire at the closer ranges, if the gun position, friendly troops, and the enemy are approximately in the same place, while at long ranges the dispersion of the cone of fire and difficulty in ranging may make it dangerous.

Overhead fire therefore may normally only be employed under the following conditions:—

(*a*) When the gun is fired *from* or *at* a commanding position, or across a valley.

(*b*) When the distance to the target has been obtained accurately, that is by a highly-trained rangetaker, who is able to guarantee the distance within 5 per cent. of error.

(*c*) When the No. 1 at the gun is an expert firer.

(*d*) When an angle of 30 minutes is formed by the intersection of imaginary lines drawn from the target and friendly troops to the gun, the distance to the target being 1,000 yards or under.

If the distance to the target is over 1,000 yards and not more than 1,500 yards the angle thus formed must not be less than 60 minutes.

The above angles give a sufficient margin of safety at 1,000 and 1,500 yards respectively. At distances within 1,000 yards, and between 1,000 and 1,500 yards, the margin of safety continually increases. If the distance to the target is over 1,500 yards direct overhead fire should not be employed, as the position of the lowest shot of the 100 per cent. cone over 1,500 yards is uncertain.

The foregoing may be modified provided accurate and reliable observation is insured. This, however, is a matter for the exercise of judgment and commonsense on the part of the Machine Gun Commander. Too much reliance must not be placed on the ability of an observer to pick up the cone of fire during an attack. The fire of the attacking troops, as well as supporting troops, together with the artillery, may be such, that the machine gun cone of fire cannot be picked up correctly.

The safety angles of 30 and 60 minutes may be obtained as follows:—

1. From prismatic field glasses graticuled for Mark VII ammunition. In this case the distance between the zero line and the 600 yard graticule gives the required angle for 1,000 yards and under, while the distance between the zero line and the 1,000 yards graticule will give the angle for distances between 1,000 yards and 1,500 yards. This method of obtaining the safety angles is unreliable, since it is quite possible for the wrong lines to be used.

2. With the aid of the machine gunner's protractor, as follows: Hold the protractor vertically and at the full length of the

cord from the eye: the space between the safety lines marked will then give the required angles.

3. By means of the tangent sight:—

Lay the gun on the target with the correct elevation, then if the distance to the target is under 900 yards, move the slide up 400 yards; if 900 yards or over move up the slide 250 yards. In each case adopt the auxiliary aiming mark thus formed.

This method has its advantages and disadvantages. In one sense it is against the principles of machine gun training which emphasizes the importance of the No. 1 looking at the target, and not along his sights when firing. Again the gunner, having carefully marked the spot on which the sights are aligned, is trained to take the heads of the advancing infantry as his aiming mark, when they reach and pass this spot, a proceeding which may not always be desirable. The chief advantages obtained from this method are:—

Each gunner can obtain the safety angle required for the particular troops he is supporting; when the troops who are being supported pass the spot marked as an aiming mark, the gunner can still continue firing by elevating the gun so as to maintain his aim on their heads.

Thus the cone of fire passes over the heads of the friendly troops with a uniform margin of safety at each advance, and may search ground in rear of the enemy's position possibly occupied by supports and reserves.

The disadvantages of this method can be minimized by the Machine Gun Commander using a protractor as a check on the firer. This is particularly necessary when the nature of the ground on to which fire is being directed, gives a false impression as regards the limit of safety.

Indirect Fire.

On rare occasions indirect fire may be used. This form of fire is rendered possible by the "fixed mounting" of the machine gun. Lewis guns and others of a similar nature must *never* be used, owing to the fact of their being "air-cooled," and fired from light mountings.

Indirect fire may be of great value in annoying the enemy and affecting his morale, but except under unusually favorable conditions, cannot be expected to inflict serious loss,

The main disadvantages of indirect fire are:—

It requires in most cases a great deal of preparation, but accuracy in calculation. Unless officers possess experience, it may sometimes be employed under conditions, where direct fire is not only possible but necessary. Under certain conditions it may be positively dangerous to our own troops.

Spirit Level Method.

With the aid of a carpenter's ordinary spirit level, indirect fire can be quickly and accurately applied with machine guns, to a target which is invisible to the firer. The conditions necessary for success with this method are:—

(*a*) The target must be visible to the controlling officer from a position behind, and slightly above the gun.

(*b*) The gun must be far enough away from the obstruction to insure the bullets clearing it. This can only be ascertained definitely after the correct elevation has been placed on the gun to hit the target.

(*c*) The gun and the target must be approximately on the same level.

(*d*) The controlling officer, or the range-taker, must observe the fire through field glasses or the range-finding instrument respectively, preferably from a flank.

The method of employing this fire is as follows:

(1) The controlling officer raises his head only just sufficiently to enable him to give orders to the No. 1 as to aligning his gun on to the target for *Direction* only.

(2) Having finished aligning the gun, as described above, the controlling officer now gives the following orders:

(*a*) "Sights at zero."

(*b*) "Level gun with spirit level."

This is done with the Vickers or Maxim gun by laying the spirit level on the top of the breech casing and then by moving the elevating wheel until the bubble in the spirit level is central.

(*c*) "Place an aiming mark where sights are now pointing on near side of obstruction."

For example, a stone or handkerchief, or anything No. 1 can see plainly.

(*d*) "800" (or whatever the range to the target happens to be from the gun position).

(*e*) "Relay on aiming mark."

(*f*) Ascertain if shots will clear obstruction by adjusting the sights for the distance to the obstruction. If the line of sight now clears the obstruction, the cone will also clear.

(*g*) "Fire" (or signal to fire).

Since the gun is now laid, with the correct angle of elevation for the range to the target on the sights, the bullets will now strike the target or in its vicinity.

Any necessary alterations in elevation, or in deflection, are made according to the results of the fire which will be signalled in by the range-taker, observing the fire through his powerful instrument.

This method must not be employed when firing over the heads of our own troops.

Spirit Level, Contoured Map, and Elevating Dial.

From the map ascertain the distance to, and difference in height between, the gun position and target. From this work out the angle of sight in minutes in the following manner:—

Divide the difference in height reduced to inches by the number of hundreds of yards in distance, *e. g.*, difference in height 40 feet, distance 2,000 yards, angle of sight is therefore 24 minutes. The angle of sight can also be found by the following formula:

$$\frac{\text{VI X } 19.1}{\text{HE}} = \text{D.}$$

Where VI is the difference in height in feet, H.E. the distance in yards, and D is the angle of sight in degrees.

Add or deduct the angle of sight thus found to or from the tangent angle for the distance, according to whether the target is above or below the gun position. This will give the Quadrant Elevation to be placed on the gun.

To place the required Quadrant Elevation on the gun:—

Level gun by spirit level, No. 1 holding the while.

Slip dial round till zero is under pointer, without disturbing the bubble.

Clamp dial to, but without disturbing, elevating wheel,

One revolution of the elevating wheel equals 4° elevation or depression on the gun. To obtain an angle of elevation of 8°, the elevating wheel would have to be revolved twice.

The Elevating Dial is accordingly graduated to 4° showing sub-divisions of 5 minutes which are easily capable of sub-division by eye.

When the required elevation has been placed on the gun, put a suitable aiming mark in position between the gun and target; the night firing screen will do for this purpose. Raise the slide of tangent sight as when firing by night, without altering the elevation of the gun. The direction of the target can be obtained by means of the traversing dial, or prismatic compass. During pauses in the firing the gun *must* be relaid on the auxiliary aiming mark. The spirit level should also be placed on the gun at frequent intervals and the gun levelled. If the zero mark on the dial is then not opposite to the pointer, the dial should be unclamped and adjusted so that the zero mark is in the correct position as described above. The correct Quadrant Elevation should then be placed on the gun and the tangent sight slide altered as necessary.

Clinometer and Contoured Map.

From the map ascertain the necessary Quadrant Elevation to place on the gun. Now set the clinometer to the required reading, and place it on the cover with the arc to the rear and with the long edge parallel to the axis of the barrel. Turn the elevating wheel, No. 1 holding correctly, till the bubble is central. Place an auxiliary aiming mark in position.

The clinometer should be placed on the gun at frequent intervals and the elevation checked.

When firing over the heads of our own troops no clinometer should be used, unless it has been tested, and if necessary corrected, immediately prior to firing.

Graticule Method.

By means of graticules cut across the focal plane of a pair of prismatic field glasses, indirect fire can be as quickly applied, as ordinary direct fire.

These graticules represent the angles of elevation for the gun. The topmost graticule represents zero, and the lines below represent every 100 yards upwards, from 200 yards.

Proceed as follows:

(1) Obtain the range to the target.

