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GENERAL ROHNE

THE PROGRESS

OF

MODERN FIELD ARTILLERY

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TABLE OF CONTENTS.

TABLE OF CONTENTS.

CHAPTER IV.—ORGANIZATION.

CHAPTER V—EMPLOYMENT OF ARTILLERY.

APPENDIX I.—FIELD ARTILLERY MATERIAL IN 1908.

NOTE BY THE AMERICAN TRANSLATOR.

Just at this time of reorganization of our artillery, a clear and concise discussion of the principles underlying the necessity for this marked step in advance should be of interest to every officer in our service.

All this is to be found in General Rohne's admirable pamphlet entitled "The Progress of Modern Field Artillery," expressed in language not too technical to be perfectly clear to any student.

The author wins our respect at once by his dispassionate discussion of French and German ideas on the organization and use of artillery, and in not allowing national prejudices to influence his decision, which is in favor of French methods as opposed to the German. These two great nations have developed the best artillerists of the present day, and the majority of the powers seem to agree with the author's estimate of the former, for imitation is the sincerest form of flattery, and nearly all artilleries have united in adopting the long-recoil shielded gun and to a great extent the scientific and rapid methods of adjustment of fire developed by the French. The Germans, however, still hold to their own methods and materiel, though the boldness of the French in rearming with a gun of a design radically different from any theretofore used, and adopting entirely original rules and methods of fire has induced even them to make some vital changes in matériel if not in methods of fire. We have adopted a new materiel designed by our own ordnance officers after a study of the best foreign models, but we should not forget that German methods and rules of fire have their good points as well as the French. A perusal of this work will therefore tend to enable our artillery officers to form their own independent opinions and enable them to judge what would be best for our own service.

For officers of other arms who wish to bring themselves up to date on modern field artillery in general, this little work is especially recommended. They will seek in vain for the requisite information in works on the Russo-Japanese War, from the fact that neither side in that conflict was up to date in its field artillery materiel, either light or heavy. It is sad to relate, but all of it has already gone or is going to the scrap heap except some pieces purchased from Krupp, who sold impartially to both sides. The Russians were rather late in purchasing, but practice with the 120-cm. field howitzer sent to the front after the Battle of Mukden was a revelation to them and a convincing proof that their 6-inch field mortar was an artillery anachronism—a clumsy, inefficient piece. Those eye-witnesses of the campaign who were without technical knowledge were amazed at the power of what they mistook for up-to-date artillery, and prattled loudly about the terrible effects of modern quick firers. Really there were no field guns of this type used during the war.

For the above reasons General Rohne's work is recommended to all officers who wish to get a clear idea of the present development of field artillery. In fact it is essential that both infantry and cavalry officers should be familiar with the general principles governing the use of the new materiel, its powers and limitations, in order that they may handle it intelligently in time of war, for after all it is the commanders of the higher units embracing all arms who should know what to do with their artillery in order to get results. In our service the great majority of these commanders will not be artillerymen nor will they be competent, without careful study, to make the most of this arm in preventing useless loss of life in those other arms whose successful advance it is designed to aid.

For the convenience of our officers several appendices have been added which cover the progress of field artillery during the four years which have elapsed since this work was written, thus bringing it practically up to date. Thanks are due Capt. W. J. Snow, Adjutant 6th United States Field Artillery, for assistance rendered in compiling these additional data.

NOTE BY LIEUTENANT-COLONEL FRIQUE.

General Rohne published in No. 4 of 1904 of the *Vierteljahrshaftefür Truppenführung und Heereskunde* an important article entitled, "Entwicklung der modernen Feldartillerie," in which he brings out with his usual ability and lucidity the recent improvements in field artillery and the present state of the question of rapid-fire cannon.

The author, with the hand of a master, delivers a finishing blow to those opponents of the shield and of the gun with long recoil on the carriage, who, even up to to-day, have been so numerous among German artillerists.

Passing then to the study of curved fire in campaign, he brings out clearly its advantages and drawbacks and demonstrates the necessity of heavy artillery.

There follows a very close comparison of the French and German methods of fire, which he concludes by acknowledging the superiority of our rules for adjustment of fire.

In the fourth chapter he discusses the grave questions of four- or six-gun batteries and the suppression of corps artillery, and comes out frankly for "the small battery," and the assignment of all artillery to divisions.

The fifth chapter is devoted to the technical and tactical use of artillery upon the field of battle: the principle of the *effect of massing*, extolled in Germany, and that of *economy of forces* adopted in France are there compared with each other, and the author makes no secret of the fact that his preference is for the principle of *economy of forces*. He demands more than ever the intimate cooperation of artillery with infantry, before, during and after the attack.

The article concludes with a rapid survey of the actual state of armament among the principal powers.

The above brief résumé is sufficient to give an idea of the importance of the questions taken up by General Rohne in his little work. His reputation as an artillerist is such that it has been thought useful to acquaint French officers with his conclusions, especially as this work seems to have contributed greatly to a complete reversal of the opinions which up to this time have formed the *corpus doctrinæ* of German writers.

It was with this object that the translation of this study was undertaken, and is now submitted for the consideration of our comrades.

INTRODUCTION.

During no epoch in the history of field artillery has progress been so rapid as since the discovery of smokeless powder, which, independently of its ballistic advantages, has permitted a notable increase in rapidity of fire. It may be stated that improvements in rapid-fire cannon, from now on, have found practically their final formula in guns recoiling upon the carriage, and that shortly there will be a general revolution in the construction of material.

All the powers are on the point of renewing their field artillery, if they have not already completed its transformation. The moment seems opportune to give an account of the nature of the new material, of its effects and of its influence upon the organization and use of artillery, as well as the state of the question with the principal European powers.

The Army is not a dead machine, it is a living organism, and the progress made can be best judged by rapidly reviewing the history of field artillery.*

*The author feels it his duty to remark that this study contains only purely personal opinions, often differing from official opinion.

THE PROGRESS OF MODERN FIELD ARTILLERY.

By General H. ROHNE, 1904.*

CHAPTER I.

MATERIEL.

The immense success of the German cannon in the war of 1870 caused all countries to transform their field material by adopting breech-loading cannon and the percussion fuze, the two principal factors which had marked the superiority of our artillery. While the first had considerably increased the precision, the second had permitted the use of that precision, because the cloud of smoke produced by the burst on graze permitted the determination of the point of fall relatively to the target.

All the powers sought for a cannon superior to that which had just been proved. After a war the impression produced by the effect of fire is still vivid, and tends to cause primary importance to be given to ballistic power, throwing somewhat into the background the question of mobility; besides, war brings out clearly the advantages of simplicity. In 1870 the German artillery employed only two calibers, 8 cm. and 9 cm. (3.15″ and 3.54″): after the war all mounted batteries received the same armament; horse batteries alone retaining a smaller caliber which, we may note in passing, disappeared after a score of years.

Improvement of the Gun.—The new cannon enjoyed ballistic qualities markedly superior to those of the old 9 cm. With a slightly reduced caliber, the projectile had greater weight and initial velocity, the muzzle† energy was more

*Translated into French from the original German by E. Frique, Lieutenant-Colonel of Artillery, 1905. Translated from the French by Col. M. M. Macomb, 6th Regiment, Field Artillery, U. S. Army, June, 1908.

†In mechanics, work or energy is measured by the product of the weight of the projectile by the height to which it rises in space. The unit is the kilogrammeter. The work of the cannon of 9 cm. was 36,200 kgm. that of the cannon, model 1873, 74,700 kgm.

than double. but the weight of the piece was greater. This advance resulted both from the substitution of large grained powder for quick powder, and from perfected methods of fabrication. The old cannon was in one piece; the new was composed of a tube with a jacket shrunk on, permitting it to stand heavier pressures. The wooden flasks were replaced by flasks of pressed steel. Owing to the increase in the ballistic coefficient, due to the diminished caliber and increased weight of the projectile, the latter overcame the resistance of the air better.

Improvement of the Projectile.—But it was the design of the projectile itself which received the most important improvements. In campaign, the shell acts principally by its fragments; it was therefore sought to increase their number. To do this, the shell was given a double wall. About a central core, consisting of a cylinder with projections like a waffle-iron, a second one was cast. Seventy to eighty fragments were thus obtained. Later, the double walled shell was replaced by a *ring shell* of which the core was formed from several superimposed rings, having a star-shaped exterior outline. This projectile gave about 150 fragments of a weight sufficient to disable a man or a horse.

The fabrication of shrapnel had been decided upon some time before the war, but it was possible to supply only a few batteries with it. The adoption of this projectile, which gradually replaced the shell, was the most important improvement of the armament introduced up to that time. The shrapnel contained at first about two hundred balls, but their individual weight was progressively diminished until now it encloses three hundred. As they spread out from the point of burst in the air, the balls form a sheaf and cover a space of considerable depth and a corresponding breadth. A time fuze permitted the point of burst to be changed at will. Later this fuze was replaced by a double-action fuze which, in addition, permitted the projectile to burst on graze. The bursting charge employed for shrapnel was at first just sufficient to break the metallic envelope enclosing the balls, but it produced so little smoke that observation was difficult.

In spite of the adoption of the double-action fuze, the shell was still required for ranging. It was only after having placed the balls in successive layers in a smoke-producing matrix (shrapnel model 1891), that it became at last possible to take full advantage of the double-action fuze, and to adjust the fire by percussion shrapnel. Thenceforward, shell became superfluous for field artillery and would have disappeared entirely had not the need been felt of reaching from above an adversary behind cover and inaccessible directly. With this object, a shell charged with a powerful explosive was invented (high explosive shell).* The shell charged with black powder (common shell) was suppressed.

In 1870 the field gun fired, in addition, canister which was used only on the defensive, at close range. The increase of range of the gun deprived this projectile of most of its value, and if canister did not disappear immediately after the Franco-German War, their number was at least greatly diminished in the ammunition supply.

French Gun, Model 1877.—All nations except England, which retained for a long time muzzle loading, followed a similar course. France had suffered the hard experience of the effect of a superior artillery; she naturally dreamed of creating a cannon of great power. The Army had lost all its artillery material. It was necessary to adopt as soon as practicable a new piece. The Reffye gun, which had already been tried during the latter half of the war, was only a transition arm. The gun which was to constitute the final armament (de Bange, model 1877), appeared four years after the German gun. One condition required was that it must exceed the latter in ballistic power; this was successfully accomplished, but at the expense of too great an increase in weight. Germany had already reached the extreme limit of weight for a field piece (1,980 kg. = 4,356 lbs., limbered; 1,000 kg. = 2,200 lbs., in battery). France deliberately exceeded this (2,200 and 1,200 kg. = 4,640 and 2,640 lbs.). She also armed all her mounted batteries with a single cali-

*The question of fire against covered targets will be taken up later.

ber (90 mm. =3.54″), and the horse batteries with a lighter caliber (80 mm. =3.515″). In spite of its weight, in spite of the initial velocity and weight of its shell, and the great ballistic qualities resulting therefrom, the gun of the mounted batteries never succeeded during its six years of existence in producing effects equal to those of the German piece. The French had forgotten that the gun is, after all, merely a means of throwing the projectile, which carries the effective force into its sphere of action, and that the effect produced depends essentially upon the construction of the shell. It was in 1883 that the French began to create in their so-called "obus à mitraille" a shell equivalent to the German shrapnel. This shell, provided from that date with a double-action fuze, replaced the common shell in the ammunition supply. They still retained the canister, but in reduced proportion; finally they adopted the high explosive shell also, but with a different object from that sought by the Germans.

The light gun of the horse batteries was more happily conceived. It fired a shell heavier than the corresponding German gun, with a greater initial velocity, and moreover the weight behind the teams was notably less: which is explained by the fact that in Germany, for the sake of simplicity, the same carriage was supplied for both calibers.

The maximum range, which for the German gun of the war of 1870 was 3,800 m. (4,156 yds.), now reached 7,000 meters (7,655 yds.). With fuzed fire the Germans went up to 4,500 meters (4,921 yds.), and the French to 5,600 m. (6,034 yds.).

Most other countries patterned after Germany in the transformation of their artillery, but it is a significant fact that all these chose both a smaller caliber and weight of shell. The calibers adopted from 1880 to 1890 varied from 84 to 87 mm. (3.20″ to 3.43″), the German caliber being 88 mm. (3.46″), and the French 90 mm. (3.54″). In fact a lighter gun was everywhere desired.

Introduction of Smokeless Powder.—Such was, in its main features, the state of artillery material when in the second half of the decade, 1880–1890, the invention of smokeless powder caused a complete revolution in the armament. The new propelling agent possesses two important properties, viz., slow combustion, giving considerable ballistic work with low pressures, and burning almost without smoke. The first property allows the ballistic value of all firearms to be increased, carrying with it reduction of caliber, increased initial velocity, and ballistic coefficient, consequently a flatter trajectory and greater range; the second permits aiming during rapid fire. Thus the repeating rifle promptly obtained a foothold, the more so because the light weight of the cartridge allowed the ammunition supply to be largely increased.

The artillery contented itself at first in profiting by the advantages given by the almost complete absence of smoke. Smokeless powder was quickly adopted everywhere, but the charge was calculated so as not to change the initial velocity given by black powder. It might have been increased, it is true, without overworking the gun, but the benefit thus obtained would have been insignificant and would not have compensated for the trouble and expense resulting from the computation of new tables of fire and the fabrication of new fuzes. On the other hand, the difficulties of pointing having been vastly diminished by the absence of smoke, all were practically forced to increase the rapidity of fire. France and Germany adopted a rope brake working automatically upon discharge; this brake reduced the recoil to a quarter of its old amount, and diminished proportionally the hard work of returning the piece to battery.

