Unitarian Society of Christians in Dover," his attitude towards Christianity was less purely negative, for, at the time of his ordination, he had two children baptized in the name of the Trinity, &c., and he "believed in Jesus Christ as the Messiah," and regarded his religion "as a revelation from God." This was in 1864; but Mr. Abbot gradually changed his religious views; and on April 1, 1868, he resigned. Towards the close of his ministry it appears that he voluntarily abandoned all connexion with Christianity. In the course of Mr. Abbot's progress to his present position many of his congregation became dissatisfied, and the members finally split into two parties, both of which naturally desired to get hold of the church property. An independent Society was organized which desired to retain Mr. Abbot; they proposed substantially to do this by getting him to preach, and by swallowing up the church organization in their own. Certain members, however, brought a bill in equity against the wardens of the Society and others, praying for an injunction; and this they got, the Supreme Court holding that the church property being held in trust for a "Christian Unitarian Church" could only be used to support Christian Unitarian worship. An injunction has therefore been issued, forbidding the Society to "hire, employ, allow, suffer, or permit Francis E. Abbot, or any other person, to preach in the meeting-house of the Society doctrines subversive of the fundamental principles of Christianity generally received and holden by Unitarians."

THE 'Middle and Old Netherlands Dictionary,' edited by M. Oudemans, senior, had gone through the press as far as the letter S, when the veteran philologer passed away. The publishers, however, have announced that the whole of the remaining copy is going through the press, and, moreover, that it will be revised by Dr. de Jager.

MR. H. H. FURNESS, we learn from the *American Bibliopolist*, has nearly finished the third volume, containing 'Hamlet,' of his Variorum Shakspeare. Mr. H. N. Hudson, the same journal says, is engaged on an edition of Shakspeare.

WE thus catch a glimpse of an old acquaintance under especially agreeable circumstances: "A few days since was married Mr. Roubilliac, an eminent statuary in St. Martin's Lane, to Miss Crosby, of Deptford, a celebrated beauty, with a fortune of Ten Thousand Pounds."—See the *General Advertiser*, Jan. 11, 1753, p. 1, col. 2.

THE following is interesting, and might be recommended to foreign printers of English, who do not seem much more capable than English printers were, according to this advertisement from the *General Advertiser*, January 12, 1750, one hundred and twenty-five years ago:—

"*Please to take* NOTICE. That the new *French Magazine*, the first number of which is to be publish'd on the 1st of February, will for the future be *advertiz'd* in the English Language only, on account of the Difficulty of getting the *French* correctly printed in the News Papers. *** The Preface design'd for the First Number, is now given gratis by R. Griffiths, Bookseller, at the Dunciad, in St. Paul's Churchyard."

M. BACHELIN-DEFLORENNE has sent us the Catalogue of the Library of the late Mr. Benzon, which is to be sold in Paris this month. It contains many bibliographical rarities, being particularly rich in missals.

## SCIENCE

*Compound Guns, Many-Barrelled Rifle Batteries, Machine Guns, Mitrailleurs.* By Capt. J. F. Owen, R.A. (Mitchell & Co.)

THOSE who study the more scientific branches of the art of war, are much indebted to Capt. Owen for giving in a collected form the result of the latest experience with regard to those engines of war known under various names, but most familiar to the public under the title of Mitrailleurs, Mitrailleuses, or Gatlings. These formidable weapons first came prominently into notice in the Franco-Prussian War of 1870–71. Much mystery had been observed by the French with respect to them. They were kept in the deepest seclusion, experiments were tried with them amidst the greatest precautions, and only a limited number of officers were fully trained to their use. Much was expected from the moral effect of the weapon, and it was believed that whatever the deficiencies in numbers of the French army, the rapid and deadly fire of the mitrailleur would supply ample compensation. It was expected, moreover, that the uncertainty which prevailed about its powers, and the vague stories afloat about the wonderful results which it would produce, could not fail greatly to impress the German mind. These anticipations were not altogether belied. The mitrailleur did not, it is true, annihilate within the space of a few minutes whole battalions, but it certainly produced concentrated destruction; and the German soldiers, whose minds had been prepared for almost miraculous results, never throughout the war could quite shake off their awe of the sensational weapon. To the last, they feared the mitrailleur more than artillery or musketry; and who can tell but that their dread might have been justified if the properties and method of employing the new weapon had been better understood? In their anxiety, however, to produce a startling surprise, and to preserve the secret of its construction and effect, the French had confined themselves almost entirely to what we may term experimental training, and had, we believe, only initiated a certain number of Artillery Captains into the mysteries of the mitrailleur. When the war broke out, these captains, being scattered all over the country, were not all available for the command of the mitrailleur batteries.