(2) Move to a position whence you can observe the target through graticuled field glasses, look at the target in such a way that the graticule, representing the range to the target, falls across the target, then look for a suitable aiming mark above the target (which aiming mark must be visible from the position where the gun is mounted) and see which graticule falls across this aiming mark.

The range corresponding to this graticule, is the tangent elevation at which to open fire, using the suitable aiming mark to lay on. By this means great accuracy is obtained while the gun and firer are invisible to the enemy.

This method becomes inaccurate when the eye of the officer using the graticuled glasses is more than 6 feet above the gun.

It is important to get an aiming mark vertically above the target making any necessary allowance for wind. If it is found necessary to increase or decrease the elevation after fire has been opened, since the position of the slide does not indicate the range to the target, another method other than the normal must be employed; there are roughly as many clicks on the ratchet of the tangent sight as there are hundreds of yards in the range, at all ranges below 1,500 yards.

For example, if using 500 yards on the sights and the range to the target is 900, we observe our cone what we judge to be 100 yards short of the target, the officer would order the firer to increase his elevation by 9 clicks, when he will find the elevation recorded on his sight to be 700 yards.

This method must not be employed when firing over the heads of our own troops.

Long Range Searching Fire.

In trench warfare, where the positions of our own and the enemy's troops are clearly marked, long range searching fire, over the heads of our own troops, may sometimes be safely employed.

To obtain the best results, observation of the strike of the bullets is essential. The element of chance, due to errors in ranging, climatic conditions, errors as to the exact position of the gun, etc., will thus be removed.

When observation of results is possible fire may be directed on the hostile support or reserve lines, communication trenches, etc. When no observation is possible the most that can be

hoped for is to engage an area of ground with the object of sweeping reverse slopes of hills which are defiladed from fire at short ranges; interrupting traffic on roads, etc.

To insure the safety of our own troops the following must at all times be strictly adhered to:—

1. No target should be engaged at a range of less than 1,500 yards.

2. The guns must never be more than 1,500 yards distant from bodies of our own troops, over whom they are firing.

3. When the guns are 1,000 yards or under from our own troops, the range at which they are fired must be such as to ensure the center of the cone of fire passing at least 60 feet over their heads.

When the guns are between 1,000 yards and 1,500 yards from our own troops this height must be 125 feet.

4. The position of our own troops with reference to the gun must be accurately ascertained.

5. When there is a *negative* angle of sight between the gun and target, or a *positive* angle of sight between the gun and our own troops, the heights shown in the trajectory table will be reduced.

The guns must therefore be moved back to fire at a range which will give the required safety limits under these conditions.

6. Climatic conditions must be carefully studied.

7. As a slight sinking of the tripod during firing may seriously affect the safety of our own troops, owing to the altered angle of elevation, every precaution must be taken to prevent this happening. The legs of the tripod should be firmly imbedded in the ground, and provision made to prevent them moving from their original position.

8. When "traversing" or "searching" is used provision must be made in the shape of wooden battens, etc., to limit them to a safe amount.

9. A worn barrel should not be used.

10. All calculations must be carefully checked before firing.

11. Troops over whom fire is to be opened must be cautioned, and a certificate to this effect signed by the Company Commander.

12. Clinometers if used, must be tested, and if necessary corrected, before use.

To direct fire on to a target invisible to the guns, a map having

a scale of not less than 3 inches to 1 mile must be used. In order to find the correct elevation, the map must be contoured.

The following information is required from the map:—

The exact position of the gun, the direction and distance between the guns and target, and the angle of sight from the guns to the target. Small errors in the position of the gun will cause serious errors in direction.

The position of the gun on the map can be found by "resection" with the prismatic compass.

The direction of the target can be obtained by means of a compass bearing or by the use of the traversing dial.

To find direction with the traversing dial proceed as follows:

Select some convenient object visible from the gun position which can be identified on the map for use as a reference object. On the map draw lines from the gun position to the reference object and target. Measure with the protractor the angle formed by these two lines at the gun position.

Place the gun in position on the ground, and lay on the reference object. Note the reading shown by the pointer on dial. Add or deduct this reading from the angle already obtained from the map, according to whether the reference object is to the left or right of the target.

When the reference object it is desired to use cannot be identified on the map, its compass bearing must be taken from the gun position and "plotted" on the map. The required angle can then be measured and used with the traversing dial as before.

To place the required elevation on the gun use either of the methods of "Indirect Fire" described above.

To facilitate the making of notes on angles of elevation, bearings, safety of our own troops, etc., it is advisable to enlarge the area to be engaged.

TACTICAL SUMMARY OF MACHINE GUN OPERATIONS FOR OCTOBER, 1917.

(British General Staff.)

1. Nature of Information.

The material on which the present *résumé* is based consists of the brief list of tactical lessons noted in the Army Machine Gun Reports for October, Intelligence Summaries for the same

month, and the narratives of particular operations from September 20th onwards.

Owing to the large measure of agreement which has been reached among Armies as to the principles of the tactical employment of Machine Guns in warfare against highly organized defenses, no striking novelties are to be found in the technical lessons mentioned in the Army reports. On the other hand, the narrative of particular operations shows manifold variation in detail, and sheds fresh light on the application of these agreed principles to the special kind of warfare that was experienced in the fight for the Passchendaele Ridge.

2. Intelligence Publications.

In the daily summaries and special publications issued by the General Staff, Intelligence, the following facts stand out:—

(*a*) There is evidence that the enemy is beginning to copy our methods of indirect fire.

(*i.*) A captured graph was very nearly a facsimile of the clearance graph used in one of our Armies, but it appeared to contemplate the putting on of elevation by some form of tangent sight method.

(*ii.*) Prisoners captured in the beginning of November state that "Barrage and Indirect fire is now being taught to all men in the field as far as possible. One man from each Machine Gun Company is being sent to the *Deutsche Gewehr Fabrik,* at Spandau, for a course including instructions in Machine Gun construction and in Barrage and Indirect fire."

(*b*) In Flanders, during the month of October, the enemy changed his defensive dispositions in a way which very closely affected the tactical employment of Machine Guns on both sides. Instead of the thinly held front line defended in depth by nests of Machine Guns and mazes of wire which afforded gaps through which his counter-attacking Divisions could sally, he placed more reliance on a concentration of troops in the forward area liberally supported by Machine Guns. His counter-attacks were therefore delivered much sooner than previously, and by troops much closer forward. By the end of the month he seems to have found that this change had been carried too far, and reverted to a middle policy of keeping his main counter troops well in rear, and at the same time maintaining his extra

stock of fire power in the front line, especially Machine Guns. These changes affected our own Machine Gun tactics in two ways:—(*i*) It increased the importance of the task assigned to the Machine Guns sent forward to consolidate in the neighborhood of the final objective. (*ii*) It made an *immediate* response to S.O.S. calls of critical importance.

The effect of the machine gun barrage, as reported by prisoners, under the latest tactical conditions may be estimated from the following extracts:—

"Our machine gun barrage was so effective on October 30th, that reinforcements were entirely cut off. Several attempts were made to get through, but proved unsuccessful on account of the heavy fire of our machine guns.

"The 22nd Bav. Inf. Regt. were entirely cut off from their reserves by our machine gun fire. Both the front line and reserve companies sustained very heavy casualties, and the men in the front line, seeing that they could not expect any reinforcements, surrendered." (Second Army Summary of November 2.)

On the subject of Intelligence the Second Army report makes the following recommendation:—"The Machine Gun Company being a single unit distributed over a brigade front and in close touch with brigade headquarters, has opportunities for collecting information greater than those possessed by any infantry battalion. Section officers and N. C. O.'s should be trained in what to report and how to report it. Opportunities might be taken during winter months of attaching officers and N. C. O.'s of the Machine Gun Corps to the Intelligence Branch of the Staff for this purpose."

3. Forward Guns for Consolidation.

The lessons emphasized in the Army reports may be divided into two groups according as they deal with forward or rear guns:—

"The striking feature throughout these operations has been the execution done by machine guns pushed well forward—usually by guns close to the final objective. Excellent targets have been obtained, both as the enemy were retreating and when they counter-attacked. Enemy machine guns and strong points have been engaged and defensive flanks have been formed. Good

results have been obtained both at the intermediate and final objectives; and the rôle of these guns has not been merely a defensive one. On the 20th September on one Corps front 10 to 12 guns went forward in connection with each attacking brigade. About 4 guns were in most cases allotted to the final objective, the remainder consolidating in depth. In view of the results obtained, the casualties were not excessive. Those actually incurred on the day of attack were in many cases slight. Some 30 casualties and the loss of two or three guns may be taken as an average for a company on the day of attack and the two following days." (Second Army.)

"To hold a brigade front it was found that eight guns sent forward with the atacking waves were probably more than sufficient." (First Army.)