Consequences of the Employment of Smokeless Powder.— The appearance of smokeless powder was practically a signal for improvements in the gun. It acted to increase at the same time both the effectiveness and the mobility of the material. I shall not study here the various trials and failures in the matter; I will content myself with pointing out the results attained. There was an effort to increase the effectiveness of the gun by adding to that of the individual shot, as well as rapidity of fire.

To increase the effects of a shot, we have:

1. Increased the initial velocity.

2. Increased the ballistic coefficient while reducing the caliber, because the question of mobility forbade adding to the weight of the projectile, and finally;

3. Improved the design of the shell. This last improvement demanded the most serious thought, for the weight of the piece permitted no notable increase in the initial velocity.

Shrapnel of Great Power.—The most important projectile of modern field artillery is shrapnel; its effect increases with the number of balls, which latter is a function of the interior volume of the projectile and of the weight of a ball. To increase the volume, the walls had to be made thin, hence of a resisting metal. The first shrapnel were of cast iron; now only steel is used. In order to have a large number of balls, the weight of a ball was reduced to the lowest limit. In the first shrapnel this weight was 17 grammes (262.3 gr.); later it fell to 13 (200.6 gr.); it fluctuates now between 10 and 12 (154.3 and 185.2 gr.). This diminution of weight has been made possible by the great velocity of the shrapnel at the point of burst. The velocity of the balls is moreover increased by the bursting charge, which is placed behind them instead of in a central tube as formerly. The balls thus gain 50 to 60 m. (164 to 197 f.s.) in velocity. This arrangement (rear charge), has still another advantage over the old (central charge); the balls are dispersed less and are spread quite regularly over the interior of the sheaf. The shrapnel with central charge gave too open a sheaf, especially at long ranges, because of the velocity of rotation peculiar to oblong projectiles; for shrapnel with rear charge the angle of sheaf varies but little with the range.

Metallic Cartridge Cases.—By the changes in ammunition, gun and carriage, the *rapidity of fire* was increased. Cartridge bags were replaced by metallic cases to hold the charge and primer, and comparatively recently the case has been united to the projectile, the whole forming a cartridge. This arrangement simplifies and accelerates loading and firing. The metallic case serves as an obturator, per-

Development of the Gun Recoiling on the Carriage.—This desideratum has been realized in cannon which *recoil on the carriage.* The gun is joined to the carriage by a yielding connection (hydraulic brake), which deadens the shock of recoil. By fitting the trail with a spade and arranging the whole system so that the pressure developed by the brake is less than the resistance of the ground to the spade, the gun will recoil upon a rigid carriage. This result is attained by giving the gun the longest recoil practicable.

The construction of hydraulic brakes of this kind presented great difficulties. The first test began about 1880; but it was only in 1897 that the French succeeded in obtaining a gun really satisfactory. The German factories of Erhardt and Krupp followed closely, and later Skoda at Pilsen, Nordenfelt and Cockerill in Belgium, etc. All guns which recoil upon the carriage are composed of three principal parts:

1. The carriage properly so called, with the axle and wheels, which can be fixed to the ground by means of a trail spade, generally folding.
2. The top carriage or cradle, which rests upon the main carriage and has a slide on its upper part.
3. The gun which at each shot moves upon the slide parallel to its axis, like a sled.

The gun and cradle are united by the hydraulic brake, which is composed essentially of a cylinder, a piston, and piston-rod. The cylinder is solidly fixed to the rear portion of the gun, the piston-rod to the forward part of the cradle. When the gun recoils, carrying with it the cylinder, the inner surface of the latter glides with slight friction upon the piston which remains motionless. The liquid in the cylinder is forced from one side of the piston to the other through small openings. Besides this the recoil of the gun compresses a strong helical spring enveloping the cylinder. This spring absorbs part of the energy of recoil, and also returns the gun to its firing position, when the recoil is checked. The return into battery is made gently because the liquid in the cylinder must again pass through the narrow openings in the piston.

In the French gun, the "recuperator" (counter recoil) spring is replaced by compressed air. The recoil compresses the air, the expansion of which later returns the gun to its firing position. I will abstain from all comparison of the two systems. I will limit myself to saying that the Russian rapid-fire gun, model 1900, possesses a recoil buffer of rubber instead of a recuperator spring.

The gun, as we have said, recoils upon the cradle parallel to its axis. This arrangement permits other important improvements of the pointing apparatus. There results from this practically that the pointing apparatus acts not only upon the gun, but also upon the cradle, which oscillates about a horizontal axis fixed to the forward part of the carriage. It has been possible to change the line of aim from the gun to the cradle; since the latter does not share in the recoil of the gun, the pointer can commence to change the laying during the return of the gun into battery. The pointing apparatus, having no longer to sustain the shock of recoil, may be composed of more delicate instruments. The long line of aim, formed by the front and peep sights, has been replaced by optical lines of sight which, in spite of their short length, give more precision than the old line of sight; they permit, besides, the use of any aiming point whatever.

The French have gone further still in improving the pointing apparatus. Their system of pointing in elevation is so arranged that the inclination of the gun may be changed at will by turning a hand-wheel on the right flask, while the line of sight is at the same time kept constantly upon the target (independent line of sight). If, on the contrary, the hand-wheel on the left flask is turned, the inclination of the line of sight and that of the gun are changed together. This arrangement greatly shortens the operation of pointing, and lightens the task of the gun pointer. He has simply to keep the line of sight on the target (angle of site), while the cannoneer seated on the other side of the piece (firer), gives to the gun the inclination (angle of fire) corresponding to the given range. To do this he has only to turn the hand-wheel until an index points to the figure denoting the range; he does not need to manipulate either the rear sight or elevating arc. The latest Krupp pieces have equivalent arrangements, very simple and strong.

Rapidity of Fire with Long Recoil Guns.—The complete suppression of the recoil does away with "running up," and increases rapidity of fire considerably. In 1870, the gun fired one shot a minute, or at most one and one-half; with the model of '73 after the adoption of smokeless powder and the rope brake, well-drilled gun crews got up to two shots and a half. Under the same conditions the model of '96 reached eight shots a minute, the Krupp rapid-fire gun with trail spade ten to eleven shots, the gun with long recoil on the carriage twenty shots and twenty-four without relaying.* The rapidity of fire of the French gun should reach seventeen shots a minute.

Undoubtedly such rapidity of fire would never be used in war, or even at schools of practice. It nevertheless remains that the gun with long recoil on the carriage has vastly increased the rapidity of fire without impairing its accuracy, or imposing extra exertion upon the gun crew. It may be asserted without exaggeration that the modern gun fires ten times as fast as the German piece of 1870.

Increase in Efficiency.—All these improvements have increased the efficiency to a degree which can hardly be expressed exactly in figures. We will note that in 1870 a shell gave some thirty fragments, while a modern shrapnel gives three hundred, the effects of which are felt over great depth and are independent of the nature of the ground, besides having increased accuracy and range. We are thus led to conclude that the gun will give to-day, in the same time, at least *one hundred times more hits* than the heavy German gun of 1870, assuming, of course, that the ammunition supply is unlimited. With the same weight of ammunition, the present gun has an efficiency at least ten times greater than that of the gun of 1870.

*The maximum rate was ten shots in twenty-one seconds; over twenty-eight shots a minute.

Table 1 (page 29) gives a summary of the progress accomplished by artillery from 1870 to 1904.

Mobility.—The mobility of a piece of artillery depends principally upon its weight, which is itself a function of the power. Just after war, power is first sought for as we have already noted; then after a long period of peace, mobility is demanded again. This is a phenomenon which reproduces itself unceasingly, as Lieutenant-General von Müller has remarked in his *Progress of Artillery.** In time of peace the ballistic effect is not seen, while the inconveniences of weight make themselves disagreeably felt during maneuvers and drills. This causes a demand for great mobility in new pieces, which is obtained by reducing the ballistic requirements and introducing important technical improvements.

Leaving out of account a transient increase in the weight of shrapnel, it will be seen that the weight of the projectile has varied but little in Germany since 1870, and that in France it has been constantly diminishing. The initial velocity has not increased much in Germany, but in most other artilleries it has run up to about 500 m. (1640 f.s.).

Since the war, the muzzle energy of the projectile has increased from 45 per cent in France to over 100 per cent in Germany; the adoption of the rapid-fire gun has not changed it with us, but has increased it by a quarter with our neighbors.

To judge of the progress accomplished in the construction of the material, it is sufficient to examine the ratio of the amount of work done to the weight of the gun in battery. Table 1 shows that this ratio has doubled for the French as well as the German gun.

The important factor bearing upon mobility in the battlefield is the weight of the piece hitched, and, consequently, of the limber (including the ammunition carried there). The rapid-fire piece consumes a great deal. The constructor should therefore force himself to reduce the ratio of the weight of the carriage to that of the ammunition. From this point of view the model 1896 gun shows decided progress;

*Entwicklung der Feld artillerie, par le general H. von Müller, 1893.

with a greater weight of ammunition, its limber loaded weighs much less than that of model 1873.

The supply of the caisson plays a more important part to-day than that of the limber, since it is the caisson body which is drawn upon during fire. The caisson, then, must not be too heavy and yet it must carry a sufficient number of rounds. From this point of view also great progress has been made (see Table 1).

Traction Buffers.—There is still another means of increasing the mobility besides the diminution of weight, and that is to husband the force of the teams. It is with this object in view that the French field artillery has been furnished with elastic *buffers* which, upon irregular terrain, diminish the blows upon the shoulders of the horses, and consequently lessens the fatigue of the animals.

The Danish and Swedish artilleries have adopted similar arrangements.

Shields.—The immobility of the new piece during fire presents still another advantage: it permits steel shields to be attached to the carriage, which protect the gun crew from rifle or shrapnel bullets. A sheet of good steel, of 3 mm. (0.118″) thickness, resists a rifle bullet fired from ranges over 400 m. (437.4 yds.); shrapnel balls will not pierce it at any range. The weight of these shields is about 50 kg. (110 lbs.); it increases about 16 kg. (35 lbs.) for each millimeter (0.039″) in thickness.

The French have also plated the bottom of their caisson with steel. In battle, the caisson body is upturned beside the piece, the bottom being toward the enemy. The cover of the chest opens like the doors of a wardrobe, and as it is also made of rolled steel, the caisson servants find themselves protected not only from frontal fire but also from oblique fire.

The protection is not complete, undoubtedly; large fragments may penetrate the shields; there are open spaces; the gun servants, two cannoneers seated upon the carriage seats, may also be hit. The exposed surface is nevertheless reduced to one-sixth at least. Comparative tests made in Switzerland with two guns, one with shields and the other without, showed positively that the servants of the latter suffered six times as many hits as those of the former. In the face of such an advantage, a small increase of weight is allowable.

It has also been claimed that the shield increases the visibility of the gun and makes a better target, but the assertion has not been verified at the imperial maneuvers.

Unanimity of Opinion in Favor of the Long-Recoil Gun with Shield.—The best proof of the slight weight of all these objections is that all countries which have decided in favor of the gun recoiling on the carriage have, at the same time, adopted the shield, with the single exception of Russia.

Russia has followed her own way in what concerns armament; her gun is quite distinct from all others; it is not the gun only which recoils upon the cradle, but the gun and upper carriage, the latter carrying the pointing apparatus. This gun exceeds all others ballistically (shell 6.55 kg.= 14.44 lbs.; initial velocity 589 m.=1,942.4 f. s.; muzzle energy 116 meter-tons=374.5 foot-tons), and this very fact gives rise to an inconvenience greatly felt in Russia because of the poor roads. It is easy to see, therefore, that there is an unwillingness to aggravate the evil by adding shields; moreover, as the carriage is not absolutely rigid at the moment of firing, the gun servants would be forced to move outside the wheels, and would thus lose the benefit of the protection afforded by shields.

Curved Fire in Field and Heavy Artillery.—The trajectories of guns, the only species of artillery thus far discussed in this study, have become more and more extended; the effects against objects in the open have become more and more deadly, and naturally more and more importance is attached to the utilization of cover. This tendency has been particularly marked since the Russo-Turkish War. The troops of Osman Pasha were able, thanks to the fortified position of Plevna, to arrest the triumphal march of the Russians, and to repulse with bloody losses the repeated assaults of very superior forces. The failure of the Russians was unquestionably due to the fact that their infantry attacks were insufficiently supported by the artillery; the greatest fault was the defective use of the latter arm, which came into line only in fractions, and fired only at long ranges, ceasing fire when the infantry advanced to the attack, instead of redoubling it. Skobelev succeeded in his offensive because his artillery accompanied the assaulting troops, and he retreated only because he was not supported. The Russians attributed the inefficiency of their artillery to faulty material. The direct fire of their light guns destroyed neither the troops covered nor the cover, and these are precisely the two effects which it appears necessary to obtain, in order that the attack of fortified positions may have some chance of success. These considerations caused the adoption of a heavy field gun (caliber 4.2-in.; weight of projectile about 28 lbs.), and a field mortar of 152 mm. (6 inches) caliber. The gun proved unequal to its task and has long since disappeared from systems of field artillery.

