

back 10 feet to 12 feet clear of the face. The shield is then pumped forward and the iron lining erected and bolted up. The usual time taken by the navvies for excavating sufficient for a ring in front of the shield is from one and a half to one and three-quarter hours; pushing the shield forward and erecting the iron occupies about the same time. When the machine had been in use for two or three months, the time occupied in pushing the shield and erecting the iron was very much reduced, and during the last few weeks' work of the machine eight rings were put in several times during the two shifts. The average number put in, however, was three 20-inch rings per shift of ten hours. The number of men at the face, including the driver, was usually eight, but was reduced latterly to six. The number of men employed at the same work by hand was fourteen. The machine was constructed by Messrs. Scott & Mountain, engineers, Newcastle, to the designs of Mr. Thomas Thompson, Messrs. Walter Scott & Company's agent on this work.—The Engineer.

THE TACTICAL APPLICABILITY OF THE MAXIM MACHINE-GUN.*

By Lieutenant-General A. V. BOGUSLAWSKI, of the German Army.

TAKING as a basis of speculation an average of the results obtained in war and on the proving-ground, it must be conceded that it is a most dangerous policy, so far as the armament of a force is concerned, to set up a fixed principle, and in the light of this principle to examine new inventions superficially or to reject them entirely. The entire history of war from 1859 to the most recent times proves the truth of my assertion. The memoirs of Generals Lebrun, Du Barail, Fleury, and Trochu, for example, glaringly expose former French criticisms of the needle-gun and its inapplicability to practical uses.

Although we have ever carefully tested new inventions, and have kept abreast of the times in introducing them, periods of delay and decline are noticeable. Such a period was, for example, that from the ending of the Austrian war to the beginning of the French. During this period we thought we would be able to keep up with the latest improvements by making slight changes in the needle-gun. But the fact that with this weapon we had just won great victories must also not be forgotten in explaining this remissness.

For decades after 1871 it was obstinately insisted upon that all weapons should be of the same type; and that only one particular kind of shot (shrapnel) should be used, notwithstanding that the experiences of Plevna showed quite plainly—as I emphatically declared at the time—that for field-operations we needed mortars. Future developments have confirmed this view. We are now going to obtain field-howitzers.

To have types of weapons as nearly as possible alike is undoubtedly of great advantage; but the conditions of war are too various in order firmly to adhere to this principle.

The Maxim gun has now reached a stage of development which demands the most thorough examination of its utility. According to general belief, such an examination will be made by the German government.

The weapon has been introduced in our colonial troops, in our navy, and, if we are rightly informed, in our fortresses.

In several battles fought by our troops in Africa the gun was not particularly serviceable, for often it missed fire. The latest improvements lead us to expect that such accidents will in the future occur but rarely. In the battle of Atbara, Maxim guns were most effective against the Dervish cavalry. The reports which have been received of the recent victory of the British over the fanatic hosts led by the Khalifa at Omdurman, have again proved the effectiveness of the gun. We have here an instance of its efficiency against cavalry attacks in which solid bodies of men were also directly employed. It must, however, not be forgotten that the artillery of the Dervishes appears to have been of no use whatever. In the Spanish-American war, the Maxim gun, it seems, was not used.

Comparatively small bodies of colonial troops can turn this weapon to good account in increasing the efficacy of their fire when opposed by uncivilized tribes. In such cases the gun partly compensates for lack of men. Results thus obtained are, however, of little value so far as European wars are concerned.

The question with which the tactician must concern himself is, whether the peculiar character of the gun permits its use in the field and in forts.

England has answered this question in the affirmative, and has furnished every mobile brigade of infantry and cavalry with Maxim guns. The Swiss have also taken steps in this direction. When used on the battlefield the gun can be considered only as an auxiliary weapon for cavalry and infantry. Every addition of this nature causes the organization to become more complicated. Such complexity is to be avoided so far as possible; for our organization has become intricate enough through the formation of bodies of technical troops.

The machine-gun demands new technical and tactical study on the part of the officer, whose sphere of knowledge and field of activity, compared with former times, have uncommonly increased. One officer, at least, must take charge of the fire of every two or three machine-guns, even though the work of sighting and aiming is done by the gunners. But more than one officer in each battalion or cavalry regiment must be familiar with the use of the gun; for substitutes must always be at hand to take the place of those who have been disabled.

It would seem that the gun can be used with good results by cavalry. Not long ago I heard it said that the addition of mounted artillery would be of little value; that the guns could with difficulty be employed during a fight; that the artillery, only in rare cases, would be enabled to fire with effect, and would often even be captured. That it is difficult to bring artillery into action is generally known; but the obstacles mentioned seem more likely to be encountered in maneuvers than in actual warfare. The conditions of war are so various and the tasks of the cavalry so many-sided that artillery cannot be easily spared. This many-sidedness argues apparently for the introduction of Maxim

guns. The theory has been much defended and also practically demonstrated in the Russian and Austrian armies, that cavalry far in advance of an army, regardless of their being armed with carbines, must be supported by a reserve-body of infantry. But it can be argued that a body of infantry would be unable to keep pace with the cavalry. Various remedies have been proposed, among which may be mentioned the transportation of the infantry by wagons, or the use of bicycles. But against these proposals many objections can be opposed. The machine-gun, however, offers a means for providing deploying cavalry with an effective reinforcement.