In the operations at Polygon Wood, September 26 to 30, the 88 machine guns available to support the attack of one division were distributed as follows:—

Mobile guns	16
Mobile reserve guns	16
Barrage guns, creeping	24
Barrage guns, S.O.S.	32

The mobile guns were under orders "closely to support the attack of their respective brigades."

The mobile reserve guns were under the control of the G.O.C.'s of assaulting brigades.

"The number of mobile guns, 8, allotted to each brigade proved quite sufficient, even in the case of the 15th Brigade where heavy calls were made on the machine guns to cover the exposed flank. . . . Not lsss than six men per gun should be sent forward with mobile guns. These men should all be machine gunners and not attached men." (Report by D.M.G.O.)

The object of forward or mobile guns is to effect consolidation in depth: the guns coming into position after each objective has been definitely captured by the Infantry, and being thinned out where possible in the intermediate objectives after the final objective has been sufficiently organized for defense.

On September 20 to 22 at Langemarck Ridge the work of defense was organized as follows:—

(*a*) "No guns were actually attached to the Infantry at all, but given certain objectives to go to in the ground captured by each battalion, and were given strict orders to work in close co-operation with the battalion.

(*b*) "The teams trained specially with the Infantry whose advance they were to support. A miniature board model was made, showing the whole ground to be taken, the objectives of each battalion, and of other gun-groups, the approximate direction in which they would fire when in position, and the artillery barrage . . . Every N.C.O. and man, both machine gunners and carriers, knew as much of the scheme as the officer did before going over, and this proved invaluable, especially in the cases when the officer was wounded early in the attack.

"N.C.O.'s carried on and went straight to their objectives, having a full knowledge of what their teams had to accomplish."

(*c*) The group of 6 guns which had been detailed to go forward for the defense of Wurst Farm area (which was in the neighborhood of the final objective and the tactical key to the whole situation), picked their way without loss through the artillery barrage with the exception of one gun team which went astray. On arrival the guns were established in their pre-arranged positions. "Infantry officers were informed of the positions of these guns, and the M.G.O. endeavored to assist in the organization of their Lewis guns for counter-attack defense, as the orders were that this position was to be held at all costs: Wurst Farm area being the key to everything. Eventually, by 12.30 p. m. the whole ground around this stronghold could be swept by machine gun, Lewis and rifle fire.

"No gun, Vickers or Lewis, had a field of fire of less than 600 yards. The co-operation between these guns, and their excellent field of fire, proved later, in the counter-attacks, to be invaluable. Every gun, Lewis and Vickers, had a clear and specific portion of ground to cover, which minimized the amount of ammunition that might be wasted (such as would be caused by the Vickers and two Lewis firing on the same point)."

In the operations by a division at Wallemolen at the foot of the Passchendaele Ridge, October 26th and 30th, all four ma-

chine gun companies, in accordance with an earlier Divisional instruction, received their orders from the D.M.G.O., who also had the supervision of all machine gun training. The forward guns came under the orders of the Group Commander of the rear guns at advanced brigade headquarters. This arrangement was made with a view to co-ordinating the work of forward and rear guns and keeping the D.M.G.O. in immediate touch with the general machine gun situation. Thus, when two guns of the right consolidating section were hit by shell fire, they were promptly replaced from the barrage batteries which, in turn, received guns from the rear. On October 26th the casualties were very heavy, and therefore on October 30th the gun teams were under orders to proceed more slowly with their guns wrapped in water-proof sheets. The casualties were then very light, and "as soon as the Infantry line was established, the whole front was covered by the cross-fire of these guns." Their orders were:—"These sections will advance after reconnaissance by bounds of about 50 yards. They will take every precaution to keep their guns and belt-boxes clean. Their duty is to deal with counter-attacks in force and not with snipers and small parties which will be dealt with by riflemen or Lewis guns of battalions."

4. Rear Guns for Covering the Advance, and S.O.S.

In contrast with the advance attempted on July 31st, the advances made by the Infantry in the latter stages of the Ypres operations were much shorter. This materially affected the tactics of the rear guns and enabled them to take steps for surmounting difficulties which had been experienced in the earlier stages.

"The shortness of range of a machine gun barrage makes it difficult to select positions clear of the hostile artillery barrage. In consequence, barrage machine guns are very liable to be silenced, and it has been found in operations on a large scale, machine gun barrages soon become thin and patchy." (First Army.)

"The failure of machine guns to be able to deliver effective barrage fire in certain operations has been invariably traced to the difficulties in reloading wet belts by hand (the employment of the existing type of belt-loading machines being alto-

gether out of the question) and the lack of ammunition in dry belts." (Second Army.)

To give the fullest value and the greatest reliability to the machine gun barrage under the exceptionally difficult fighting conditions in the Ypres theatre, various expedients have been adopted.

In the case of one division, dumps of S.A.A. and strong weather-proof belt-filling shelters were erected in the forward area during the comparatively quiet period before the divisional relief; and on the night following the firing of the barrage, by which time the objective had been fully organized for defense, the barrage guns were very considerably thinned out.

In other cases higher rates of fire than usual, *e. g.,* 100 rounds per minute for 1 hour 40 minutes, and wider traverses were adopted. "In a program shoot in shelled areas guns should not be called on to fire at a less rate than 75 rounds per minute. To fire at a slower rate involves the exposure of more guns and teams than is necessary. All available guns should be mounted at the conclusion of the shoot for the S.O.S." (First Army.)

Nearly all reports of operations emphasize the importance of avoiding, when possible, the necessity for a forward move of the barrage batteries, for two reasons:—

(*i.*) The exposure to shell fire while moving.

(*ii.*) The difficulty of carrying up sufficient S.A.A. to a forward position for S.O.S. work.

In contrast with Vimy and Messines, where a continuous covering barrage was considered necessary, it has now become more usual to put the machine gun barrage on selected parts of the front only. The chief reason for this has been the exceptional density of our own artillery barrage in the Ypres sector, and the small depth of advance attempted on any one day. For example, on September 26th, at 'Sgrafenstafel, the 64 guns of one division were divided into:—

Rear guns	40
Forward or mobile guns	24
Total	64

Instead of a continuous barrage the guns fired by batteries on (*i*) "Pill-box" areas, (*ii*) the 'Sgrafenstafel cross-roads, (*iii*)

along the Hannebeke valley. They had also as their second task a final S.O.S. line 400 yards ahead of the infantry objective.

The covering fire, beginning at zero or later, was maintained for two hours after the arrival of the infantry at the final objectives, which were consolidated without interference from the enemy.

The S.O.S. barrage line was on the basis of 30 yards per gun, and when called for at 3.15 p. m: it was down before the artillery barrage.

"On September 26th, at Polygon Wood, another division adopted a further modification. Each of the two groups of rear guns had a separate task. The creeping barrage group (right) covered the infantry advance to the intermediate red line, firing 50 rounds per minute. It was then under orders to "Stand by until ordered to withdraw;" but the attack of the division on its right partially failed, and therefore batteries of this group were switched to assist the arrested advance by area shooting. They were instrumental in breaking up counter-attacks on more than one occasion, and on the 27th opened fire on seven different occasions in the British area. At 4.30 p.m. on the 27th these guns were firing on localities where the enemy were reported to be massing for attack, one minute and ten seconds after the information reached me" (Report by D.M. G.O.). Constant telephonic communication was maintained between D.M.G.O. and the creeping barrage group. The guns were in position for 60 hours.

The S.O.S. rear group was allotted the task of replying to S.O.S. calls on an S.O.S. line 500 yards ahead of the final objective. In addition, during the consolidation of this line it searched its frontage to a depth of 800 yards. Between 7.30 a.m. of September 26th and 11.55 p.m. on September 28th, ten S.O.S. calls were answered, at a total expenditure of 738,000 rounds (including 314,000 for the first call on September 26th). The guns were in position for 85 hours. After 8.45 a.m. on September 26th, all communication with the S.O.S. group was by runners, as the buried cable was cut. This, however, did not interfere with their work. "These guns are usually firing for many minutes before word can be sent to the Group Commander even when communication holds."

The above arrangement suggests a very interesting point. It

is of course open to the objection, noted in the Second Army report, that two sets of positions have to be dug, and two sets of men have to be kept under fire during operations. But where there is a choice of ground and good cover in positions which would not be suitable for S.O.S. work, it is possible that batteries here can fulfill a double function. They can take part in covering the initial advance; and also, because, being on less exposed ground they can hope to maintain telephone communication, they can be used as switch batteries for concentrated fire on areas opposite their own front or that of an adjacent division.