It is everywhere admitted that field works will play a more important part in future wars; everywhere the numbers of infantry entrenehing tools have been increased, and the means of fighting an entrenched enemy deeply studied. In Germany the question was taken up about 1880, and experiments commenced almost immediately. The introduction in the field artillery of a new specially designed gun to demolish such objectives was generally regarded as a great inconvenience, so they first tried firing field-gun shrapnel with a reduced propelling charge against defiladed objectives. This means was evidently impracticable; it was impossible to obtain under these conditions the angle of fall which the bombardment of defiladed targets demanded. So it happened that about 1890 a 120 mm. (4.72 in.) field mortar was constructed (called the short gun) with the special object of giving a *plunging shrapnel fire* against covered objectives.

About the same time a method was discovered of firing safelv from guns shell charged with high explosive. The immense power of the bursting charge broke the projectile into a vast number of fragments, spreading in every direction

batter barrier forts, and the normal ammunition supply requires a great number of vehicles.

Thus, at this epoch, in firing against hasty entrenchments which afford shelter only against direct fire, they contented themselves with field artillery supplied with explosive shell, while the preparation of the attack of more solid works, which protected the defenders even against fragments falling at large angles, was accomplished by the *heavy artillery of the army.* They even went further; they also required the field artillery to reach the defenders in shelter proof against fragments. Naturally, this result could only be obtained by guns with curved fire, which led to the creation of the *light field howitzer.*

But it was not thought desirable to make an absolutely specialized piece, fitted only for a particular function; it was desired to have it suited for general use in campaign, that is to say, capable of giving with shrapnel an effective direct fire, without exceeding the limit of weight. These desiderata were partly incompatible, and to fulfil them was no easy task for the designer. To pierce resisting cover, a heavy projectile was needed; to work effectively with direct fire required a high initial velocity. Two different projectiles were adopted, a shell and a shrapnel. The shelters could not be destroyed, nor the defenders within these shelters annihilated except by using two kinds of shell, one detonating on graze (non-delay action), the other shortly after impact (delay action). Only the former permitted ranging, for, with small angles of fall, the delay action shell ricochetted, and, with large angles, buried itself too deeply to make a bursting cloud clearly visible. The latter shell is the one used to destroy earthworks, because neither the force of impact nor the bursting charge of the shell produced the required effect at the instant of striking; this effect could be obtained only when the shell burst at a suitable depth in the covering mass.

So, three different sorts of projectiles were needed, the ammunition supply of each sort was thus greatly reduced, and the more so as the complete round weighed more than twice that of the field gun, model 1896. If the fuze could have been made so as to function at will, with or without delay, the ammunition supply would have been greatly simplified. There still remains, however, the inconvenience of being unable to see the bursts of shell with delay action fired against shelters, when the said shell failed to strike the target. Moreover, the noise of the detonation of the shell in the earth is deadened, and produces far less effect upon the nerves than when it bursts in the air or on impact.

The non-delay action shell is employed not only for ranging, but also for fire against troops defiladed, but not sheltered. They are for this reason furnished with double action fuzes and fired direct with time fuze. Their efficiency is very superior to that of the explosive shell of the field gun.

The shell of the heavy field howitzer has a weight and bursting charge which permit it to break through shelter, with a great excess of force. If the object fired at is not hit, there remains at least the effect produced by the fragments and by the detonation.

Variety of Curved Fire Field Pieces.—The new field guns of various countries can hardly be distinguished from each other ballistically, but curved fire pieces differ considerably. Everyone agrees practically upon what should be demanded of a field gun; the differences being mainly upon the question of mobility. A mountainous country like Switzerland, or a country which will have to employ its guns mainly in roadless colonies, like Holland, needs lighter pieces, and must be content with less ballistic power than a nation whose army will have to fight in a region well provided with means of communication; but, after all, the differences are but slight.

It is quite otherwise with the howitzer; opinions have always differed on this subject. Some attach more importance to the curvature of the trajectory, others to the weight of the projectile; in the age of smooth bores there were already the short howitzer and the long howitzer. One side seeks in the howitzer a way of reaching troops behind an entrenchment, the other the means of destroying the entrenchment itself. The one, regarding it necessary to have such pieces always at hand, attaches them to the field artillery and allots some to the Army Corps; the other, considering that they should not be called upon to take part in combats of an active campaign, except under *certain circumstances*, assigns them to the heavy artillery of the army and places them under the immediate orders of the commanders of the army. Some countries completely ignore this piece.*

Tables 2 and 3 (pp. 30, 31) give information upon the principal dimensions, weight and ballistic elements of modern guns adopted by the principal powers.

*It is not without interest to state that in recent military publications, German artillerists themselves differ in opinion upon the employment of the light field howitzer. Some appreciate more highly its qualities as a direct-fire piece, of which the shrapnel fire equals that of the gun, if it does not surpass it; others expect the best effects from its time-fuzed shell-fire against covered targets; still others see in it, above all, the piece for curved fire, and consider that it should be exclusively adopted for plunging fire, to which the former reply that plunging fire is of no importance except in war of positions, or in siege warfare. The question of ammunition supply, however, indicates well enough for what object this type of artillery has been created. In the Army Corps, 40 per cent of the total number of its projectiles are delay- action shell suited solely to plunging fire. About a third are shrapnel and only a quarter shell with non-delay fuze, which serve for ranging the plunging fire and for fire with time fuze. All this shows very clearly that the principal service expected of this howitzer is plunging fire, and that it should be only exceptionally employed for time-fuzed shell-fire. Shrapnel has been supplied so that this piece may be used in place of the gun whenever, for lack of its special objectives, this may seem desirable.

	1870.		After 1870.		1904.		
	France.	Germany.	France.	Germany.	France.	Germany.	Krupp.
Caliber (c) mm.	121.3	91.6(73)	90	88	75	77	75
Weight of projectile, shrapnel (p) kg.	11.5	6.9	8.16(8.7)	7.0(8.15)	7.2	6.85	6.5
Weight per square cm. of cross-section $\left(\frac{4p}{\pi c^2}\right)$ gr.	100	105	128	115(134)	163	147	147
Initial velocity (Vo) m	307	323	437	444(417)	529	465	500
Velocity at 1,000 m. (V_{1000}) m.	255	274	336	320	413	369	390
Velocity at 2,000 m. (V_{2000}) m.	210	244	288	264	334	310	324
Velocity at 3,000 m. (V_{3000}) m.	169	220	258	235	290	279	287
Muzzle energy $\left(\frac{pV_0^2}{2g}\right)$ meter-tons.	57.8	36.7	79.4	70.3(72.2)	103.5	75	82.8
Remaining energy at 2,000 m $\left(\frac{pV_{2000}^2}{2g}\right)$ meter-tons.	25.8	20.9	34.5	24.9	40.9	33.6	34.8
Dangerous space at 1,000 m. for targets 1 m. high. m.	13	19	26.0	25	41	31	36
Dangerous space at 2,000 m. for targets 1 m. high. m.	4.7	6.9	10	9.1	15	12	13
Dangerous space at 3,000 m. for targets 1 m. high. m.	2.2	3.7	5.6	4.7	7.6	6.5	7.1
Number of bullets in shrapnel	150	180	237	262	300	300	295
Weight of a single shrapnel bullet gr.	28	17					
Ratio of weight of bullets to weight of projectile	0.37	0.41	0.51	0.42	0.50	0.46	0.50
Weight of the piece in battery kg.	1223	1018	1210	1030	1100	945	975
Living force per kilogram of above weight kgm.	47	36	66.7	68.2	94.1	79.3	84.9
Weight of a complete round kg.	12.5	7.5	9.4	8.1	9.1	8.0	8.14
Number of rounds in limber	18	38	26	32	24	36	44
Weight of limber loaded kg.	714	815	915	950	700	825	800
Weight of its ammunition kg.	225	285	244	259	218	288	358
Ratio of weight of ammunition to weight of limber kg.	0.31	0.35	0.31	0.273	0.31	0.35	0.445
Number of rounds in caisson	54	99					
Weight of caisson loaded kg.	1845	2212	2200	2055	1900	1830	1850
Weight of its ammunition kg.	675	738	795	576	874	705	897
Ratio of the above two weights	0.31	0.33	0.36	0.28	0.46	0.38	0.48
Weight of the piece limbered	1937	1835	2140	1980	1850	1770	1775

Table 2.—FIELD GUNS ACTUALLY IN SERVICE 1904.

	Germany.	France.	Russia.	Italy.*	England.	Switzerland.
Year of manufacture	1896	1897	1900	1900	1900	1902
Caliber (c) . . . mm.	77	75	76.2	75	76.2	75
Weight of projectile (p) shrapnel . . . kg.	6.85	7.2	6.55	6.707	6.35	6.35
Weight of projectile shell . . . kg.	(6.85)	(7.0)	....	(6.055)	....	....
Weight per square cm. of cross-section $\left(\frac{4p}{\pi c}\right)$ . . . gr.	147	163	144	152	....	144
Number of bullets	300	300	260	180–127	290	285
Weight of a bullet . . . gr.	10	12	10.6	10 and 11	11	11
Total weight of bullets . . . kg.	3	3.6	2.76	3.2	3.19	3.13
Ratio of useful weight to weight of projectile	0.44	0.50	0.42	0.48	0.50	0.49
Initial velocity (Vo) . . . m.	465	529	589	480	....	485
Weight of gun and breech block . . . kg.	434	460	360	350	....	327
Weight of gun in battery (P) . . . kg.	945	975	1050	984	....	952
Weight of gun limbered . . . kg.	1770	1850	1884	....	....	1752
Muzzle energy $\left(E=\frac{pV_0^2}{2g}\right)$ . . . meter-tons.	75.5	105	116	78.8	....	76.1
Muzzle energy per kilogram of the piece in battery . . . kgm.	79.9	108	111	80.0	....	80.0
Number of rounds which can be fired in 1 minute	8	17	15 to 20?	....	....	20
Number of rounds in the limber	36	24	....	....	....	40
Number of rounds in the caisson	88	96	....	....	....	96 to 100
Weight of the caisson . . . kg.	1830	1850	1923	....	....	1820

*With spring trail spade.

Table 3.—Field Howitzers Actually in Service 1904.

	Germany.		France.		Russia.	Austria.		England. Mark II.	Switzerland.*
Year of manufacture	1898	1902	1895†	1895	1886	1899	1899	....	1902
Caliber ... mm.	105	149.7	120	155	152	105	150	127	120
Weight of shell ... kg.	15.7	41	20.35	43	26.8	14	39	22.6	21.0
Weight of shrapnel ... kg.	12.8	....	20.35	40	29.6	12	37	22.6	21.0
Bursting charge of shell ... kg.	1.5	7.7	4.0	12	7.4	....	2.3	4.5	2.1 & 4.2
Number of bullets in shrapnel	500	....	637	416	683	....	380	8 284	650
Weight of one bullet ... gr.	10	....	12	?	21.3	....	24.4	28.389	16
Initial velocity of shell (maximum) ... m.	330	300	290	300	220	305	291	239	300
Initial velocity of shrapnel (maximum) ... m.	295	....	290	?	?	300	276	....	300
Maximum range ... m.	5600	6800	5700	6400	3400	5600	6600	4500	6400
Weight of piece in battery ... kg.	1090	2100	1475	2400	1280	954	2660	1168	1185
Weight of piece limbered and packed ... kg.	2370	2600	2365	4100	2130	2223	2960	2299	2071
Weight of caisson limbered and packed ... kg.	2440	....	2360	....	....	2055	....	....	2100
Artillery to which piece belongs	Field	Foot	Field	Foot	Field	Field	Foot	Field	Foot.

*Under trial. † French short gun.

CHAPTER II.

EFFECTS OF ARTILLERY.

GUNS.—The information condensed in the various tables annexed to this study is not a complete presentation of the effectiveness of the various guns, but simply a means of forming a general idea of it.

Field artillery, and particularly field guns, produce their principal effect against animate targets by what may be termed "sprinkling." Their action depends essentially upon the number of fragments, upon their dispersion, and their force of penetration.

Shrapnel for Guns.—Modern shrapnel all have the base charge with a sheaf of moderate angle of spread. In the guns, model 1896, this angle is 16°; to be precise, we will say that it varies with the range from 12° to 20° The greater the interval of burst, the greater the dispersion of fragments, the less the density, and consequently the smaller the number of hits; besides, the velocity of the balls decreases, and with it the power of penetration. This power becomes insufficient to put a man out of action when it falls below 125 m. (410 f. s.).* The density and the force of penetration thus determine the limit of action in depth of the sheaf of bullets; at great distances it is the range itself which fixes that limit.

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*Dr. Blrcher, a Swiss physician, concludes from numerous experiments that a velocity of 100 m. (328 f. s.) is sufficient.—*Author's Note.*

To merely indicate the velocity is hardly sufficient; the weight of the ball should also be taken into account. For this reason in France it is generally admitted that it requires considerably over 8 kgm. (57.85 ft.-pounds) to put a man *hors de combat* (Revue d'Artillerie, Vol. 58, p. 474). In Germany they appear to be contented with 8 kgm. This figure corresponds approximately to a striking velocity of 115 m. for a ball of 12 grams, 120 for a ball of 11 grams, and 125 for a ball of 10 grams (377, 393 and 410 f. s.) for balls of 185, 170, and 155 grains.—*French Translator's Note.*

to an interval of 50 meters. The lower the height of burst, the smaller the surface covered by the sheaf; it will, of course, be less elongated at great distances. The numbers on the figures give the density (*i. e.*, the number of hits upon a vertical surface 1 m. square), and the width of the zone of dispersion. The product of these numbers, which is also given, shows the total number of hits to be expected upon a target of that width, 1 meter high, at the indicated range. Actually a greater number of hits is generally obtained, especially at short distances, because a large part of the balls which strike hard, flat ground, in front of the target, ricochet and then strike it.