It is a trite saying that history repeats itself, but it is a remarkably true one as regards inventions. From time to time somebody announces that he has made an important discovery, which the popular voice, after a little doubt and hesitation, pronounces to be one of the glories of the age. A little later the antiquary steps in, and declares the pretended discovery to be, after all, a mere revival of an invention made centuries ago, and since forgotten. There is, however, this to be said for the second inventors,—for practically they are inventors,—that the invention is generally revived in a more useful and perfect form than that which it originally assumed. This is precisely what has happened with the mitrailleur and its congeners. "In the earliest days of artillery, we find machines used under the names of ribeaudequins, orgues, orgels, organ or tube guns, &c., in which several barrels of small calibre were united in a single mass, or a rigid framework." In 1347, such guns were employed for the protection of fortresses in Flanders. They consisted of four breech-loading tubes of small calibre, and were mounted on two-wheel carts. The idea of these many-barrelled guns was soon largely developed. "Andrew Cattaro mentions a machine used in Italy in the fourteenth century . . . . which consisted of a carriage having 144 small bombards (bombardelles), ranged in rows of twelve, three of which rows could be fired at once, and so thirty-six balls, about the size of an egg, discharged at a time. The carriage was drawn by four horses, and three men were sufficient for loading and firing the 144 bombardelles." In 1411, "the Duke of Burgundy's army of 4,000 men had 2,000 organ guns, besides cannon."

We can well understand the popularity of these organ guns, for arquebuses were clumsy, heavy, and ineffective, while cannons could only be fired slowly, required many horses to drag them, and were necessarily almost stationary when once they had taken up their position on a field of battle. About the beginning of the sixteenth century, therefore, "wheeled carriages, strong enough to resist the recoil of a field-piece, and yet fairly mobile, were constructed," and from that time organ guns began to be less used, and after the year 1600 were rarely employed. A space of two centuries and a half followed, during which the only organ gun seen was occasionally one in a museum. In 1853, however, Mr. Goddard invented a rifle battery of 36 barrels, and a little later Sir J. Scott Lillie brought to the notice of the British Government several descriptions of compound guns on frames or wheels. These, however, found little or no favour till the American Civil War broke out, when, at the siege of Charleston, a Requa rifled battery was tried and reported favourably on by General Gilmore, commanding the besieging army. "It consisted of 25 rifled barrels, each 2 feet long, arranged horizontally on an iron frame upon a field carriage, and it weighed altogether about 1,400 lb. It could fire at the rate of 175 shots per minute." In 1862, during the operations before Richmond, there were several Gatlings attached to General M'Clellan's army, but they received the contemptuous name of coffee-grinders, and were never tried. About the same time, several inventions of a similar nature were submitted to our own Government, but were not considered to be worth experiment. In 1869 the machinery of these engines had been greatly improved, and the prejudice against which all inventions have at first to contend having been weakened, different nations began to take the matter up in earnest. The United States ordered 100 Gatlings, chiefly for the flank defence of fortresses, but partly also for employment in the field. Several European States caused a few Montigny mitrailleurs to be manufactured for trial. Two years previously our own Government had tried "a Gatling gun against a 9-pounder rifled breech-loader gun, with very fair results for the former." In 1869, the Montigny being manufactured largely