The extent to which observation can be obtained varies with the weather and the position which the battery or group occupies with reference to the operations as a whole. On the flank in clear weather, as for example, at the capture of Hill 70, north of Lens, in August last, it was possible to direct the fire of a group of batteries in a division covering the Canadian left flank from an observation post on commanding ground. It is also on the flank of an attack where the Infantry advance is small or nil, that telephonic communication can be most easily maintained. It is, however, sometimes possible to get good observation even in the centre of an attack. Thus, on September 20th from Shrewsbury Forest it was possible to observe not only enemy movements, but also the strike of the bullets on the ground (the ground being dry and the concentration of fire intense.) The rear guns here, which were divided as usual into two groups right and left, were sufficiently under control to enable one group to co-operate with the other when there was a check on the latter's front.

The battery positions had been selected as far forward as possible with a view to avoiding a forward move. In addition to covering the infantry advance and firing on the S.O.S. line during the main counter-attack later in the day, the batteries, by reason of having good observation and communication, were able to fire on several different occasions on enemy troops as they were preparing for the counter-attack. In this way machine gun fire could be directed on to enemy targets from zero hour right down to and including the main counter-attack.

5. Forward and Rear Guns.

Hitherto the term mobile gun has been applied to guns detailed for consolidation because they have to go forward before they

can consolidate, and the arrangements for their move are almost the most important part of their work, but it would be a mistake to suppose that forward or mobile guns are in any sense peculiarly appropriate to mobile warfare. The contrary is the case. These guns are only intended to come into action when a position has been won and the fighting is momentarily stationary. While they are fulfilling their normal rôle they are not helping to cover the infantry advance. Moreover, inasmuch as when the infantry are moving, the guns also are moving at some distance behind, they are apt to be caught at a tactical disadvantage if they are hurried up into action suddenly. It is therefore to be anticipated that just as the stationary barrage guns cover the advance in warfare against highly organized defences when the total move is a small one, so some form of barrage guns of the nature of mobile batteries will be required to follow up and support by overhead fire the several successive stages of a more or less continuous advance. It is therefore possible that more instruction will be obtained from a study of the arrangements at the earlier fighting at Vimy and Messines than from the subsequent and perhaps exceptional type of warfare now under consideration.

6. S.O.S. Barrage in Defense.

The report of the Division referred to on the operation of September 26th submits as the final tactical lesson, "The advisability of considering machine gun S.O.S. barrage a permanent portion of all defensive schemes, owing to the *rapidity* with which such machine guns can open fire." This is in accordance with the suggestion put forward in previous *résumés*. Central control, flexibility and rapidity of action are the three great desiderata of machine gun barrage fire, and the operations of the third battle of Ypres have supplied a most valuable training ground for the realization of these lessons in the most trying conditions.

7. Lessons.

The principal lessons to be learnt from the operations under review may be summarized as follows:—

(*a*) The Germans are undoubtedly very much impressed by the effectiveness of our present methods of employing Machine

Guns, and we may expect a gradual development on similar lines in the German army.

The normal German establishment is now:—

Light Machine Guns: 2-3 per infantry company. (72-108 per division.)

Heavy Machine Guns: 8-12 per battalion machine gun company. (72-108 per division.)

The minimum figure is probably normal for divisions in quiet sectors of the front, the maximum being reached in active sectors.

The average number per division is:—

90 light Machine Guns
90 heavy " "

Total 180

There are also about 90 independent machine gun "marksman" detachments (each of 3 companies), which are G.H.Q. troops and are allotted as required to particular sectors of the front. These companies are similar in establishment to the battalion machine gun companies. Any development of scientific machine gunnery by the enemy, therefore, is deserving of the most serious consideration and can only be met by still further scientific development on our part.

The development of rapidly produced barrage fire by organized machine gun batteries will be an essential feature of any successful effort at pushing forward under conditions of open warfare to exploit an initial success, when adequate field artillery support is lacking.

For this reason, it must be realized that the development of scientific machine gunnery is as important from an open or semi-open warfare point of view, as it is from a trench warfare point of view, and this should be very carefully considered in the winter training of all machine gun companies.

(*b*) There is still a tendency to push forward too many forward guns into the forward portions of the positions to be consolidated.

(*c*) The fact that the forward guns should work on as carefully a thought out plan, and be given as definite orders, as the rear guns, still wants further emphasizing.

(*d*) Forward guns should seldom be definitely attached to

infantry battalions; they should have definite orders as to routes, positions, etc., and be directly under the brigade to which they have been allotted. The Machine Gun Commander at Brigade Headquarters should also be the channel of communication between the Brigade Commander and the forward guns.

(*e*) The great importance of an efficient Machine Gun S.O.S. Barrage has again been brought out, and the necessity of the Machine Gun Barrage being "flexible" and easy of control has been demonstrated on many occasions.

(*f*) There still appears a tendency in some divisions to use machine guns for work that is essentially the rôle of riflemen or Lewis guns, namely, to deal with snipers, infiltration, and early small local counter-attacks.

The tendency is dangerous insomuch as it weakens the machine gun defense in depth against the larger counter-attacks which develop later.

NOTE.—It is clear that the terms "Mobile Guns" and "Barrage Guns" hitherto used are misleading. It has therefore been decided to adopt the following:—

Forward Guns, that is, the guns allotted to infantry brigades to go forward in support of the attacking battalions and carry out consolidation in depth of the ground won.

Rear Guns, that is, the guns which supply barrage and other forms of covering fire from positions in rear.

THE BRITISH MACHINE GUN TRAINING CENTER.

(Report of an American Observer.)

When on April 20, 1915, I visited the Machine Gun School at the front, its Commanding Officer, Major B. stated that he had recommended the organization of all the machine guns of a brigade into a single company, to be attached to Brigade Headquarters. As a result of efforts along this line by officers expert in the matter of machine gun work and the necessities of its service, a machine gun corps has been organized in three branches—cavalry of the line, infantry of the line, and the motor machine gun service.

The training center of the machine gun corps, except as regards the motor machine gun service, has been estab-

lished at ———, in ———. It is commanded by Colonel (temporary Brigadier-General) H., C. B. He has a staff of eleven officers (one of these being at present a vacancy), ranging from the grade of Lieutenant to that of Lieutenant-Colonel, and consisting of two Assistant Commanders, two General Staff officers, one Deputy Adjutant and Quartermaster-General, a "Major," an Adjutant, an Assistant Adjutant, a Quartermaster, an Assistant Quartermaster, and an Instructor. This "Centre" at ——— consists of three branches or departments—the machine gun companies in process of organization and training, the machine gun depot companies, and the machine gun school. The staff of the school itself consists of 16 instructors, 22 assistant instructors, and a large and varying number of attached officers of all grades. The diagram shown in Appendix No. 1, which was drawn up for me by the senior Instructor of the school, Major C., will show the general outline of the administration of the Centre as a whole. The entire force on duty at the Centre at the present time consists of 1,830 officers and 12,500 enlisted men.

Colonel J. told me that at first they had some difficulty in impressing on unit commanders and commanding officers of training camps the importance of sending to them only the fittest men. They are gradually educating the service at large to correct ideas in this respect by promptly returning as unfit a great deal of the personnel sent to them. He said that in one case they sent back to a single unit 87 men of a draft of 130 from that unit. This raised a considerable stir and he was called upon for an explanation.

HEADQUARTERS,

9th March, 1916.

The depot companies and the machine gun companies are all under the charge of a Chief Supervising Officer with the rank of Major, who has several assistant supervising officers to direct the work. The new Field Service Manual, including the War Establishment for a machine gun company, has just been gotten out provisionally for the use of the training center at ——— and a copy of it was given to me. It has

already been changed to some extent as it shows a machine gun company with a strength of 150 while it is now in fact 153, as it includes an extra officer with the rank of Captain as second in command, one saddler, and one officer's servant. It is said by all here that the machine gun company is not nearly large enough, that it should contain at least 200 men, and that in the Guards Division which is able to regulate its own affairs to a much greater extent than can be done in other parts of the army they have already realized this and have taken ordinary infantrymen from the ranks and increased their machine gun companies to 250, a company in one case having reached 270. They are urgently impressing on the War Office the necessity for a larger number. As the organization stands now there is one machine gun company for each brigade attached to Brigade Headquarters and in no sense dependent on the individual battalions. This company has four sections with a total of 16 Vickers guns. There are in addition 32 Lewis guns with the battalions, eight to each battalion. (After I had returned from ——— Colonel L——— told me that he has understood there are but 16 Lewis guns to the brigade, while a wounded officer just back from the front told me that they aim to have one for each platoon which would give 64 to the brigade. The figures given me at ——— must of course be correct but it is probable that we are in a transition period in this respect.) There are thus three machine gun companies to a division, but Major L——— impressed upon me the serious error of having but three of these and having them attached to brigades. He says there should be five, giving a Division 80 Vickers guns, and that the organization should be completely divisional so that no Brigade Commander could interfere with the proper disposition of the guns of a divisional front by the claim that certain guns belong to him. As things are now he can and does.