The effects against a line of skirmishers, one man per running meter, may be obtained by multiplying the area of surface exposed expressed in square meters by the number of hits upon a target 1 meter high. This surface is in the several cases as follows:*

Skirmisher standing.	. . .0.560 sq. meter.
Skirmisher kneeling	. . .0.410 sq. meter.
Skirmisher half covered...	. . 0.280 sq. meter.
Skirmisher lying down...	. . 0.135 sq. meter.
Skirmisher covered...	. . .0.075 sq. meter.

For a battery the number of hits is obtained by multiplying the number of hits upon a target 1 m. high by 0.24.

A shrapnel, model 1896, will therefore give an average of hits for a 50-meter interval of burst:

*The dimensions of the targets do not correspond exactly with the vulnerable surface of the skirmishers. These surfaces are smaller for the standing and kneeling figures, and greater for the lying-down figures. (See *Militär-Wochenblatt*, supplement 11, 1898.)—*Author's Note.*

The figures given on this subject are various. The following are borrowed from the *Rivista di artiglieria e genio* (See Revue d'Artillerie, Vol. 34, p. 79).

Infantryman standing, facing to front, 0.4753 sq. m.
Infantryman standing, facing to flank, 0.2799 sq. m.
Rifleman kneeling, facing to front, 0.3248 sq. m.
Rifleman lying down, facing to front, 0.1612 sq. m.
Horse and rider, facing to front, 1.1299 sq. m.
Horse and rider, facing to flank, 1.8006 sq. m.—*Translator's Note.*

Ranges.	Line of Skirmishers. Standing.	Kneeling.	Half covered.	Lying down.	Covered.	Artillery.
Meters.						
500	20.2	14.1	10.0	4.8	2.9	....
1,000	15.4	11.2	7.7	3.6	2.1	6.6
2,000	12.9	9.5	6.4	3.0	1.7	6.5
3,000	11.9	8.7	5.9	2.7	1.5	5.1
4,000	10.8	7.9	5.4	2.5	1.5	4.6
5,000	10.3	7.6	5.1	2.4	1.4	4.4

In order to avoid exaggerating the effects at great distances, we will remark that the above numbers refer to a single round bursting at a *type height.* At long ranges the least displacement of the point of burst will notably reduce the effect produced.

If the intervals of burst increase, the effect will vary inversely to that interval for short ranges (up to 3,000 m.), and very much more rapidly for longer ones.

The same is true for foreign guns; the number of hits diminishes with the number of balls; an increase in the opening of the sheaf diminishes the effect produced. The effect increases with flat trajectories, but the differences are inconsiderable.

We will sav further, to be complete, that walls of a thickness not exceeding 75 cm. (2.95 feet) are traversed by percussion shrapnel, and that planks 5 cm. (1.97 in.) thick generally afford sufficient cover against the balls of this projectile.

The best measure of efficiency is the number of hits obtained in service fire by the tactical unit (the battery), in the unit of time (a minute). This number is a function of the kind of fire employed, of the strength of the battery (8, 6 or 4 pieces), and of the rapidity of fire; we will speak of it again further on.

Shell for Guns.—There is but little to say about shell. The various artilleries demand different effects from them and design them according to the result to be attained.

In Germany they are fired with time fuze against covered troops; they act by their fragments. The shell also is of steel; its walls are thick, and it is given a strong charge of explosive. On bursting it gives a very great number of fragments, one hundred and thirty-five of which may be considered *effective*, their weight being sufficient to put a man out of action, even with long intervals of burst. They are scattered in every direction so that a certain part of them strike the ground at large angles (60 to 70 degrees). Naturally their action in depth is small; only those projectiles with a point of burst, very well placed, are deadly. Again, although a shell bursting very near and in front of a target produces a very considerable effect, results cannot be counted upon without expending a great deal of ammunition. The power of penetration of the fragments is about the same as the shrapnel bullets, so that a light covering of plank suffices to neutralize their action.

The high explosive shell of the French field gun is intended to destroy obstacles; it acts especially by the expansion of the gas produced by the explosion. In order that it may carry a very strong interior charge, the walls are made thin; it has only the percussion fuze.

Other field artilleries have no explosive shell. The shell which their field guns fire are charged with black powder and are used in ranging because their shrapnel do not produce sufficient smoke to make observation easy.

HOWITZERS.—The effects of the various field guns are easily comparable; on the contrary, those of *field howitzers** show marked differences. A glance at Tables 2 and 3 suffices to show that while the calibers of modern field guns are comprised between 75 and 77 mm. (2.95 and 3.03 inches), those of field howitzers (including the Russian 6-inch field mortar) vary between 10.5 and 15.5 cm. (4.12 and 5.99 inches).

The rôle of the howitzers is not so clearly defined as that of the guns; besides, they are to be employed not only in

*When we speak of field howitzers, the Russian field mortar is always included.

field but also in siege operations. But the latter is more particularly the domain of the *heavy* field howitzer.

Moreover, the light howitzer fires shrapnel and shell; the heavy howitzer often fires only shell. In some artilleries (Germany, Austria) shrapnel is fired only with heavy charges; but it is desired that the howitzer should be able, on occasions, to take the place of the guns and deliver a particularly effective fire with full service charge. In other countries (France, Russia) it is fired with variable charges; the principal rôle of the howitzer is, then, the bombardment of defiladed objectives. It is well to note in this case that plunging fire with shrapnel produces less effect than the fire with full service charge of time-fuzed explosive shell. In Germany, and only in that country, the explosive shell is supplied with a double-action fuze; in other artilleries it has only a percussion fuze.

Under these conditions it is impossible to make a precise comparison between the effects of the various field howitzers. I will therefore limit myself to some notes concerning the German field howitzers; even then the data will be rather vague, from the fact that thus far very little has been published concerning the ballistic value of these pieces of artillery.*

Shrapnel of the German Howitzer.—The howitzer shrapnel is fully as efficient as that of the gun. *The Manual of Fire* (27 *Schiessvorschritt fur die Feldartillerie,* Berlin, Mittler, 1899) gives about 19° as the angle of opening of its sheaf. This value corresponds practically to a distance of 2,000 meters (2,187 yards). The angle increases with the range, but more slowly. Of the 500 balls of this shrapnel, 425, or 85 per cent, are spread over the interior of the sheaf;† at 2,000 meters, and for an interval of burst of 50 m., the breadth of the sheaf is about 17 m. and, upon a target of indefinite length 1 m. high, thirty-two hits are obtained,

*See Revue d'Artillerie, Vol. 58, p. 83.

†The other 75 balls (15 per cent) have a dispersion too irregular to be considered.

that is to say forty per cent more than the gun shrapnel will give under the same conditions.*

This proportion probably holds good at all ranges. It will, however, be premature to assume from this fact alone the superiority of the howitzer shrapnel; because of the marked curvature of its trajectory, its effectiveness diminishes more rapidly than that of the gun, as the interval of burst increases. Besides, we must take into consideration that the gun shrapnel gives at 2,000 meters 3.36 hits per kilogram of its weight, whereas that of the howitzer gives only 2.56; finally the gun fires incomparably faster than the howitzer.

High Explosive Shell of the German Howitzer.—The explosive shell of the howitzer, fired with time fuze against defiladed objects, acts like that of the gun but very much more effectively. According to the *Manual of Fire* (§27), the angle of opening of the sheaf is as much as 200°, almost double that of the gun. In consequence, the effect is not so closely connected with the position of the point of burst. In the gun, for instance, the shell bursting at a height of 10 m. cannot be effective against an object defiladed at 30°, except when the point of burst happens to be between 17 and 6 meters in front of the objective; for the howitzer, the shell may burst at 3 meters beyond the target without all its fragments being over. This piece, therefore, gives a very large proportion of useful shots. Let us add also that the fragments of its shells are heavier and more numerous than those of the gun shell.

It may be concluded from the preceding that the effects of the high explosive shell with time fuze are at least four times greater for the howitzer than for the gun.

The percussion shell is fired with seven different charges; the corresponding initial velocities vary from 170 to 300 m. (558 to 1084 f. s.). Against vertical targets the maximum

*An advantage often claimed for this howitzer is its alleged superior effectiveness against guns with shields. I very much doubt, however, in spite of its curved trajectory, whether its balls will more easily reach the cannoneers covered by the shields—the difference can only be slight.

charge (direct fire) is employed; against horizontal targets the charge is varied with the distance (plunging fire, so as to obtain at the same time large angles of fall combined with a sufficient force of penetration. Against splinter proofs of field forts, there is required an angle of fall of at least 28°. This angle is obtained at 2,000 m. (2,187 yards) with the minimum charge. As has been previously stated, this shell is fired *with delay* in order that it may penetrate deeply enough in the soil. The projectile penetrates the covering mass and acts by its fragments upon the interior of the cover.

One shell is enough against all the splinter proofs of field warfare, but, these shelters being of slight extent, it is impossible to count upon them being hit by but a small proportion of the shots fired. They are often only 6 × 2 meters (Manual of Fire, Example No. 7).* The Krupp field howitzer, for an angle of fire of 30°, has a mean error of 30 m. in range, and 6 m. in deviation; against an isolated bombproof of the dimensions indicated above, even after perfect ranging, only about 2 per cent of hits on the target would be obtained, and that proportion will diminish still more if it is necessary, because of the indistinctness of the target, to have recourse to progressive fire.

As to heavy field howitzers, we have already said enough of their effect. Their accuracy scarcely exceeds that of the light howitzer.

These considerations, taken with the numerical data of Table 3 (see page 31), will permit an approximate idea to be formed of the effects of the curved fire pieces used by foreign artillerists.

*In Switzerland, in 1903, the field howitzer was fired against splinter proofs 3 x 1 meters, that is to say, shelters whose horizontal surface was a quarter of the surface of the shelter referred to in the German Manual of Fire.

CHAPTER III.

FIRE.

The fire of field artillery comprises two entirely distinct periods: fire for adjustment, and fire for effect. The former has for its object the determination of the data required for fire for effect, namely, the range, the fuze setting, and the distribution of fire so as to obtain rapidly *sufficient* effect with a small expenditure of ammunition. The precision of rifled cannon led at first to attempts at getting the maximum effect with the minimum expenditure of ammunition, without considering the factor of time. Long after the adoption of shrapnel, ranging with percussion shell was continued, which was succeeded by fire with shrapnel; more than that, at target practice, if only one objective was being fired at, shrapnel was not used until the shell was completely exhausted. It was not until 1880 that the rule was followed of changing to shrapnel as soon as the range had been found, and of concluding the practice with the remaining shell.

Short Bracket and Long Bracket.—It was learned gradually that very precise ranging did not increase the effect in proportion to the time spent. Therefore, the maximum effect was abandoned for a sufficient effect obtained as quickly as possible. At first it was customary to make corrections as small as 25 meters, an absolutely useless requirement in fuzed fire; then the process of ranging was simplified and broadened more and more, and finally the method was reached of covering a zone of a certain depth by firing with several elevations (progressive fire). Such was the general direction taken by the methods of fire in all countries, and to-day they are still following the same course.

Everywhere adjustment begins by seeking a *bracket*, that is, the determination of two limiting distances, having the target between them. The first bracket, in general from 200 to 400 meters, can be halved by firing at the mean range, and so on, according to the degree of accuracy to which it is desired to carry the ranging.

pieces are habitually laid upon some plainly visible point of the objective, and the fire is not distributed until the opening of fuzed fire. *The German Manual of Fire* attaches especial importance to ranging in direction (*streich schiessen*), that is, to the correct location of the shots laterally in regard to the target. In firing against artillery the enemy's pieces are taken as points of aim. Corrections in direction are made generally by chiefs of section (platoon).

What has just been said refers solely to shrapnel fire. In percussion shell fire, the action of which amounts to little in depth, precise ranging is needed; it is carried even to the 25-meter bracket.

Fire for Adjustment in France.—In France they have gone to the extreme limit of the consequences following the adoption of the rapid-fire gun.

It has been said rightly that in the face of the enormous increase in fire effect, troops, and infantry in particular, do not expose themselves except for a very short time to artillery fire, and utilize to the utmost all available cover. To succeed, then, it is necessary that the fire should produce effects from the instant the objective appears, and consequently the process of adjustment must be shortened as much as possible. *The French Regulations* do not prescribe precise ranging against a *definite target*, but the covering of a zone of considerable extent with iron and lead so thoroughly that no object can either move about or remain there *uncovered*, without being put *hors de combat*.

A special point is made of requiring all the pieces to be laid in direction quickly and well, without all those long descriptions of the objective which lead only too easily to misunderstandings. Whenever the objective is not clearly visible and easily recognized, an aiming point is taken. This has been made possible by the adoption of a collimator which turns 360° in azimuth; it is a sort of *goniometer* which permits the horizontal angles to be measured with great precision, nearly as we do with the "pointing plate" (*Richt-fläche*), or the "pointing circle" (*Richt-kreis*). The angles are expressed in arc lengths (thousandths of the range). If it is desired to use an aiming point, there is first measured, either from one of the pieces laid upon the target or from the captain's position, the angle formed by the directions to the target and to the aiming point, and the pieces are laid from this point as a reference by taking into account the angle found, exactly as it is done in Germany with the pointing plate.