In the meeting of strong masses of cavalry in an open field, it would be difficult for mounted artillery, in preparing an attack, to take up with sufficient rapidity a position at the side of a wing, or in spaces between brigades and regiments, and if the enemy be already moving forward, to break his formation by their fire. Can this be more rapidly accomplished by machine-guns than by artillery? We believe that it can. The Maxim gun can be mounted upon a four-wheeled field-carriage, upon a light two-wheeled carriage, upon an infantry or cavalry cart, upon a light field-carriage, or it can be packed upon a horse. We consider the use of light carriages and gun-horses the most suitable means for transporting the piece when used by cavalry. Two or three light wagons drawn by two horses each, and containing ammunition, could no doubt bring the machine-guns into position with greater rapidity than a battery. Even though this may not be the case, the machine-guns undoubtedly offer a smaller target than a battery, besides making as good use of their ground as regular artillery.

It would therefore appear that the Maxim gun, at the very moment of the meeting of two cavalry forces, will be found to be an auxiliary weapon by no means to be despised. The Maxim gun in actual warfare can be considered effective up to 1,500 meters. At ranges of 800 meters the effect of the fire is particularly good. Field-artillery undoubtedly surpasses the machine-gun in effectiveness for longer ranges. The moral effect of well timed exploding artillery projectiles is also greater. But, on the other hand, the Maxim gun has the merit of permitting the gunner to move his piece sidewise as well as vertically. It is, therefore, possible to sweep the field with an uninterrupted fire—an advantage against a rapidly approaching line of attacking cavalry. The weakness of artillery when opposed by cavalry is most apparent in such moments and would be partly overcome by the Maxim gun. At the moment in which two cavalry forces meet it would not be endeavored so much to harass the enemy from a great distance by gun-fire, as to destroy him by firing at medium and short ranges, in order either to open the way for an attack or to repel his onslaught. In such cases the Maxim gun can perform the work of an improved *mitrailleuse*.

If the cavalry advance to capture places held by the enemy, the Maxim guns would be of service in opening a way by enfilading the approaches to villages and the outskirts of forests. The chief work must, however, be performed by artillery in preparing for an attack of the dismounted cavalry, of the infantry, or of the bicycle corps.

All the more effective will the Maxim guns prove themselves in holding such places. The proper use of the guns would here probably consist in enfilading the approaches or the regions most favorable to the deployment and to the attack of the enemy and to take their position accordingly. All this demands a quick, tactical eye and knowledge of the weapon's peculiarities.

The use of the gun by infantry appears to us of far more doubtful value than by cavalry. It will always be a questionable procedure to carry along weapons which cannot be used under all conditions. Among the causes which diminish the value of the weapon when used by infantry, is the fact that the Maxim gun, unprotected by some shield, would always present a higher target than a soldier stretched on the ground. At short distances this circumstance is a most weighty consideration. That it would be impossible to shield the gun by digging trenches during the actual attack, is a great obstacle against the use of these weapons by infantry. If, as many hold, an attack in a modern battle is a kind of siege-attack (*Belagerungsangriff*), then, to be sure, the Maxim gun might possibly be used, but only at long ranges. We believe, however, that this theory will be disproved when the gun is tried in actual warfare. The attack on important points must be well prepared, and must be incessantly followed up.

A further discussion of this particular phase of the subject is not within the province of this essay. The statements made, it must be understood, apply only to decisive attacks. During sham attacks it can, of course, happen that a force, having entrenched itself on the ground captured, may possibly have time enough to provide protection for the machine-guns.

The Maxim gun is incapable of keeping pace with the rapid onward movement of infantry necessary in modern attacks. Though the machine-guns be transported in whatever way we will, in actual battle they can be used only on the lowest possible mount. Whether carriages or portable gun-mounts, which can be easily carried by two men, or sleds will prove most efficient in transporting the piece, exhaustive tests alone can show. If it be taken into consideration how often the fighting of the infantry in 1870-1871 consisted in a wild surging hither and thither, and that in future battles the same surging will occur, our view of the inapplicability of this weapon to infantry attacks will receive more consideration.

In prepared defenses, on the other hand, protection can be provided for the Maxim gun. A number of Maxim guns against a body of infantry, both firing the same number of shots at the same time, would be more effective than the infantry at ranges from 900 meters up, on account of the concentration of the fire, accurate aiming being presupposed. But the question can here be raised whether the fire from individual infantry rifles cannot be more easily corrected than that of the Maxim gun. On the other hand, it is easier to observe the effect of the Maxim gun-fire, and a correction can be made if the battery be properly commanded.