for the French, our Ordnance Select Committee was directed to try that weapon against the Gatling, and the experiments took place in August, 1870. The result was in favour of the Gatling, and a recommendation that a certain number of the latter should be purchased for further trial. In consequence of this recommendation, 24 medium and as many small Gatlings were ordered. In November, 1871, the Committee having prosecuted further inquiry, and weighed the results of the practical test applied to machine guns during the Franco-Prussian War, adhered to their former opinion, and advised that the ·65-in. bore Gatling should be adopted for coast defences and naval warfare, and ·45-in. calibre Gatlings for field purposes. The French had as many as 190 mitrailleurs of the Montigny type when the war of 1870 broke out, and subsequently procured others, chiefly of American manufacture. They still adhere to their original pattern. In 1869, the Prussians carried out some experiments with the Montigny and the Gatling, but did not approve of either. Large numbers of mitrailleurs were captured by the Germans during the war, but they have introduced none into their service. Russia has a large number of fortress mitrailleurs, and, in addition, 400 Nobel machine guns, a species of Gatling, for field purposes. The Austrians have manufactured about 400 mitrailleurs on the principle of Christophe and Montigny, which have been distributed among the Hungarian Honved regiments. Spain has one battery of six mitrailleurs in each brigade of artillery, but we have not heard of their being used during the present civil war. Turkey possesses a certain number of Gatlings. America possesses 50 Gatlings for service against the Indians, and ordered, a few months ago, 209 for fortresses. These 209 were to be in position by the 1st of August, 1874. In Sweden and Norway much attention has been paid to the subject, and a weapon, the invention of Messrs. Winborg & Palmcrantz, is likely to be adopted. It is supposed to be the best mitrailleur in existence.

We now come to that part of Capt. Owen's book which treats of the employment of machine guns. The author is of opinion that experience justifies the belief that their use will be restricted to the following :—

"1. *For field service.*—An addition of a light nature in small numbers to the reserve artillery of an army for increasing the fire of infantry at critical moments, and for the defence of bridges, villages, field entrenchments, &c.

"2. *For fortresses or siege works.*—In *têtes du pont*, breaches, and flank defence generally, and for use in advanced trenches.

"3. *For naval purposes.*—Firing from ships' tops, and in boat operations."

We are disposed to think that though Capt. Owen and the Special Committee have taken, on the whole, a tolerably correct view of the mitrailleur, yet that both are somewhat inclined to underrate its effect. The great disadvantage of mitrailleurs is, that they are useless against cover of any sort. To artillery also which is able to choose its range, mitrailleurs must, as experience teaches us, always succumb. Against, however, cavalry and infantry *in the open* the mitrailleur is a most deadly weapon. In fact, it should only be used under the same conditions—though it ranges further—as musketry. It has this great superiority over the latter, that the mitrailleur has no nerves, and the destructiveness of its fire depends on the very moderate skill and the nerves of only two or three men. Another advantage is, that a small space covered with mitrailleurs can pour forth a more destructive, rapid, and effective fire than the same space occupied by infantry. With regard to its application to fortresses, siege works, or field works, there can, we think, be no question of the great value of the mitrailleur. In the first place, it increases enormously—more than doubles—the length of the lines of defence; in the second place, it can bring a concentrated fire on an enemy passing the ditch or mounting the breach; in the third place, by its means a steady, unintermittent, and accurate fire can be kept up on the head of a sap. No remarks are needed to show how useful it would be in naval operations. In spite, however, of all these advantages, the Committee are of opinion that it would be useful only as an addition to field or garrison artillery, and not as a substitute for it. We are not disposed to restrict the uses of the weapon within such close limits, but think that it might with advantage replace some portion of the artillery of an army. Our reason for arriving at this conclusion is, that the effect of artillery is chiefly moral, and that compared with musketry, artillery places comparatively few men *hors de combat;* but the mitrailleur, while producing quite as much moral effect as a field-piece, is more destructive. We use the term mitrailleur as the most powerful type of machine guns, for in reality the mitrailleur is very inferior to the Gatling.