If it is not desired to open fire immediately, the time is occupied in determining, as has just been stated, the direction of the principal points of the terrain (registering the terrain). It is also recommended to get the elevations corresponding to these points either by ranging or by measurement. These preparations shorten both the adjustment and the opening of fire for effect, and play a very prominent part in the exercises of the French artillery; they should be undertaken not only before opening fire, but also, whenever possible, during a period of quiet.

In France, to expedite adjustment, they seek to determine simultaneously the elevation and the height of burst; with us these two operations are successive. We use percussion ranging; the French, low fuzed ranging, firing a sufficient number of observable shots at the height of the target. Experiments made in France and elsewhere have shown that low fuzed shots (at about one-third the usual height of burst) can be better observed than percussion shots under certain conditions, for example, with a very irregular or very marshy terrain.

In adjusting they proceed generally by salvos of four shots fired at short intervals (2 to 3 seconds), with the fire distributed over the whole front of the objective. If the height of burst is not satisfactory, it is modified by simply altering the time of burning (corrector).

All the pieces are laid, as has been explained, upon a common aiming point easily seen; each piece has a deviation corresponding to its place in the battery, which is given by the captain (distribution difference); for example, the sight of the first piece is at graduation 120; the other pieces each increase this reading by 10 from the right. If there is a general error of direction, the captain orders a common correction for all. If the distribution of fire is too great, or too small, he diminishes or increases the distribution difference. The chiefs of section (platoon), simply see that the shots spread over the front of the objective in the order of the pieces, and at nearly equal intervals. If this result is not obtained, they change the direction accordingly. This procedure eliminates all chance of misunderstanding in the designation of the objective.

In general, fire for effect begins after having obtained the 200-meter bracket. Sometimes a salvo is fired first regulated upon the shorter limit, to verify the elevation, the height of burst, and the distribution of fire. The fire for effect is oftener at several elevations. Habitually, progressive fire is employed; two or three shots are fired by piece at four elevations, differing by 100 meters, beginning at one smaller by 100 m. than the inferior limit. For example: The limits of the fork are 2,600 and 2,800 m.; at the command of the captain—"progressive fire," each piece fires two or three shots, rapid fire, at 2,500, 2,600, 2,700 and 2,800 meters.

Against a narrow objective (front less than 100 meters), only two shots at each elevation are fired, and the direction is unchanged. Against a broad objective (front up to 200 m.) each piece fires three shots at each elevation. In this case the initial directions of the pieces make large angles with each other, and each piece changes its direction; at first twice toward the left, and then at the next elevation twice toward the right, and so on. This change of direction is obtained by turning the hand-wheel for laying in direction. This is called *sweeping fire*. The captain only has to add to the command for the elevation, the single word SWEEP, and the whole system starts automatically. The elevations are changed, and firing is done at the command of the chief of piece.

If the captain wishes to retain close control of his fire, he may prescribe for each elevation two or three shots per piece rapid fire (2 rounds, 3 rounds). He thus has the advantage, if he can observe easily, of being able to note which elevation gives the best results.

When time is not pressing, if the firing is against inanimate objects, or has been somewhat successful, or, finally, if the distance to certain points is wanted, precise ranging is resorted to. The 50-meter bracket is then sought, and the firing is at a single elevation. There are available then four mechanisms of fire: fire at one elevation; fire at several elevations; and in each of these two cases, with or without sweeping. The rules of fire leave great latitude to the captain; for example, nothing forbids ranging with one piece.

The distinctive idea presented by the French regulations is that of beating a broad and deep zone by a single battery in rapid fire. It is for that very reason that I have gone into so many details on this subject.

To appreciate more fully this procedure, it is necessary to have at least an approximate idea of the results which can be obtained by it. Progressive fire *without sweeping* beats a zone of 500 m. in depth by 100 m. in breadth; it requires thirty-two rounds. If the front is greater (200 m.), sweeping fire is employed, and forty-eight rounds are needed. The effect obtained in this last case against an objective of the given dimensions will be three quarters of that produced by the first kind of fire. Progressive fire without sweeping distributes quite evenly 9,600 balls, in round numbers, over a surface of 50,000 square-meters, which would be a mean of 0.192 balls per square-meter. The number of hits per square-meter of vertical surface is the greater as the trajectory is flatter; the ratio of this number of hits upon a horizontal target is equal to the ratio of the height of the objective to the danger space (cotangent of this angle of fall). The balls have, it is true, different angles of fall, but it may be said that their mean angle of fall is that of a projectile which did not burst. At 2,000 m. (2,187 yards), the danger space of the French projectile is about 15 m. (16.47 yards); so that a vertical target 1 meter high by 1 meter wide would receive 15×0.192, or 2.88 hits. The German shrapnel for the model 1896 gun has the same number of bullets, but its danger space is only 12 m. (13.1 yards), which will give, therefore, only 12×0.192, or 2.30 hits.

The above being assumed, our model 1896 gun should give upon a vertical target 1 m. high by 1 m. broad:

$31 \times 0.192 = 5.95$ hits at 1,000 m.
$12 \times 0.192 = 2.30$ hits at 2,000 m.
$6.5 \times 0.192 = 1.25$ hits at 3,000 m.
$4.2 \times 0.192 = 0.81$ hits at 4,000 m.

From this table may be calculated the number of hits upon any target whatever; it is enough to express the surface of the objective in square-meters, and multiply it by the number of hits for the range. A target of 1 meter high and of indefinite length would receive 100 times as many hits, since the effect would extend over a front of 100 meters. A chain of skirmishers standing (0.56 square-meter on the target, at the rate of one skirmisher per running meter, would receive, at the range of 1,000 meters, $0.56 \times 100 \times 5.95 = 333$ hits; a battery of six pieces without shields (surface about 24 square-meters) should receive, at 2,000 m., $24 \times 2.3 = 55$ hits.

After comparing the results of the French and German methods, it may be asserted at once that for the same expenditure of ammunition the latter will give many more hits. The German fire beats a zone of only 250 meters in depth, while the French progressive fire spreads over double that depth. But the effects of the German fire are more uncertain; for with a bracket of 100 meters, exactly determined, the target may occupy three very distinct positions within the limits of the bracket; it may be near the shorter limit, at the middle of the bracket, or near the outer limit.

The intervals of burst vary:

In the first case from -50 m. to $+50$ m.
In the second case from -100 m. to ± 0.
In the third case from -150 m. to -50.

Against a very long target, 1 meter high, there could be counted upon for each round at 2,000 meters:

In the first case, 11.5 hits.
In the second case 10.5 hits.
In the third case 14.9 hits,

which would be a mean of 12.9 hits. With thirty-two rounds (as in a French progressive fire), there would be against a like objective:

At 2,000 m. about 413 hits.
At 3,000 m. about 297 hits.
At 4,000 m. about 240 hits.

For the same number of rounds the German fire would give results from 1.8 to 3 times greater than those of the French method of fire. With sweeping they would become from 2.4 to 4 times better. But it cannot be repeated too often, that in war it is not a question of obtaining the maximum effect, but of getting a *sufficient* effect as quickly and and as surely as possible.

Progressive fire without sweeping gives 1.25 hits per square-meter. The personnel of a battery without shields, with 6 pieces and 3 caissons, in battery (51 men), presents a surface of 24 square-meters. It will receive, then, thirty hits, which will probably put 22 men *hors de combat*, or 44 per cent of the effective strength.

Fire for adjustment may be completed in three salvos; estimating thirty seconds per salvo, which is liberal, it is plain that fire for effect may begin a minute and a half after opening fire. Each piece fires eight rounds at rapid fire which would take one minute to one minute and a half at the most; the fire would consequently last from two minutes and a half to three minutes.*

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*According to an article published in the *Kriegstechnische Zeitung*, 1903, p. 375, during practice by Roumanian artillery with long recoil guns, manipulated by a personnel which had received no special instruction, 48 shots rapid fire (12 shots per gun) required only 52 seconds. Ranging against a battery, executed by one gun only, in which the fork obtained was 100 meters and in which 2 shots were fired for each range, took only one minute and a half The hypotheses adopted by me are, consequently, not too favorable.

According to the German method, four shots would be necessary to obtain a fork of 100 meters under the same conditions; four or five percussion shots more would be needed before the first shot with time fuze, after which, only, fire for effect may begin. Effective fire, consequently, begins at least two minutes after the opening of fire. The examples given in the Firing Manual contain an account of practice with service charges in which the first shot with time fuze was fired three minutes and twenty-five seconds after opening fire; moreover, the two following shots were doubtful, which prolonged the ranging by forty seconds. In any case, there remains in favor of the French method a gain of one minute and a quarter, which with the rapidity of fire and the effectiveness of the modern gun may be of decisive importance.

The French process presents, moreover, a substantial guaranty against unsuccessful adjustment. The German method is only good when the fork of 100 meters has *really* been obtained, and naturally the smaller the fork the greater the chances of failure. Add to this the fact that fire for effect is opened at an elevation 100 meters less than the inferior limits and you will find that the French method gives, against chances of error, a security increased, in such a case, by the verification salvo at the inferior limit. It is even quite possible that one of the adjusting salvos may produce effect.

With sweeping fire, a zone of double width is covered, but each gun fires three rounds at each elevation,* the result being that each square meter of the objective gets three-quarters of the hits obtained by non-sweeping fire. On the other hand, such fire is only used against wide targets so that in reality nothing of the effectiveness of the fire is lost. In fact, two six-gun batteries may well be placed on a front of 200 meters. Progressive firing, without sweeping, would give thirty hits against such a target; sweeping fire would give twenty-two, but as there are supposed to be two batteries in the zone swept by the fire, forty-

*Instead of two in progressive fire without sweeping.

CHAPTER IV.

ORGANIZATION.

The new armament of field artillery has brought about, in all countries which have adopted it, certain modifications in the organization, especially in matters concerning the strength and composition of the batteries.

Four or Six-gun Batteries.—Increased rapidity of fire has wonderfully enhanced the power of each piece. A non-recoil gun may fire with equal precision twenty shots while a recoil gun is firing eight. Two non-recoil guns may, consequently, be substituted for five recoil guns. A protest might be raised against this arithmetical conception of the question, but it is an incontestable fact that a battery of four non-recoil guns produces more effect than a battery of six recoiling guns. This justifies limiting the number of guns in a battery to four. However, the aim of a new armament is not merely to maintain the power already acquired, but to increase it to the utmost limit and to endeavor to obtain the best results from the resources at one's disposal.

The four-gun battery of non-recoil guns, as we have already said, is equal or even superior in efficiency to the old six-gun battery. Let us admit that *fire by piece** is retained in firing for effect even to the present day, each shot being observed separately. In such case the rapidity of fire cannot be increased beyond a certain limit. There remains no doubt as to the fact that even under these conditions a four-gun battery will produce the same effect as one of six, for the first gun will *surely* be ready for firing when the fourth has fired its shot. Should there be a fifth or sixth gun, the result would be the same. These guns would only take up space in the column and in battle and be uselessly exposed to the enemy's fire.

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*The German "Flugelfeuer" is the old fire by piece of the French Firing Regulations.

If fire for effect is executed at rapid fire, the six-gun battery will evidently fire more shots in the same period of time, but it is a question if greater results will be obtained. Nothing is more apt to shake fire discipline and render conduct of fire difficult than rapid fire. On the other hand, it is far easier to keep both in hand with four guns than with six; with six guns the front is more extended, supervision is more difficult, and the voice is not heard so well. But it is from the viewpoint of a change from a peace to a war footing that the small battery compares most favorably with the large, as in the time of peace the effective strength is the same for four or six guns. In order that the rapid-fire gun may produce its maximum effect, it is necessary to be absolutely sure of the personnel, *i. e.*, it must be possible to give it the most rigorous supervision. With the four-gun battery each gun may be entrusted to an officer or a noncommissioned officer invested with the authority of the former; this is impossible with a six-gun battery. *One officer cannot supervise efficiently* the detachments of two rapid-fire guns. I therefore consider that the use of rapid fire, in fire for effect, is practicable only in four-gun batteries and that for six-gun batteries it must be limited, as prescribed in the German Service Regulations, to cases of close defense, or of life and death.

The French method of laying an entire battery upon a single aiming point and "sprinkling" a wide zone with sweeping fire is practicable for a four-gun battery and not for a six-gun battery, especially if the effective peace strength is not appropriate to six guns. I am convinced that, on account of the better quality of the personnel, the four-gun battery is at least equal if not superior to the six-gun battery for zone fire.

This reduction in material allows the battery to be well supplied with ammunition without increasing the number of horses, and this is as true for the total amount of ammunition transported as for the supply of the firing battery. It is only necessary to harness to the caissons the horses made available by the suppression of two guns. The number of rounds transported by the firing battery and by the train is thus increased from 1,132 to 1,236, the amount almost equalling that at the disposition of the French battery (1,248).* A caisson may then be assigned to each gun placed in battery in the firing line thus increasiug by one-third the ammunition which is immediately available. This is a matter of greatest importance, for it is possible to count only on the ammunition available in the first line; its amount is, consequently, never too great. A six-gun battery, with a caisson behind each gun, would form too unwieldy a mass, the manipulation of which would present almost unsurmountable difficulties.