Speaking to me most impressively Major L———, who is completely wrapped up in his work. seemed to be intensely desirous of hammering into me and through me into our service certain facts that he regards as basic. I noticed that he dwelt on much the same line in his lecture that I attended afterwards, and also in the notes which he sent me at my request and which form a sort of pamphlet that he

has prepared for the use of the school. There will therefore be some repetition in this respect. In our first conversation he said: "Organization is everything. Fire power is the one thing to be attained and the only thing that counts. In battle as a rule a man can command only himself or at the best he is very lucky if he can manage to control one man in addition. For that reason plans must be so thoroughly laid and so perfectly communicated in advance that all will follow out the plan and the result of the combined efforts of self-commanded individuals will thus in the long run be practically the same as if a real command had actually been exercised. The essential elements of a defensive line consist of a depth of wire and a front of machine guns. The machine gun with its personnel is no longer an auxiliary appanage of infantry and cavalry but is an arm of the service superior in fire power to any arm except artillery. A brigade is too small a unit to occupy a defensive front. A unit sector for defensive purposes must be occupied by at least a division. The infantry of a Division must be free for maneuvering and must not be held down to defensive fronts. To this end the machine gun corps of the division must be capable together with a small infantry support and a detachment of bombers detailed to it, of holding the defensive line while the main body of the infantry is left free to carry out the larger plan. In such a front there will obviously be certain places which will require a large number of guns and other places where guns would simply be wasted. For this reason the control must be central and divisional so that it can be exercised with a single view to the interests of the front taken as a whole The Machine Gun Commander should have the grade of Lieutenant-Colonel because the infantry units composing the division are battalions commanded by Lieutenant-Colonels. Controlling the entire sector he will place all of his guns according to the real demands of the situation as he sees it, and in such a way that they will afford mutual support. Otherwise, and as things now are, there is almost bound to be a diversity of plans on the part of the different brigades, each occupied with the apparent needs of its immediate front. The plan should provide for a number of curtains of fire, say, three, echelonned in such a way that every blade of grass in the whole sector will be covered, and all should

be in such complete readiness that at a simple signal from the commander these curtains of fire may be turned loose instantly over the entire sector. Communicating trenches will of course be arranged through the barbed wire so that infantry can move about at will according to the provisions of the higher plan."

Captain M———, one of the assistants to the Chief Supervising Officer, took me through the work of his office. He explained that each depot company takes care of six machine gun companies as to drafts, and here again it was pointed out by all of the officers with whom I talked that this is far too much. What they hope to do is to increase the strength of the depot companies and make one, thus greatly augmented, take care of the division unit when that comes to be organized. There are 20 of these depot companies at ———, each consisting of 20 officers and 250 N. C. O.'s, and men. In addition to furnishing drafts to their six companies at the front they are also used to form the machine gun companies here. As has been seen the Receiving Board may and frequently does send to the individual companies special men asked for daily, but as a rule recruits as received are assigned to the various depot companies and from these from time to time machine gun companies are made up as required. These machine gun companies are organized in groups of 12 each under an Assistant Supervising Officer. There must always be three of these groups of 12, the first consisting of companies almost ready to go to the front, the second of companies that are mobilizing, that is, under instruction and obtaining the necessary equipment but having already been completely formed as to personnel, and the third of companies that are in the process of forming from the depot companies as a matrix. There are just at present five of these groups. The number varies naturally according to the inflow of recruits. Major C——— told me that they are organized, equipped, and munitioned at ——— to turn out one of these 12 company groups to the front every week but that this is not actually done because they cannot get the men fast enough. He expressed great regret that having worked the system up to such a point they are so hampered by the slow recruiting.

The men are instructed first in the depots and afterwards

in the machine gun companies under the direction of officer graduates of the school. These officers spend a month as a rule instructing in the depots before they are posted to their companies which they then instruct for six weeks before leaving with them for the front. While the regulations do not at present provide for specializing the depot companies they have found it advisable to do so, and thus one depot is composed entirely of drivers, another of signallers, and others of gunners.

Each machine gun company when formed has 22 drivers. These have been given six weeks instruction in driving in the depot company before being posted. Their instruction is then continued in their company. Wherever possible drivers are specially selected from men who have had previous experience with horses. They must also be men of very good physique. They seem to make quite a specialty in this respect and to regard the selection and training of these drivers as a matter of very great importance.

Speaking generally as regards training Major L——— said that they do not have anywhere near enough time to give the proper training, but they go on the theory that it is better to send out a large number of partially trained units than to hold them back here for more detailed instruction while feeding the lines slowly with highly trained units. The idea is that once at the front they will learn very rapidly from actual experience in the trenches if they are given a good working basis to start with.

Captain M——— told me that during the first three weeks after the organization of a company the training is elementary, and that during this time the mobilization continues, the men being furnished their equipment, including guns and targets. During the third or the fourth week they get their mules and horses. The latter half of the course is devoted principally to target practice at the longer ranges and to such tactical instruction as can be given them in the short time at their disposal. He regrets that they have not eight weeks instead of six, in which case they could devote more time to tactical instruction. But as it is, they feel that they ought not to take too much time for this sort of work, in view of the present conditions of trench warfare. In other

words, as something has to be sacrificed, they think it best to let the loss fall on the tactical side. With the exception of the drivers, the minimum of instruction for men in depot companies is two weeks. The theory is that if drafts are sent out with but two weeks' instruction, the companies at the front can absorb these small numbers without danger and can continue their instruction there, while on the other hand an entire company formed here from the depots and sent out as a whole would be fatally handicapped if dependent on so short a course.

The matter of administration is carefully differentiated from training. A large number of "dug-outs"—old retired officers—have been attached, and it has been found that the proper use to make of these is in the administration work, and that while, on the one hand, these officers must keep their hands off of training, which is along lines that they were never familiar with in their service of a former day, on the other hand the officers engaged in the actual training must be relieved absolutely of the burden of administration. They find that this works very well. All the paper work, mess management, care of barracks, inspections, except such as are involved in the instruction, etc., etc., are taken care of exclusively by these dug-outs, while the younger officers trained for this purpose are given complete control of the instruction, regardless of rank. This goes even as far as the General commanding the Centre. At first there was considerable embarrassment in the matter, but they finally hit on the scheme of regarding the Director of the training of the whole camp, Major L———, and the Chief Instructor of the school, Major C———, as staff officers of the Commanding General, and as such charged with the exclusive control, nominally under him, of their respective departments, in which he allows them respectively an absolutely free hand.

The Machine Gun School.

The object of the school is to train officers in machine gun work with a view to their teaching their N. C. O.'s and men when posted to companies. The course of instruction lasts for five weeks, at the conclusion of which, and after a week's leave, the student officers are posted to companies

as Company, Section, or Sub-section Commanders, according to their efficiency and experience.

The standard of efficiency is gauged by:

(*a*) Result of a written examination held on completion of the course.

(*b*) Oral examination held during the course.

(*c*) Personal reports by the officers conducting courses.

(*d*) Note-books.

Officers who, at the completion of the course are not considered suitable to command a sub-section, but who have worked faithfully and shown the proper spirit, are retained in the school for a further course. If, on completion of this second course they are still considered inefficient, they are returned to their units as "Not likely to make M. G. Officers." Student officers who fail to take the proper interest are generally sent back to their units during the fourth week of the course. On an average about two per cent. fail to qualify. The standard of each officer completing a course is entered on his card, which is forwarded to the Chief Supervising Officer of the companies.

The instructional staff is composed of:

(*a*) Officers with war experience and considerable army experience generally, who are temporarily or permanently unfit for further active service.

(*b*) Officers selected from courses on recommendation of their instructors. Also a certain proportion of those who have been promoted from old regular army N. C. O.'s. Some of these have served as Staff Sergeants at Schools of Musketry.

(*c*) Staff Sergeants selected from regimental N. C. O.'s or reported on favorably by the "Examining Board." Some of these N. C. O.'s have previously been employed at Schools of Musketry.