The following results of the experiments, made by Col. Wray's Committee in August and September, 1870, may prove interesting; but it must be remembered that machine guns have been much improved since that time. On that occasion, targets representing 90 cavalry or 100 infantry were set up, and the time was two minutes. Shrapnell shell only was used with the field guns. At 300 yards, the small Gatling made 369 hits, and the 12-pounder breech-loader 268; at 400 yards, the Gatling made 310 hits, the 12-pounder 166; at 600 yards, the Gatling made 522 hits, the 12-pounder 142; at 800 yards, the Gatling made 229 hits, the 12-pounder 152; at 1,000 yards, the Gatling made 62 hits, the 12-pounder 218. It will be seen, therefore, that up to 800 yards inclusive the Gatling had a marked superiority over the 12-pounder, and that the best range of the former was 600 yards. After 800 yards, however, the 12-pounder asserted its superiority most unmistakably. With deliberate firing at the same mark the 12-pounder fared better, similarly when segment shell was used. Deliberate firing, however, is what it is difficult to obtain in action; and it must be remembered that deliberate means slow firing, and that the accuracy of the Gatling depends on the strength of fewer men's nerves than is the case with the field piece. The weight of ammunition expended must also be taken into consideration. Now we find that the small Gatling, with an expenditure of 492 lb. of ammunition, made many more hits than the 12-pounder breech-loader, with an expenditure of 1,232·5 lb. The small Gatling also weighs but 3 cwt., while the 12-pounder breech-loader weighs 8 cwt.

The organization of mitrailleurs varies in different countries. The French have six, the Bavarians four, the Russians eight, and the Spaniards six per battery. Col. Wray's Committee recommends twelve per battery, probably for the reason that six field guns occupy on the line of march 353 yards, while twelve Gatlings only require 156. The field battery of six pieces, moreover, requires 203 men of all ranks, and 184 horses; while the Gatling battery of twelve pieces requires but 107 men of all ranks, and 90 horses. The Swedo-Norwegian Committee, however, consider that four machine guns are as many as are likely to be required on one spot, and Col. Wray's Committee is of the same opinion. The latter, therefore, was no doubt influenced by administrative rather than tactical considerations when it suggested that a Gatling battery should consist of twelve pieces. It is generally admitted that the mitrailleur can be used only for defensive purposes, though we can conceive exceptions; consequently the natural place for Gatling batteries is with the corps artillery; and Capt. Owen considers that for every six field pieces there should be one Gatling. We are, however, still in the experimental stage as regards mitrailleurs, and it is highly desirable that our Government, having taken into consideration the result of the recent experiences of Russia and Sweden, and having definitely decided which is the best machine gun, should at once form batteries of the same, and accustom officers and men to their management both at the butts and at manœuvres.

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*An Elementary Treatise on the Integral Calculus.* By B. Williamson, A.M. (Longmans & Co.)

This book will be found in many respects useful alike to student and to teacher. Beginning with the view of integration as the inverse of differentiation, the first five chapters are devoted to a complete consideration of the different modes of integration. It is to be regretted that geometrical illustrations are not introduced more frequently; it would be useful to show that the process of integrating is in fact solving a differential equation of the simplest form; and the geometrical meaning both of the differential equation and of the complete primitive could be explained in a very elementary way. Many students find great difficulty in following long analytical investigations, and this difficulty is unnecessarily increased when the object of the analysis is not put definitely before them. After the methods of integration have been explained, there is a long chapter on definite integrals, some parts of which are hardly suited to an elementary book; it is not till this chapter that we have any mention of integration regarded as summation, a point of view which ought certainly to be brought into prominence in a much earlier chapter. The subject of Multiple Integration is almost altogether absent, an omission which is much to be regretted as the more elementary propositions on this subject should certainly be studied before much that is here inserted. The most striking chapters of the book are the last three, in which the calculus is applied to the areas and lengths of curves and the volumes and surfaces of solids. These chapters include, in addition to the ordinary propositions, Steiner's beautiful theorems as to the connexion between the areas and lengths of roulettes and pedals, a description of the elegant planimeter invented by Prof. Amstler, of Schaffhausen, and many other interesting theorems. The style of the book is throughout clear, and the examples are numerous and well chosen, hints being frequently given for their solution.

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THE CHALLENGER.

The Admiralty have just issued to the scientific world and to those interested in ocean telegraphy