The advantages of small batteries, here enumerated, are generally recognized. However, many officers demand that the present number of guns of the army corps (144) be maintained in spite of everything and everybody. The majority of German artillerymen wish to have 144 guns in the first line, forming 36 batteries and, in case this should be found impossible, they prefer the present organization to reducing the strength of the batteries without, at the same time, increasing their number. In other words, they prefer 144 guns in 24 batteries to 96 guns in 24 batteries. They quote the opinion of Clausewitz: "It is necessary to have as much artillery as possible without inconvenience." I am certainly the last to depreciate the advantages of a strong artillery, but I deem that it can only attain its maximum efficiency upon condition of having *sufficient space* for deploying and being *liberally supplied with ammunition.*

Front Available for the Artillery of an Army Corps.—It is doubtful whether a mass of 144 guns per army corps could find a front necessary for its deployment. Thirty-six four-gun batteries would normally occupy 2,700 meters (2,953 yards), two-thirds of the front of an army corps. As far back as 1870, when an army corps had only 84 to 90 guns, in many battles combat space was insufficient to allow

*In the United States the four-gun battery carries 1,432 rounds of ammunition, *i. e.*, 358 rounds per gun.

all the batteries upon the firing line. At Weissenburg, on the position south of Windhof, three batteries of the Fifth Corps lacked room; in the same way at Woerth there was not sufficient space for three batteries of the Eleventh Corps near Gunstett; on August 18, three batteries of the Seventh Corps could not find a position on the right bank of the Mainz; at Sedan, to the east of the city, 15 batteries—one of the guard, four of the Fourth Corps, four of the Twelfth, and six of the First Bavarian Corps—could not take positions on account of lack of space. There is no doubt of the fact that there are a great many instances when the entire artillery of a corps could enter the firing line, but it is unwise to conclude from this that there would have been no difficulties in its deployment if it had 144 guns instead of 90.

Reduction in the Number of Guns of an Army Corps.—To prefer 24 six-gun batteries to 24 four-gun batteries is to make light of the inconveniences adherent to a great number of guns without considering the advantages of small batteries. If, in 1870, the German batteries had had four guns, on August 18 the Seventh Army Corps could have put into line fifteen batteries instead of ten six-gun batteries and could have obtained *one and a half times as much effect* without paying for this advantage with the slightest inconvenience. With the rapid-fire gun, success depends not so much upon the number of guns as upon the number of batteries. It is only in *exceptionally rare* cases that it is possible to deploy 144 guns on a front allotted to an army corps, and that 24 six-gun batteries would have any advantage over the 96 guns of small batteries. Their fire, concentrated against a smaller area, would inflict greater losses upon the adversary who would have to cover a larger front; it must, of course, be admitted that the firing on both sides would be of the same power. However, it would still be possible for the small batteries to decrease their inferiority by skilfully making use of cover, or by taking large intervals, a thing that is much easier for them than for large batteries.

By increasing the number of guns beyond 96, the effect of firing would not be materially increased. A battery of four guns in *sweeping fire* (*tir fauchant*), beats *sufficiently* a front of 200 meters; and even, as has already been mentioned, Roumanian experiments proved that it could be done successfully with a front of 300 meters. The normal front of an army corps is 4,000 meters (4,374 yards); twenty batteries are sufficient to fire against it successfully, even fourteen might do it; there would thus remain from four to ten batteries available for firing against points where a specially energetic effort might be necessary. Practically, it is superfluous to have more; the increase of effect obtained would cost dear, even if all the guns could be deployed.

It would be rational to increase the corps artillery beyond the limit in question only in case the principles of infantry tactics are altered and the fighting front increased, at the expense of depth, and provided our neighbors increase their artillery in the same proportion. At the present time the German Army Corps possesses normally 5.76 guns per 1,000 infantrymen; with the same number of four-gun batteries the ratio would be 3.84; this proportion is not surpassed by any power.* In order to demand so lightly a large number of guns, one must have entirely lost sight of the caissons during the last few years, not so much on account of the increase in weight of the projectiles as because of the need for ammunition. When smooth-bore guns were in vogue, the six-gun batteries did not need more than half a caisson per gun; the adoption of rifled guns has doubled this number; it increased to 1½ per gun with the materiel of 1873, to 1⅔ with the gun of the 1896 model (the train inclusive), and the creation of the non-recoil gun will bring it to 3, which has already taken place in France and in the United States. Let us imagine an artillery column of an army corps of the present day with its 393 vehicles; the

*There are in France 3.3 guns per 1,000 men of the infantry; in Russia, 3.65; in Austria, 3.43; in Italy, 3.5; in Switzerland, 2.7; in Holland, 3; in Sweden, 3.2; and in Denmark, 2.84.

echelons inclusive, but without its regimental trains; if increased to 576 guns or caissons it would lengthen to 4 kilometers (2.5 miles) in round numbers.

France has reduced the strength of her batteries without increasing their number; her army corps has only 80 guns instead of 120 which it counted formerly. No other country has followed this example. Sweden, Denmark and Switzerland, which have just formed their four-gun batteries, have at the same time increased the number of batteries *while decreasing, however, the total number of guns.* It should be remarked that these countries were formerly very weak in artillery, and that even to-day they have somewhat less than 3 guns per 1,000 men.

DIVISIONAL AND CORPS ARTILLERY—*Historical Sketch.*—In regard to the proper distribution of the artillery between the larger units, we are confronted with two diametrically opposite opinions. Some believe in assigning the *entire* field artillery absolutely and organically to infantry divisions; others want to leave a part, the corps artillery, at the disposition of the corps commander. In order to form an opinion on this subject, a hasty glance backward is necessary.

When artillery first appeared in field warfare, a part of the arm was closely attached to the infantry; the remainder constituted a separate mass. The former, consisting of small-caliber guns (*battalion and regimental guns*), formed an integral part of the troops to which they belonged and never left their ranks; they *accompanied* rather than *prepared* the infantry combat. These guns were not drawn by horses; they were brought to the field of battle by hand. The other part comprised large-caliber guns united in "batteries," the strength of which varied according to the necessity of the case. Although drawn by horses, their lack of mobility did not allow them any change of positions. Under such conditions, these two artilleries, the heavy and the light, had to employ very different tactics.

Later, the lightest as well as the heaviest guns were separated from the field artillery; the guns assigned to infantry units were also united in batteries (mostly of eight guns) and were assigned to larger units, first to brigades (in Austria after 1866) and later to divisions. The other batteries constituted a reserve in the hands of the higher commander and, when the armies increased, were assigned to army corps under the name of *reserve artillery*, or to armies under the name of *army* reserve artillery (*Armee-Geschützreserve*).

Experiments made with the latter in 1866 and 1870 are not favorable to them. The Austrian Northern Army had, in 1866, an *Armee-Geschützreserve* of 128 guns which served only at Königgratz, and even then without being able to accomplish its object, that of stopping the Second Prussian Army, because it went too late into action. In the Army of Prince Frederick Charles, the Army Artillery Reserve, 16 batteries of the Third and Fourth Army Corps also went into action only at Königgratz, and did nothing worth notice, while the Seventh Division was sorely in need of artillery reinforcements in order to support it in the hot combat raging in the wood of Maslowied. So, also, on August 18, the artillery reserve of the French Army, 16 batteries, was brought too late into line and at an unfavorable point.

Napoleon, who was the first to separate the artillery from the infantry, knew no army reserve artillery. When he wanted to produce at a certain point a particularly strong artillery effect, he took that of the reserve corps as we did at St. Privat with those of the Third and Tenth Army Corps, and this practice of his almost always proved entirely successful (Friedland, Wagram, Gross-Görschen).

Until his time, heavy guns were mostly used to open the combat and to repulse attacks; the light guns accompanied the infantry attacks, but they could not bring about a decisive result, their fire being too scattered. Napoleon was the first to make full use of the crushing power of this arm. He entrusted brigade and divisional artilleries with opening the combat, and then with preparing, as far as possible, and accompanying the infantry attack. He,

favorable to combined action. Each battery found by itself and chose according to its understanding both positions and objectives. To this was added a real *terror* of changes of positions so that the artillery stayed far behind while the infantry was bravely pushing forward; in a word, the artillery assisted the infantry in very exceptional cases. It was only due to the enormous superiority of its remarkable rifle and its methods of fighting that the Prussian infantry could do without the support of the artillery.

But these faults were a lesson to this arm; the battlefields of Bohemia were the cradle of its new tactics. After 1866, the principles which were to guide its use were determined upon; the first was that it should prepare the infantry combat and that, consequently, it must be pushed forward in the columns as far as possible. In order to give this idea a tangible form, the name of *reserve* artillery, given to the batteries placed under the order of the army corps commander, was suppressed, and it was given the name of *corps* artillery.

The effect and the ranges of rifled artillery force the attack to attain first of all superiority of fire, *i. e.*, dominate sufficiently the hostile guns to be able to oppose only *part* of the guns to every endeavor to reopen fire against the attacking infantry while the greater part is used for the preparation of the attack. On the other hand, the defense must likewise, as far as possible, accept the combat against the hostile artillery in order to distract its attention from its principal object, which is to crush the infantry at decisive range. The range of the present guns permits this double combat to be waged from the same position, both against the infantry and the artillery. It is not necessary to think of changing positions as in the days of smooth-bore guns; all that is necessary is to change the objectives.

Modern tactics then could and should adopt the principle of making all the batteries participate in the artillery combat. With arms of equal efficiency, the success of this combat depends essentially upon numerical superiority; if one does not possess it, it may be obtained for a time at least by forestalling the deployment of the enemy. For this reason there is no hesitation now, in case an army corps marches on a single road, in temporarily taking the artillery from the rear division so as to send it rapidly into the fighting line.

On the other hand, all the fire of all the batteries, not occupied in the artillery combat, is concentrated for the preparation for assault. Napoleon used for this purpose the *reserve artillery;* modern tactics use for this purpose mostly *divisional artillery.* In practice, the batteries least fatigued by the battle are chosen for this work as well as those best placed with reference to the object to be attained, without asking if they belong to the divisional or corps artillery. Formerly, part of the batteries were placed in reserve and the chief sent them into line when and where he wanted to give the decisive blow; at the present time it is necessary that all should go into action *as early as possible*, in order to take part in the artillery combat. It is only during the course of the combat, and at the end of the latter, that it will be possible to know against which point the principal attack will have to be directed.

Hence we see that the organic separation of the corps artillery is no longer a necessity, and that it is preferable to distribute all the batteries between the divisions, such a disposition seeming to insure better than any other the timely entry into the fighting line of the entire artillery. If the army corps marches by a single road, it matters little if the artillery sent forward is corps artillery or not. All that is necessary is that *all* be sent forward at a rapid gait in order that it may be possible to place it in line in time to oppose the enemy by superior fire. If the army corps marches by two roads, the corps artillery follows, in general, one of the divisions, most frequently the one which takes the better road. In the case of an encounter, the forces are unequally divided, and chance alone decides if the principal mass of the artillery is with the column which needs it most. If it should be desired to assign the same amount of artillery to each column, the corps artillery would have to be cut in two, a solution which would present great difficulties. But if we admit of an organization which divides the batteries equally between the two divisions, each of these will have at its disposition sufficient artillery to be able to hold its own against superior forces until the artillery of the other division comes into line.

The war of 1870 presents numerous examples of corps artillery not attached to that one of the divisions needing it most. On August 6, for example, the artillery of the Seventh Corps followed the Thirteenth Division and took no part in the combat, while the Fourteenth Division could oppose only its four batteries to a greatly superior enemy. On August 16, the Fifth Division of the Third Corps, to which the artillery of this corps was not attached, was the first to be engaged in a fierce combat, and the arrival of two batteries of the Sixth Division in the fighting zone of the Fifth was all that enabled the artillery of the latter to make a stand against the crushing forces of the enemy.

Most of the combats of 1866 and 1870 were conducted without any plan whatever. It is only in battles planned beforehand that it is possible to foresee the point against which the principal mass of the artillery should be directed. In such cases, the army corps is so concentrated that the general may keep at his disposition part of the artillery as he does with the infantry.

Suppression of Corps Artillery in Germany.—These considerations have brought about in Germany the suppression of corps artillery. Since November 1, 1899, all the field artillery has formed part of the divisions, with the exception of horse artillery, which remained attached to cavalry divisions at the rate of two batteries per division. Divisional commanders were, consequently, entrusted with the responsibility of their instruction, as they would have to handle this arm during combat; they were thus obliged to care for it in detail. Such a measure cannot fail to be advantageous for its use on the field of battle.

Function of Howitzers.—The above-mentioned considerations are applicable exclusively to guns proper. The light field howitzer, it is true, may be more appropriate than the gun for firing against artillery provided with shields, but its speciality is the preparation for attack of fortified positions. The corps commander, therefore, should retain control of these cannon, at least in previously planned encounters; they will constitute a real *corps artillery.* Nevertheless, the howitzer batteries are attached to divisions simply as a matter of convenience; no more than three such batteries are required.

The *heavy artillery* of the army is called upon to render service only against fortified positions, *i. e.*, in exceptional cases; it must, consequently, be placed under the orders of the commander-in-chief, and follow the field troops at a suitable distance. In this arm we see, in a way, the survival of the reserve artillery of the army. When it enters the fighting line, it must operate as a mass; this unity of action would be rendered difficult if it formed part of an army corps. The attack of a fortified position will never be so unexpected that there would not be sufficient time to direct this artillery against the point at which one wants to use it. Nothing hinders its being assigned to the army corps entrusted with the decisive attack. Its *permanent* assignment to a certain unit, however, would simply render more difficult and even retard the operations of the army.