In order to ensure a constant supply of officers to companies, student officers join the school in batches every two weeks. They are then allotted to courses and commence their five weeks' course of instruction. By this means the entire training staff of a course gets a clear week's break after finishing, and before commencing the next course allotted to it, while at the same time the continuity of supply is not interfered with. It is the general opinion at the school

that a course of seven weeks should be substituted for the present one. Each course is under one officer as Senior Instructor, with two assistant officer instructors, each of whom has charge of half the total number of student officers composing the course. He is therefore responsible for the instruction of his section, under the general supervision of the Senior Instructor of the course. The sections are divided into squads, the normal number in a squad being eight student officers, and each squad is under the direct instruction of an enlisted instructor. The number in a course must not exceed 100. If there are more than this to begin at any one time, they are formed into two or more courses. There are at present 900 officers under instruction. All instructors wear armlets to distinguish them, those of enlisted men being of a different combination of colors from those worn by officers. All officers and N. C. O.'s selected for the instructional staff undergo an additional five weeks' course under special instructors, after which they are attached as supernumerary instructors to courses until they are required to instruct. Major C——— said that the very best are the old army Non-Coms, but most of these are dead, so there are few left to draw from. Even those they have are men who have been wounded and rendered unfit for active service. Among officer instructors who have come from civil life the best are the actors. They seem to have the faculty of holding the attention and sounding the minds of their auditors which is naturally incidental to that profession. The next best are schoolmasters. Decentralization is the aim sought. Everyone is allowed to do his work in his own way as far as possible, but results are expected of him. An instructor who seems to be falling off in his work is warned once and then sent back to his unit (in this case, of course, machine gun unit is meant). The Major finds a difficulty here, because some are prone to let down on their work purposely in order to get to the front.

Asked as to text-books Major C——— said that of course the official manuals form the basis of all instruction, but that otherwise they get up their own courses and their own texts. I asked him if he could not make use of some of the publications on the market, and he said that one should be on

his guard in that respect; that these publications are made to sell, hastily written as a rule by some student officer of the school and almost certain to be inaccurate and misleading in many important particulars. The practice is frowned upon by the school and no recognition is given to any of these half-baked efforts.

There are twenty sets of equipment available, and two squads work each day of the first week in "Fitting equipment." The riding lectures are arranged for by the officer supervising the riding instruction. The hours for them are agreed upon between him and the officer conducting the course. In addition to these, riding instruction is given daily throughout the course from 7.00 to 8.00 a. m. As regards hours generally, the intention is to provide for an average of six hours per day for five days of the week and three hours on Saturday. In addition to this a great deal of studying has to be done. As will be observed from the above schedule the first three weeks are devoted principally to technical instruction and the last two to tactical. Courses are so arranged that in case of rainy weather indoor instruction replaces outdoor work automatically. Student officers have generally had from 5 to 7 months of ordinary infantry training. About 6 per cent. of them on an average have seen service in France or on other fronts. 187 Vickers guns are used in the school for instructional purposes. I saw several squads at work with Lewis, Hotchkiss, and Colt guns.

I was given the outlines of five of the lectures, these being among the most important of the course and dealing with the following subjects:—

The training of machine gunners.

The employment of machine guns in open fighting.

The occupation of various positions by machine guns.

Machine gun field works.

The employment of machine guns in trench warfare.

These are attached as Appendices Nos. 2 to 6, inclusive. They also gave me a number of sheets of "Lecture Notes" covering most of the lectures delivered in a course as shown in the above schedule. These are attached as Appendices Nos. 7 to 19, inclusive. They are issued out to the student officers to assist them in taking notes. As has been remarked they are graded on these notes. In connection with the practical work

they have a large room that they call the "Studio" where a number of artists, officers and men, who have been obtained from the Artists' Rifles are at work all the time getting up drawings and paintings which are lithographed and used in the course. They say that by using these drawings, especially colored ones, a much clearer idea can be quickly gathered by a student officer hitherto unfamiliar with mechanics than would be the case were he suddenly confronted at the outset with the parts of the gun themselves. And the artists are able to give a more life-like appearance to the sketches than they would have if prepared by an ordinary mechanical draughtsman. After this they are given a thorough course of instruction with the actual gun taken apart and I saw a lot of this going on, the sergeants being seated with their squads sitting grouped about them. This sort of work is done indoors and the lectures are also given indoors, the huts provided for that purpose being large and well-lighted.

In connection with the tactical lectures, diagrams of actual emplacements at various portions of the front are employed, and large reproductions of aeroplane photographs of various machine gun positions in France and Belgium are used for illustration. These reproductions have been made by the artists in the studio. On the lecture platform is a frame containing something like a score of these plates. It contains a system of pulleys so that any desired plate can be dropped down into view by the lecturer at any time as he goes along with his talk. Nothing is used to illustrate the instruction except actual positions, emplacements, etc., on the lines at the front. In other words no pure theory is made use of whatsoever. In some cases the instructor will call attention to an apparently faulty position of the guns as shown in one of these plates and will say "It would seem that this position should have been so and so, but as a matter of fact this is the way it was."

I was given a number of these plates, and notes on various operations, and I attach them as Appendices Nos. 20 and 34 inclusive.

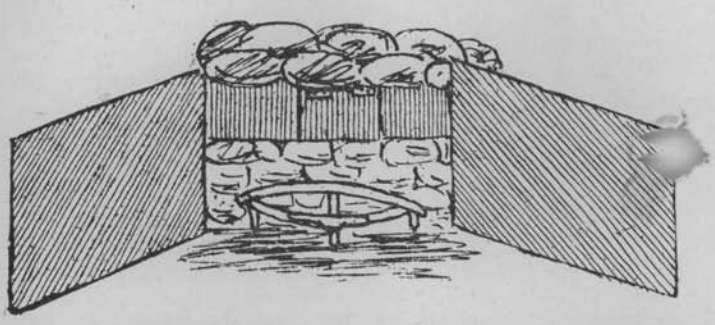
Captain M———, the officer in charge of practical trench work, took me over his training grounds. Here he has nearly a mile of works constructed and to these he adds from time to time as new types are developed at the front regarding which he is all the time receiving information from his graduates who make

it a point to keep in touch with the school. They report in full and promptly all details which come under their observation and which may be of value in keeping the training up to date. The importance of this is impressed upon them during the course.

Captain M———'s training ground serves a double purpose. Besides the instructional use to which it is put for the benefit of the school, the actual work on it is done by the machine gun companies which in this way are trained for the work they will have to do at the front. To begin with all men are given one hour in building sand-bag parapets. At the end of this time they have become sufficiently proficient. They are taught how to lay the rows in alternate headers and stretchers breaking joints and also how to slope them back to the required degree of slope. These parapets where they are built on the plan generally employed at ———, that is, having the solid ground as a step, are nine feet thick at the base and six feet at the top, and they are raised to four feet six inches above the ground. About one and one-half feet back from the parapet a shallow trench is dug. In some places the step is made of sand-bags and is one foot six inches high. The bottom layer of sand-bags is then laid ten feet thick. The working parties are divided up into sections and each section does all the work in connection with a certain sector of the line. If any sector has different features from others all the men are shown this part of the work so they will get some idea of it.

Particular attention is paid to the construction of loopholes [illegible] to their location. All are made with the idea of giving flank fire and cross-fire as this is regarded as the A B C of the instruction. All the loop-holes that I saw were very carefully blinded. This is sometimes done by means of a board covered with poultry wire tacked on its outside face, the meshes of the wire being filled with moist earth of the same color as that of the work. This earth is held in place by the meshes but from the inside the men are able to see through very well as there are always little open spaces. At a very short distance there is no sign of a loop-hole. I noticed one very elaborate loop-hole consisting of a steel box flanked on the inside of the work by steel plates set up in the form of a wall. This had been constructed in a machine gun emplacement The box had a hinged lid on its inside face, the hinges being at the top so that it naturally hung

down when not in use, thus closing the loop-hole. When firing was to commence the lid was raised. The outside face of the box was removed altogether and during the day the space was filled in by two full sand-bags, thus completely blinding it. As this face was flush with the outside of the parapet the sand-bags seemed no different from all the others. Between the hinges and the top of the dug-out in which this emplacement was constructed were simple rows of sand-bags. Captain M——— said that steel plates should have been put there as well. The plates were ¼ in. thick. They will not stop bullets of themselves but when the bullet has passed through one or two sand-bags it is said to be sufficient protection as it will not then penetrate the steel. Captain M——— remarked that they have received many complaints from the front about American steel. He says that a great deal of it is bad and that now they always use two plates of American steel laid side by side in lieu of one plate of their own. He thinks that one cause of the trouble probably is that this steel has not been tested against German bullets which he says have a very high penetration, but they have been satisfied with it when tested against some other projectile.