If we are to consider the weapon applicable to the use of infantry acting on the defensive, the questions would still have to be answered:

1. Is it desirable to carry along a weapon which cannot be used under all circumstances?

2. As a weapon of defense, is its fire, compared with that of rapid-firing small arms, so far superior as to justify its introduction?

All this can be ascertained only by carefully recording the effects of the gun-fire and by using machine-guns during the maneuvers.

Moreover, it should be observed that care must be taken to prevent a wasting of the ammunition when firing at long ranges; for, at long distances, the Maxim gun is calculated now and then to mislead infantry into premature firing.

At ranges of 1,200 to 1,500 meters the enemy's artillery will direct their fire at the machine-guns; but their task will not be so easy as was ours when we had to deal with the French *mitrailleuses* in 1870-1871; for the machine-gun presents a far smaller target than the *mitrailleuse*, which was as large as a cannon.

To summarize our statements: It appears to us that Maxim guns are well adapted to the uses of cavalry; but it is doubtful whether they will prove as effective when employed by infantry. But the matter is well worth close consideration.

The question of organization would be presumably best solved by the formation of Maxim gun corps, the members of which would be selected from the troops. Two or three Maxim guns should be assigned to each battalion and regiment of cavalry. Whether these Maxim corps, when going into action, or in cases of necessity, should be combined into larger forces, could likewise be determined during the maneuvers, and would depend upon existing conditions.

DAMAGE TO ITALIAN SHIPPING BY GALVANIC ACTION.

AN unusual and interesting case has been recently before the Italian courts. The captain of the port of Leghorn, Cavaliere Alceste Torrini, was the plaintiff in an action against the owners of certain wooden yachts with coppered bottoms lying in the Darsena part of the harbor of Leghorn to enforce a notice on the owners for the removal of such vessels from that part of the harbor. This notice was made on the grounds that the new warships and other iron and steel vessels lying in that part of the harbor were damaged by galvanic currents set up from the copper bottoms of the wooden yachts, the contact with the steel vessels being due to ropes which were made fast to different buoys in the harbor or basin. The fact of the damage to steel and iron ships having arisen, and of its being due to this cause, was clearly established before the court, and the captain's order for the removal of the wooden yachts with coppered bottoms from the Darsena harbor of Leghorn was consequently confirmed by the court.

Prof. Vivian B. Lewes, in a paper read before the Institute of Naval Architects some years ago, stated that damage to shipping was liable to arise from such a cause, and he also put forward the same theory in his book, "Service Chemistry." The fact of the existence of such a danger must be known to very few ship owners, but it is quite possible that the not infrequent phenomenon of an abnormally rusty bottom of some steel ship might be traced to her having been in galvanic contact with some copper sheathed wooden vessel.

In commenting upon this case The Engineer says that in Italy there is another cause for damage at work, which is not unlikely to manifest itself before long, in so far as several anti-fouling compositions manufactured in Italy rely for their anti-fouling effect solely upon the presence of a very large percentage—30 to 40 per cent.—of metallic copper. Such compositions are applied to the bottoms of a large number of Italian ships, in conjunction with a coat of priming, which is supposed to serve as an insulating medium. However effective powdered copper may be as an anti-fouling medium, our contemporary believes that it cannot be applied with impunity to iron and steel ships. In England anti-fouling paints containing metallic copper are also made, but in no case are they applied to iron or steel ships; they are only used for wooden ships, such as fishing vessels and wooden trawlers, on which they give good results, but manufacturers of composition in this country who supply iron and steel ships have long realized that paints containing metallic copper are absolutely unsuitable for application on steel vessels, a fact on which Prof. Vivian B. Lewes expatiated in his book referred to.

Even if insulated to some extent by a coat of priming paint from the outer surface of the vessel's plates, the presence of 30 to 40 per cent. metallic copper in a paint exposed to the action of salt water must set up a strong galvanic action in the whole structure of the ship, and this cannot fail to exhaust itself on those parts of her structure which are most exposed to corrosion or least protected against it; for instance, the floor plates, tank bearers, tank tops, bunkers, etc., for the galvanic current produced on the outside surface fills the whole metal structure of the ship, and whichever plates are most susceptible to corrosion through exposure or otherwise will be most attacked by it. For reasons of cheapness, paints so manufactured have, during the last year or two, been largely used by Italian ship owners, and have even been applied to several mail and passenger steamers, on which they are undoubtedly a source of great danger to life and property. No doubt Italian ship owners who have indulged in such false economy will, when passing their vessels through their periodical surveys, pay a bitter penalty for their ignorance and parsimonious practices. In the meantime British ship owners should be warned against accepting any anti-fouling paints in Italian ports without a guarantee that they are free from metallic copper.—Iron Age.

The density of the population of London has been doubled since 1857. "It is truly wonderful," says The Lancet, anent London, "that its vast population of 6,291,667, located on only 693 square miles, should have in 1897 so low a death rate as 17.7 per 1,000. This rate is not greater than that of a fairly healthy rural district. England well deserves the name she has received as the birthplace and home of sanitary science and practice."

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