Of all countries using army corps, Germany and Russia alone have distributed the entire artillery between the divisions. France has assigned to corps artillery eight batteries out of twenty; Austria, four out of sixteen; and Switzerland, six out of sixteen. The regulations of these various countries do not show any essential difference in the employment of artillery, which would demand a separate organization for the corps artillery.*

*This essay was on the point of being sent to press when, about the middle of July, 1904, the French papers announced that in time of *peace* the field artillery (with the exception of the horse artillery of cavalry divisions, of the colonial troops, etc.,) would be assigned to divisions; corps artillery, however, always to be maintained in time of war.

According to a project of organization, established by the Swiss Federal Council, the army corps will disappear, and the army will consist of six strong divisions instead of four army corps; this measure will naturally suppress corps artillery.

CHAPTER V.

EMPLOYMENT OF ARTILLERY.

The *increase of effectiveness,* due to rapidity of fire and *protection* insured to the gunners by the shields, will exert a marked influence upon the employment of artillery.

Artillery Initiative.—This rapidity of fire, properly utilized, will force the troops to avoid, as far as possible, exposing themselves without cover to artillery fire in order to save themselves from being annihilated. Hence, more than ever, artillery will have to take advantage of the brief intervals of exposure of a unit to meet it by violent fire which must at the same time be effective. Hence the necessity of observing the terrain most vigilantly during suspension of fire, for fear that the enemy might find a chance to execute unexpected movements unnoticed. Consequently the batteries, groups, etc., will not have precise targets to counter-batter, but rather portions of the terrain, zones or rather sectors with definite boundaries which they will have to observe and keep under fire as we have already stated in the chapter treating on artillery firing. Therefore, great independence of action must be given to the commanders of small units, and extensive initiative must be demanded from them.

Armored Caissons; Their Place.—Due to the protection afforded by the shields, the *artillery duel* will reach a decision with great difficulty. Even with accurate fire, few losses will be caused by shrapnel to batteries provided with shields, especially if the cannoneers serving the ammunition are protected. In order to attain this result, the best way is to place the armored caisson body near the gun placed in battery. Such a disposition has been adopted, not only in France, but also in all countries which have adopted shields. It has been argued against it that a projectile, by striking the caisson, might produce an explosion and wreak great havoc in the battery. Certainly no protection can be devised against such an accident; but in such cases it matters little if the caisson is near the gun or a few paces in rear of it. Danger, moreover, exists only for caissons carrying explosive projectiles. If time-fuze firing principally is used in the artillery duel, and if the caissons with the high explosive shells are brought up only after the hostile fire has been weakened, this danger is greatly decreased. In a word, the choice lies between the two following possibilities: Is it preferable to risk having the cannoneers killed by the *numberless* shrapnel bullets, or by *rare* hits on the materiel?

Utility of the Artillery Duel.—Although it is but rarely that a combat between two artilleries, equally provided with shields, ends in the final crushing of one of the two parties, there is no authority for saying that such a combat is useless and ought to be abandoned. On the contrary, a very great advantage is obtained by succeeding in silencing the hostile artillery, even for a few moments. In this way freedom of action is taken from the enemy and given to our own troops, and it can be utilized either by continuing to counter-batter the hostile artillery by precise firing, or by bombarding the positions of the infantry. The French Regulations, consequently, make it the first duty of the artillery to crush the hostile guns in as short a time as possible. They do not pretend that this first success will be decisive, but prescribe that batteries still unmasked shall be looked out for so as to nip in the bud any attempt at renewing the combat.

Should the enemy have completed the fire for adjustment first, it is recommended that firing be ceased temporarily and the personnel protected by making them crouch behind the shields, with the object of resuming fire as soon as the enemy ceases or switches to another target.

It is to be understood that the party having the upper hand will try to increase the number of its effective shots by perfecting its adjustment; but it is impossible to count upon having the upper hand *along the entire front.* If we cannot hope to put the enemy entirely *hors de combat*, it is at least possible to hinder his changes of position and the replenishment of his ammunition, which is in itself a great advantage.

Economy of Forces.—The French Regulations do not require merely the speedy crushing of the hostile artillery; they likewise exact that only the strictly necessary strength should be allotted to this work; this instruction is based upon the powerful effect produced by the rapid-fire gun. The sweeping fire (*tir fauchant*) of a battery covers a front of 200 meters with such an intensity that no troops can move over it in closed ranks or stay there uncovered without being put *hors de combat.* Such results are attained in a few minutes, as has already been proved by experiments made by the Roumanian Army. If such is the case, why assign to several batteries the task that can be done by one? Experience has proved* that several batteries do not produce any greater effect, and that, on the contrary, their simultaneous ranging demands more time and has lesser chances of success.

Effect of Masses.—The German Regulations attach a particular importance to the productions of a *mass effect* from the very beginning. The French Regulations, on the other hand, do not aim at this *mass effect;* they maintain *the mass of artillery in position ready to fire,* but actually use only the number of guns necessary to attain the desired end. The number of batteries taking part in the duel is determined not so much by the *number* of hostile guns which are revealed as by the front which they occupy. The effect of simultaneous action is not enough, but a surprise followed by immediate effect.

An example will better demonstrate the difference between the French and the German methods. Let us imagine that on both sides a regiment of two groups (six batteries) has been deployed almost simultaneously. Both parties are placing their guns in battery in rear of a crest at sight defilade, which allows each to clearly observe the positions of the enemy. On the German side it is probable that each battery will have as an objective a hostile battery; it may be that after the adjustment the batteries will concentrate their fire momentarily on one battery, while the third will divide its fire between two hostile batteries. On the French side it is probable that only two batteries of each group will

* See "Revue d'Artillerie," Vol. 59, page 460.

crisis comprises practically two periods: The first begins at the moment when the guns are brought to their firing positions, and ends at the first shot; the second lasts until the firing has become effective. The former is dangerous only when the placing of the guns in battery is not masked; the second is really critical in all cases, because the enemy then knows your position. It is, consequently, not only the first period, but the second *especially*, which must be shortened, and it is necessary to reject everything which tends to shorten the first period at the expense of the second.

The improvements made in the sighting appurtenances, and particularly the adoption of the sighting circle (goniommeter), greatly extend the application of *indirect sighting* or *aiming* (wth the aid of a reference mark); and this may be done so much the better as *sweeping fire (feu fauchant)* does not demand any precise aiming, as a wide front is to be swept and not a determined point hit. Indirect fire is no longer difficult for the gunners; difficulties exist only for the captain who must find a position from which he can both observe and conduct the fire at the same time. This double condition may be fulfilled only if he can find an elevated point in the vicinity of the battery. Belgium and Denmark have adopted for this purpose an observation ladder which can be installed on a caisson. The captain will thus have his eye at an elevation of five meters above ground, while his guns will be entirely hidden from the sight of the enemy. The principal objection against these positions is that they do not allow operating against the hostile infantry advancing for attack, and that it is both slow and difficult to run forward the gun and the caisson without their limbers.

Co-operation of Artillery and Infantry.—It will be more than ever necessary to obtain the *co-operation of the artillery with the infantry* in the battles of the future. It is quite evident that the defender will be unwilling to see his batteries annihilated in an unequal struggle. Consequently he will show them only when forced to do so by the appearance in his immediate front of objectives which must be met by effective fire. These objectives are furnished by the infantry of the attack. The latter advances against the position of the defense with the certainty that it will draw the fire of the artillery. Artillery then uncovers its positions and presents, in its turn, to the attack an objective which it may combat with great chances of success, especially at the time the guns are going into battery uncovered. Later still, at the moment of the preparation for the assault, and during the execution of the latter, success can be attained only by the close co-operation of the two arms of the attack. If the artillery should be entrusted only with the preparation for the infantry attack, the defender would make no attempt to occupy his position during this period. His infantry would remain somewhat to the rear, letting the artillery exhaust its ammunition against the unoccupied position which it will have, later on, the time to man. It is thus that the lack of success of the Russian attacks at Plevna, and of the British at Tugela, may be explained; preparation and execution were *successive* and not simultaneous. Neither the Turks nor the Boers had occupied the defensive positions which were exposed for an entire day to violent artillery fire.

It is indispensable that the infantry should approach as close as possible the hostile position under the protection of its artillery and threaten the defense so as to "force it to occupy its lines and to show its troops" (Exerzier Reglement für die Feldartillerie, art. 354; Drill Regulations for Field Artillery), and consequently to expose itself to the fire of the artillery.

Just as the artillery can do nothing without the co-operation of the infantry, the infantry alone is powerless to take a position occupied by strong forces, unless its numerical superiority will allow it to attack the position by the flank and the front at the same time. The attacking infantry will have difficulties in attaining superiority of fire against an enemy which nothing has shaken previously; it offers almost always, especially in the advance, many more vulnerable targets than the defense and, moreover, it is forced to interrupt its fire from time to time. It is only with the support of the artillery, which deprives the defense of all calmness, that it will be possible for the infantry to reach a position from which it would be able to open a decisive fire. This position must be in the effective zone of rifle fire, at a distance which would allow the artillery to fire over the heads of its troops. It is difficult to give here an exact number of yards; it would even be an error to try to do so. However, I think that 500 meters may be considered as the limit on flat terrain. The German Drill Regulations avoid giving numbers of this kind; they recommend merely great care and watchfulness in firing above the heads of troops so as to be able to switch to other objectives as soon as such firing tends to become dangerous. Experiments, made in time of peace, have shown that such fire could be continued until the infantry had approached the hostile position to a distance of 200–300 meters, yet, I believe that it is necessary to abstain from making too absolute conclusions from the experiments. In time of peace, errors and mistakes are not so frequent as in real warfare. The French Regulations likewise abstain from giving any precise numbers; but for the purpose of decreasing the danger they recommend not giving a battery as an objective the point attacked by the infantry exactly in its front (1st part, 632); in other words, the artillery must use flanking fire as far as possible. The French writers admit 500 meters on a flat terrain; for high objectives, on rising ground, the distance may be decreased to 300 meters and even to 250.

The Decoy Battery (*batterie d'amorce*).—We have seen in the preliminaries and in the execution of an attack, that the object of the infantry was to draw the fire of the enemy. This part may likewise be assigned to a fraction of the artillery. The French have even extended this idea into a system, and they give the name of "*batterie d'amorce*" to the unit which has to play this rôle. In maneuvers, which took place on broken terrain, and which were executed in the presence of General Langlois, it was supposed that the hostile artillery had taken up position on a crest, or in rear of it. In order to ascertain this, one battery was ordered to take up a position well under cover and with large intervals, having thus a front of 300 meters, and to open a violent fire against the suspicious crest. The success was complete; the hostile artillery answered. It was then attacked by the five other batteries placed in observation.* The Regulations (1st part, art. 649) recommended, it is true, that the advance guard artillery should be distributed on the terrain; but it is important to know whether this means, "Deploy the guns as skirmishers." In the same article, the Regulations observe that these batteries must be in readiness to repulse an attack at short range; scattering would hardly be an appropriate formation for such a defense. As General Langlois is one of the most remarkable French artillerymen and, without doubt, one of the clever fathers of the Regulations, his interpretation is of great importance.

Ammunition Supply.—The effect of modern firearms will force the troops not only to take advantage of all cover presented by the terrain, but also to open fire at greater distances than in former years. These two causes will increase the duration of the combat and, added to the rapidity of fire, will demand an enormous expenditure of ammunition, however great the desire to economize the latter. Consequently, strong effort must be made to have great quantities on hand and, moreover, to keep up the supply. It is of the greatest importance to have a large supply at the disposition of the firing battery; it is necessary for this purpose that the battery bring to the firing line as many caissons as guns. This is done in France and in all countries which have adopted the non-recoil gun, with the exception of Russia. In France, in addition to the caisson body, placed near each gun with seventy-two rounds, the firing battery has two other caisson bodies from which the ammunition is drawn during suspension of firing for the purpose of replacing what has been expended without its being necessary to bring a single team from the battery reserve to the firing line. In battery positions each gun has at its disposition 108 rounds or 432 rounds per battery;

*These tactics of the decoy battery, "*batterie d'amorce*," seem to have been greatly used by the Japanese in Manchuria (see "*Revue d'artillerie*," February, 1905, Vol. 65, page 389).

there is not a battle of the War of 1870-1871, with the exception of that of August 16, in which the German batteries had, on the average, fired such a number of shots. Some of the French writers find this number still too small; they propose to bring two more caisson bodies in rear of the two center guns,* if unusual expenditure of ammunition may be expected; the number of rounds of a battery would thus be increased to 576.

Course of the Artillery Combat.—The most important act of the drama of the battle will always be the assault, and it is always the artillery which will, as heretofore, play the first rôle in its preparation. It cannot be said that the new armament will bring about a change of general principles, but it will cause a change in their application. It has been established thus far that infantry attack should always be preceded by an artillery duel, and the preparation for attack begins only after superiority of fire has been obtained. If by *decisive artillery combat* is meant one which causes "the silence of death" to reign on the side of the vanquished, it must be admitted that such a decisive result will be very difficult to attain, as guns with shields are endowed with a very tenacious life. However, the preliminaries of the infantry attack, and especially the advance for the occupation of points of support and making a lodgment in front of the hostile position, will begin during the artillery duel; these movements are even a necessary accompaniment of this duel, for without them the enemy would take good care not to unmask his guns. Admitting that the attacking infantry must begin its movements while the artillery duel is being waged, the latter must, on the other hand, continue during the execution of the attack and even until the end of the latter

The artillery, as in former times, still has a double mission in the preparation of the attack: to bombard the position of the hostile infantry and to counter-batter that part of the enemy's artillery which is firing against the attacking

*See Theoretical Essay on Decisive Attack (Étude théorique sur l'attaque decisive), by Colonel Ruffey, p. 105, Paris, Lavauzelle, 1904.

infantry. Until the present day the majority of the batteries could be employed for the bombardment of the infantry positions, but at present it is not unreasonable to suppose that a greater part will have to be used for the artillery combat. This may be explained by the two principal features of modern artillery—power and resistance. Its fire rapidity allows it to obtain with only a few guns an effect which, in former times, demanded a large number of guns; hence it is possible for the attack to employ fewer batteries against the point to be attacked. Moreover, as the action of the hostile artillery against the friendly infantry has likewise increased, it must be counter-battered so much the more energetically, as its shields render it more capable of resisting fire directed against it.