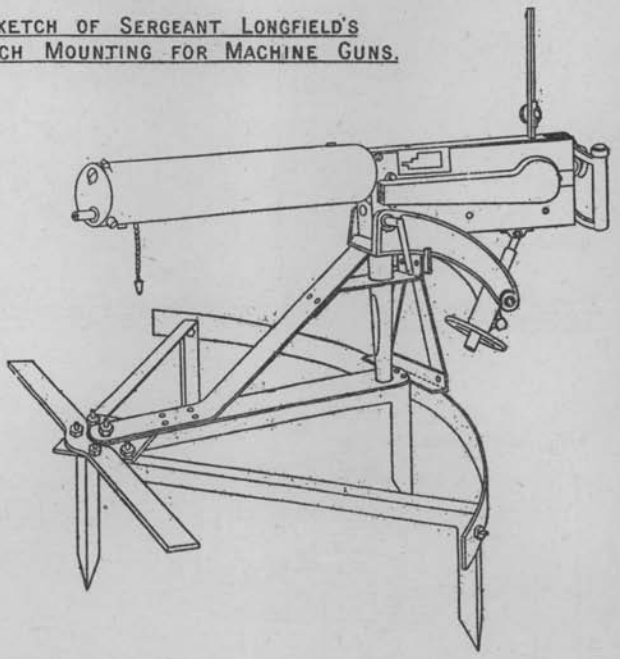


It was in this loop-hole that I first saw the muzzle pivot device. I had been told at ———, on the occasion of our visit there, of a new scheme for traversing a machine gun at the breech by pivoting it at the muzzle, thus enabling the gunner to have better protection by firing through a loop-hole splaying inward instead of outward. Major C——— gave me a set of drawings showing this method of trench mounting invented by Sergeant Longfield.

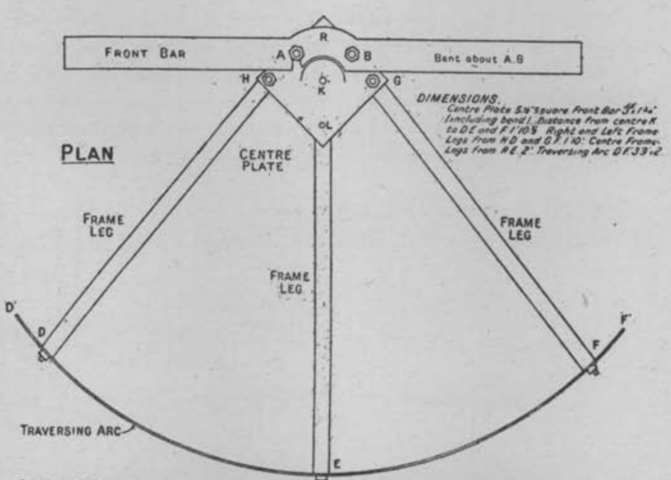
Plates showing the Longfield mounting are reproduced herewith. The gun that I saw thus mounted was made of wood but was an exact model of the Vickers gun to all outward appearance. They use these dummy guns in the emplacements wherever it is desirable to leave them in position all the time. They are just as good for instructional purposes and it saves the real ones.

Opposite the main works in this training ground they have

SKETCH OF SERGEANT LONGFIELD'S TRENCH MOUNTING FOR MACHINE GUNS.



constructed a line of simple works to represent the German defences. These are about as close to the main works or British line as are the German works at many points of the front as we saw them last year. In this way the men get a more realistic idea than they would if they were limited to a study of their own works only. One part of the British line is in the form of a pronounced salient and back of it is a moderately straight line of trench acting as a sort of chord to the arc

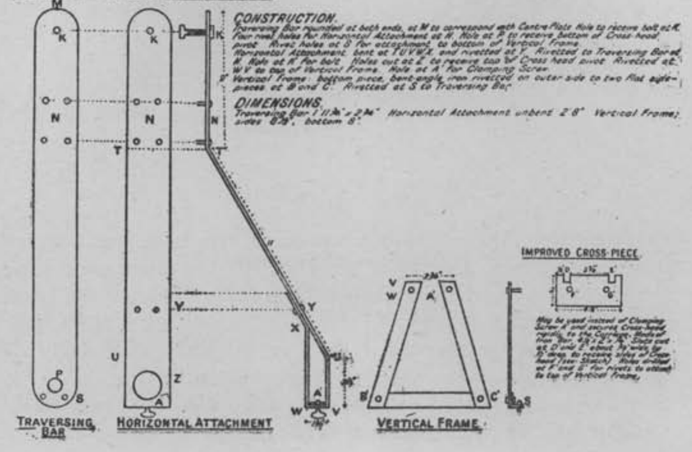


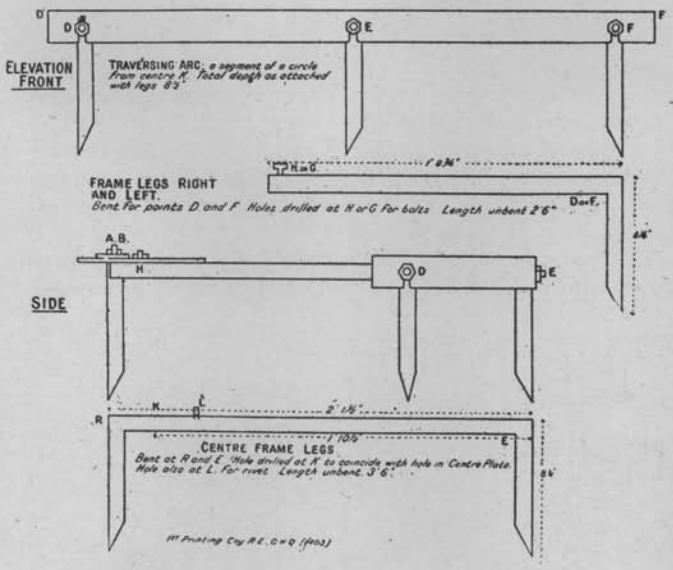
CONSTRUCTION: Centre Plate with hole K drilled to receive bolt of Traversing Bar. Front Bar attached on top by bolts at A and B. Right and Left Frame-Legs attached on underside by bolts H.G. Centre Frame Legs rivetted on underside at L. Traversing Arc attached by bolts to Frame-Legs at D.E.F. Slots are cut at A.D.E.F. as indicated, for purpose of folding and detachment.

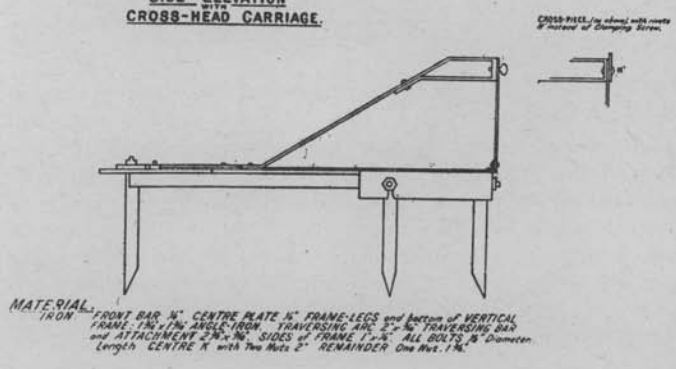
DETAIL OF CROSSHEAD CARRIAGE.

CONSTRUCTION.
Traversing Bar rounded at both ends, at M to correspond with Centre Plate. Hole to receive bolt at K. Four rivet holes for Horizontal Attachment at N. Hole at P to receive bottom of Cross-head pivot. Rivet holes at S for attachment to bottom of Vertical Frame.
Horizontal Attachment bent at TUVWX, and rivetted at Y. Rivetted to Traversing Bar at N. Hole at K for bolt. Holes cut at Z to receive top of Cross head pivot. Rivetted at W.V to top of Vertical Frame. Hole at A' for Clamping Screw.
Vertical Frame: bottom piece, bent-angle iron rivetted on outer side to two flat side-pieces at B and C'. Rivetted at S to Traversing Bar.

DIMENSIONS.
Traversing Bar 1'11¾" x 2¾". Horizontal Attachment unbent 2'8". Vertical Frame; sides 8⅞", bottom 8".

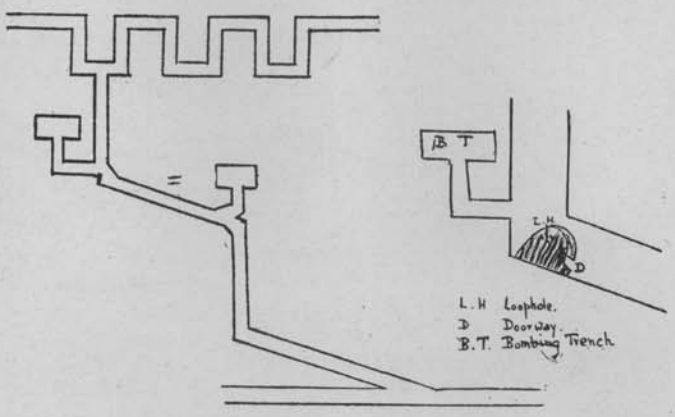






MATERIAL—IRON. FRONT BAR ¾" CENTRE PLATE ½" FRAME-LEGS and bottom of VERTICAL FRAME 1¾" × ¼" ANGLE-IRON. TRAVERSING ARC 2" × ½" TRAVERSING BAR and ATTACHMENT 2¾" × ¾". SIDES of FRAME 1" × ¼". ALL BOLTS ⅜" Diameter. Length CENTRE K with Two Nuts 2". REMAINDER One Nut. 1¼".

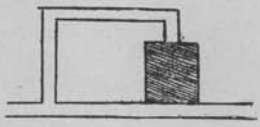
formed by the salient. This they called a "switch." It is about 60 yards behind the main work at the widest point of the sector and is connected to the salient trench by a number of communicating trenches. The idea is that if the salient is taken the switch may be held and will form a rallying point for the defenders of the line. To this end it is necessary to equip the communicating trenches in such a way as to prevent the advance of the enemy's bombing parties. Captain M——— said that there must be reaches in these communicating trenches offering at least 30 yards of a clear straight course. He has employed in some cases the "island traverse," but he does not like this method so well as what he calls "caponiers." The following diagram will show how they construct them at ———:



The trouble with the island traverse is that it can be bombed from all sides while the caponier has much more natural earth protection. These caponiers are located at every change of direction of the communicating trench and at the same point a T-shaped bombing trench is run out, as machine guns must always have bombers for their protection. They are then placed in the T while the machine gun covers the straight reach of the communicating trench from its emplacement in the caponier. The enemy is unable to ascertain from exactly what point the bombs are coming and of course the range is accurately known to the

bomber protectors of the machine guns who have a great advantage in this respect over the enemy. I saw just off one of the communicating trenches a novel form of dug-out. A loop had been made consisting of a narrow trench leading from the back end of the dug-out around into the communicating trench some yards away, as shown in the diagram. The dug-out opened into the communicating trench in front and into the loop in rear. In this way two lines of escape were open and in case of a bombardment causing a cave-in and blocking one entrance the other might still be available. If the communicating trench were congested by a movement of troops the loop would offer a secondary passage for the personnel of the dug-out to escape for some little distance and await the passage of the troops.

Captain M——— called my attention to a dug-out, the roof of which instead of resting on upright posts, had been built on



cross-beams laid on the solid ground on each side. These beams had been originally placed some distance back from the open trench and it had been supposed that the solid ground would furnish a sufficient support but the weight of the roof had caused the ground to crumble little by little away from the opening until now the beams were almost flush with the open space and in a very short time would cave in. Captain M——— said that he kept this dug-out as an illustration of the way it should not be done. Upright posts are insisted on for all dug-outs. I was also told that emplacements should never be constructed without having a gun at hand as a model. When the gun is not so used some important feature is invariably overlooked and the emplacement is found to be useless for practical purposes. They showed me one that they had also left as a shocking example, in which, although the emplacement was beautifully constructed and finished, the traversing of the gun was rendered impossible by the earth projections. This was not apparent at all until the gun was actually placed.

At one point I noticed the blinding of a loop-hole in which the color of the bags used was slightly different from that of the others in its neighborhood and the presence of the loop-hole was thus betrayed. Captain M——— said that he had suggested using white and black bags in about equal numbers, indiscriminately placed, so that any little difference that might exist between colors would be overlooked in the general break-up of the color scheme.

The traverses in the infantry trenches were 12 feet wide and 10 feet deep from the rear of the traverse to the inside line of the parapet. The bays were made from 18 to 20 feet long and were intended to accommodate six men. Dug-outs are built at least six feet back from the fire trench, and should if practicable be nine feet back. Great difference of opinion exists as to the size of these dug-outs but they have arrived at a compromise verdict of 6 by 6 feet and 10 feet deep. This gives 7 feet cover because although the posts that support the bottom of the roof are 4 feet 6 inches high, 1 foot 6 inches of earth is added on top after the roof has been built flush with the ground. (It must be kept in mind that the dug-outs in question were in all cases behind parapets and not simply behind a trench whose top would be the original ground level.) The floors of the dug-outs were of concrete and in their construction the base timbers on which the uprights rest had been placed first, then the posts were set on top of these, and finally the concrete was set in. They insist on this as they say that if the posts alone, or if both the posts and the base timbers are laid on top of the concrete, the weight of the roof will cause the latter to crack.

Captain M——— remarked that the use of dug-outs in front line trenches is now confined practically to machine guns. The danger of their demolition and consequent annihilation of their occupants is now so great that infantry must be kept back at a safe distance. For this reason it is all the more necessary that the personnel of machine gun companies, especially the gunners, should be made up of men of the highest degree of courage. He said there has been considerable discussion as to the proper station of the lookout man. Some would place him during the bombardment in the emplacement itself, the rest of the crew occupying the dug-out. In such a position he would be able to see better what the enemy is doing and to give prompt notifica-

tion to the crew so that they may re-take their posts in the emplacement in time to operate with some chance of success against the enemy's advance. On the other hand he would be out of reach of his comrades and if killed they will know nothing of it and being unwarned of the enemy's rush both they and their guns are apt to be taken before a shot can be fired. Captain M——— inclines to the opinion, which he says is now coming to be the generally accepted one, that the look-out should be placed with a periscope at the mouth of the dug-out. He can then be seen by the others and if he falls he will be replaced. He will of course not see quite so well. But no one knows when the bombardment will end except the enemy, and as the charge will take place at once and will have to pass as a rule over a very short distance, it is a matter that must be arranged for and met without the loss of a moment. I asked why it would not be a good idea to furnish the lookout man with a wire or cord or something of that sort which he could pull every half minute or so to show that he was still on the job, but they replied that this would be impracticable as it would be almost sure to be injured in some way by the enemy's fire, it would be a menace lying along the trench line where it might trip up a man advancing rapidly and thus disorganize a column at a critical moment, and that anything at all complicated is never favored in the trenches. Captain M——— said that there would generally be five men to a gun and this would leave four in the dug-out which it would just comfortably accommodate.

I noticed a considerable amount of expanding wire used for revettments. They say they find this very good for parapets but it is no good for steps because it wears out very fast owing to the weight of men passing back and forth and climbing onto the steps. When using it on parapets the posts on which it is strung should lean in against the parapet at a slope of 4 on 1, and should not be more than two feet apart. If at a greater distance the wire will bulge outwards due to the weight of the parapet, and will cause the latter to crumble. This revettment is always anchored by a tight wire fastened to stakes driven into the parapet. No tourniquet is to be used as it damages the wire and causes it to rust rapidly. The stake is simply leaned forward, the wire tightly drawn, and the stake is then pulled back and driven in sloping backwards thus tightening the wire.

I saw one emplacement made of an ammunition box fastened on top of the parapet. A little round hole is bored in the top of the box for the pivot of the gun and heavy cleats are nailed round this hole to strengthen the point of support. In all emplacements are little boards on stakes driven into the ground and tacked on these are cards giving the standing orders for sentinels and gun team commander, together with the number of the gun position. At the bottom of these printed orders a space is left for special orders. (Appendix No. 35.)

The trenches are drained by little gutters made of half sewer-pipe of pottery. They run down the middle of the trench and a slat-work walk is laid over them which they call a "duck-walk." They say the proper width for this walk in a communication trench is two feet and in fire trenches 1 foot 6 inches.

Captain M——— told me that all loop-holes for Vickers guns must be 9 inches high. The width of the loop-hole should be from 1 foot to 1 foot 6 inches on the inside and from 2 feet to 2 feet 6 inches on the outside, except of course where the trench mounting is used in which case the loop-hole may be very small and splay inward. Sometimes a larger traverse is necessary in cases where there are but few guns and each has a bigger belt to cover. 'Here the outside measurement might even reach almost three feet. Where the emplacement is roofed over there must be two feet clear from the bottom of the loop-hole to the bottom of the roof for the Vickers gun in order that the rear cover may be lifted. Major C——— told me that he saw one such emplacement near ——— where the rear sights could not be raised. They had constructed this emplacement with a view solely to close range fighting and never thought of the sights. Captain M——— remarked that elbow rests have now disappeared altogether their fault being that men are thrown too far back from the protesting wall of the parapet.

Major C——— pointed to a crest against the sky-line about half a mile back of the works and said that there had been quite a discussion as to the proper position of a redoubt or rallying point that they were going to construct. One of the officers had insisted on placing it on this crest. The Major wanted to put it somewhere where it could be sure of concealment from aeroplanes, and said that of four such redoubts that he had seen in France one was in an orchard, two were in woods, and only one was at all open and exposed to aeroplane reconnaissance.