It is, consequently, necessary to employ all the available artillery for the preparation for attack; even the heavy army artillery may be used in addition in case of a fortified position. Sometimes, but only under especially favorable circumstances, will it be possible to call for support on the corps artillery in reserve (Third and Tenth Corps on August 18, 1870); moreover, the artillery of the neighboring corps, which may not be occupied in its turn, will be able to lend a hand, be it only by engaging the artillery placed opposite it and thus hindering it from repulsing the decisive attack.

Distribution of Duties between the Various Batteries.—The French and German Regulations agree in proclaiming the importance of a judicious distribution of duties.

Is it possible, as prescribed by the French Regulations (1st part, art. 634), to unite under one direction all the batteries taking part in the preparation for attack? This seems doubtful, for it is almost impossible for one chief to observe alone the *ensemble* of a field of battle extending over several kilometers.

When circumstances allow, the batteries must adjust their fire upon their respective objectives and especially upon the hostile infantry position; this is the way to obtain the maximum effect. In a contrary case, French writers recommend the opening of rapid fire at various elevations in order to form in front of the objectives, and especially in front of the batteries of the defense, a dense cloud of smoke which would prevent them from following the progress of the attack and directing an accurate fire against it. It being impossible to annihilate batteries provided with shields, there is at least this method of making them harmless. In the book already referred to, Colonel Ruffey estimates at 500 the number of rounds necessary for a battery to cover a front of about 100 meters with a persistent cloud of smoke for some 25 to 30 minutes. This is the time necessary for the assault which, according to French ideas, must be made by picked troops and, if possible, without stop.

During the assault, a fraction of the artillery accompanies the infantry advance, but its principal mass maintains its position and continues to fire against the old objectives with increased intensity. When the attacking troops are sufficiently close to the hostile positions for the fire to become dangerous to them, the batteries increase their range so as to at least prevent the enemy from sending his reserves forward. Part of the batteries observes attentively the points from which the enemy might make sudden counter-attacks (ravines, woods, etc.), for the purpose of checking these endeavors at their inception.

The *accompanying* batteries have but one duty—to beat the hostile infantry position. In order to allow them to fire as long as possible they are placed mostly on the flanks of the assaulting columns; they are thus well placed to repulse all flank attacks. It may occur that it will be necessary not only to break up the group to let the batteries operate separately, but even to proceed by platoons or perhaps by one gun at a time as rapidity of fire allows, even an isolated gun to obtain good results. It is most important, then, for the artillery to accompany the infantry as long as possible, if for nothing else at least for the purpose of giving it moral support, as demanded by the German Regulations.

The accompanying batteries are brought to the position as soon as the infantry has gained a foothold for the purpose of pursuing the enemy or repelling counter-attacks. If the

The close combined action of the two arms will be required more than ever before.

The greatest care must be given to the *supply of ammunition* to the batteries.

Among these principles we find many that are not new; many of these have existed for a long time, but they have acquired greater importance, and any violation of these rules would be more severely punished in our time than formerly.

If I have more particularly referred to French literature and regulations, it is because France has known and used non-recoil guns with shields for a long time, and because it is in this country more than in any other that the consequences of their adoption have been analyzed. The other armies which have decided for the new gun, have not yet published any official instructions nor any private essays on their use in combat.

Horse Artillery.—I will add a few words on the *horse artillery* of cavalry divisions. The adoption of rapid-fire guns is most favorable for this arm. The batteries being reduced to four guns, the group may, without increasing the number of its guns, have three batteries instead of two—a thing of great advantage from more than one point of view. It is not necessary to increase the number of vehicles, for the horse batteries are sufficiently well provided with ammunition, especially if we consider that the combats of cavalry divisions are always of short duration. The easy manipulation of small batteries and their present power will allow them to fulfil without much trouble the task devolving upon them; horse artillery is particularly called upon to play an important rôle in enterprises directed against the flanks or the rear of the enemy. The rapid-fire gun is naturally better adapted than the old gun to preparation for attack in the combat of cavalry against cavalry; nevertheless, the success of this attack will depend much more upon the maneuvering qualities of the cavalry than upon the fire preparation of the artillery.

CHAPTER VI.

THE FIELD ARTILLERY OF THE VARIOUS POWERS.

And now a hasty glance at the state of the world's armament. The rapid-fire gun has been *adopted* in principle by France, Great Britain, Norway, Sweden, Switzerland, Holland, Denmark, Roumania, Turkey and the United States. France, Russia, Great Britain and the United States have guns of their own make; all the remaining nations have adopted guns of German origin—Norway, the Ehrhardt gun, the others the Krupp gun.

Russia, Great Britain* and the United States have guns of caliber 76.2 mm. (3 inches); all the other countries have adopted caliber 75 mm. The weight of the projectile varies from 6.350 klg. to 7.200 klg. (13.97 to 15.84 lbs.)

The French recuperator is compressed air. In Russia the gun recoils with the small carriage and the recuperator is a rubber buffer;† everywhere else it is a helical spring. There is but little information to be had as yet on the British gun.

All countries, with the exception of Russia,‡ have adopted the shield; in Norway these are not fastened to the guns but carried in a special vehicle.

In France the horse artillery of the cavalry divisions has still the old model 1880 (3.15), with an improved shrapnel, as model 1875 (2.96 inch) is too heavy and takes too long to bring into battery, and to change objective.

In Turkey the condition of the finances retards rearmament.

Russia has maintained the eight-gun battery; Norway

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*Great Britain has just adopted a gun, caliber 83.8 mm. (3.3 inches), which is a combination of guns already known. The weight of the projectile is 8.4 klg. (18.5 lbs.). (See "*Revue d'Artillerie,*" May, 1905, Vol. 66, p. 150).—*Translator's Note.*

†At least of model 1900. Model 1902 has a helical spring recuperator, as mentioned by the "*Kriegstechnishe Zeitung,*" No. 2 of 1903.—*Translator's Note.*

‡The experience of the Russo-Japanese War convinced the Russian artillerists of the value of the shield, and it has been adopted for the 1903 model some of which were sent to the front after the battle of Mukden.—M. M. M.

and Holland have kept provisionally the six-gun battery; all the other powers have chosen the four-gun battery.

The rapid-fire gun is being *experimented* with in Germany, in Austria (where compressed bronze is still used for the manufacture of guns), in Italy, in Spain, in Portugal,* in Belgium and in Servia. Italy has partially armed her field artillery with the 75 mm. gun, with carriage supplied with a spring trail-spade; she intends to adopt a gun of her own design and manufacture, which will naturally require a long time. It would be useless to study more in detail the guns at present experimented with. It is well known that Germany wants only one gun with recoil on the carriage, retaining the gun and the ammunition of model 1896; this gun comes very near the Krupp model.

The normal army corps has at its disposition in France twenty batteries (two of which are horse batteries for the corps artillery).

Austria has sixteen batteries per army corps: six per division, and four for the corps artillery. Italy has sixteen batteries: four per division and eight for the corps artillery.† Switzerland has eighteen batteries: six per division and six for the corps artillery. Sweden has nine batteries per division.

The field howitzers form part of the field artillery only in Germany and in Great Britain. Austria is considering where to assign these. In the other countries they belong to the *heavy artillery* of the army, or to *position artillery.*

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*Portugal has adopted a Schneider-Canet rapid-fire gun (see *Revue d'Artillerie*, Vol. 64, p. 299).—*Translator's Note.*

†See note on page 61.

APPENDIX I.

FIELD ARTILLERY MATERIAL IN 1908.

I. LIGHT FIELD GUNS.

As General Rohne's pamphlet appeared four years ago, it will be of interest to add now a few notes which will give an idea of the progress in field artillery material during the time which has since elapsed. The appended table, in English units, taken from the *Journal of the Royal Artillery* for April, 1908, shows the present status of the light field gun in all armies. The usual caliber for these guns, which form the bulk of the artillery of mobile armies, is about three inches and the projectile weighs about fifteen pounds.

It will be noted that England has gone her own way and supplied a field gun of 3.3-inch caliber, with a projectile weighing 18.5 lbs. This gun being manifestly too heavy for use with cavalry, a much lighter weapon with a 12.5-lb. projectile has been issued to the horse artillery.

In other armies, to avoid complicating material the same rapid-fire gun is used with both infantry and cavalry. As General Rohne predicted in his introduction to the pamphlet, there has been "a general revolution in the construction of material."

The following countries, not mentioned in the table, have also adopted the rapid-fire gun: Bolivia, China, Peru and Persia.* The latest competition between guns occurred last summer (1907), the object being to select a suitable gun for the Greek Artillery,† Seven guns (one Armstrong, two Krupp, two Ehrhardt and two Schneider) were entered, with the result that an order was given to Ehrhardt for

*Incomplete data relative to the material adopted by these countries is contained in "L'artillerie de campagne a tir rapide," in the *Journal des Sciences Militaires*, 1907–8.

†For an excellent account of these tests, see *Revue d'Artillerie*, March, 1908.

	America, 19					Denmark	England, F.	England, H.	France, 18	Germany,
Caliber, inches	3	3.01				2.95	3.3	3	2.95	3.03
Weight of shrapnel, pounds	15	14.72			14.3	14.85	18.48	12.54	15.95	15
Number of bullets.	262*	332			294	295	364	263	290	300
Number to the pound	34*	50&35	50	45	45	41	42	42	38	45
Whether H. E. shell carried	Yes	Yes.	Yes.	Yes.	Yes.	No	No.	No	Yes	Yes.
Proportion of H. E. shell.	?	22	?	?	?	Nil	Nil.	Nil	12.5	4.88*
Muzzle velocity, f. s.	1700	1625	1640	1600	1640	1640	1590	1658	1736	1525
Muzzle energy, foot-tons	300	269	267	215	267	277	324	239	333	242
Nature of powder	G.C	N.G.	N.G.	N. G.	G. C.	G.C	Cor.	Cor	G. C	G.C.
Weight of gun, cwt.	6.9	7	6.48	5.7	7.52	6.5	9	6	9	7.66
Weight of gun and carriage	20.75	20	19.5	16.3	20.25	20.5	23.75	18	23.5*	31.75*
Weight of gun and limber filled	35.75	35.5	37.2	27.7	34.5	38	38.5	31.75	38	35.4
Max. elevation, degrees.	15	18	15	17	15	15	16	16	12*	16
Traverse each way, degrees.	4	4	3	3	3	3.5	3	3	3	4*
Length of recoil, inches	50	52	51	44	50	54	48	48	44*	44
Height of wheels	4'8"	4'3"	4'3½"	4'2"	4'4"	4'4"	4'8"	4'8"	4'4"	4'5½"
Length of trail, feet	10.5	8.66	8.75	8.1	9	9	8.3	8.3	9	8.3*
Range of sight, whether independent.	No.	No	No.	No.	No.	No.	Yes	Yes.	Yes.	No
Sights—Goniometric, Telescopic, Panorama or Ordinary.	O.P.	O. P.	G.P	O.G.	O	T.G	T G	T.G.	G.	T.G.
Material of gun—steel, nickel-steel or bronze	N.S	B.	N.S.	N.S.	S.	N S	N S	N.S.	N.S.	N S
Length of gun, total, calibers	29	30	30	28	32	30.5	29.4	24.4	35*	27.3
Breech action—wedge, swinging block, or eccentric screw.	S.B.	W.	W	W.	S B.	W.	S B	S.B.	E.S.	W.
Thickness of shield, inches	0.2	0.18	0.16	0.18	0.16	0.24	?	?	0.2	.06
Traverse on pivot or along axle	P	P.	P.	P.	A.	P	P.	P	A	P.
Rounds in limber	36	33	40	32	38	44	24	24	24	36
Rounds in wagon limber	36	30	40	32	38	48	28	28	24	36
Rounds in wagon body	70	60	61	48	60	72	48	48	72	52
Rounds per gun	358†	168	242	192	250	284	176	176	312	1
Weight of wagon, packed, cwt.	37	36.4	36	28*	34	41.2	36.75	30.5	40	35
Number of guns in battery	4	6	4	4	4	4	6	6	4	6
Number of wagons in battery.	12	9	8	8*	9	8	12	12	12	6‡
Maker	State and Ehrhardt.	State, Skoda, and Ehrhardt	Krupp and Cockerill.	Krupp.	Schneider	Krupp.	State, E.O.C., V.M. and C.O.W.		State.	State.

	Greece, 19		Ital	Jap					Russia, 1903	Servia, 1907.
Caliber, inches	2.95		2.95	2.95			2.95	2.95	3	2.95
Weight of shrapnel, pounds	14.3		14.3	13.2			14.3	14.3	14.71*	14.3
Number of bullets.	305		360	234			294	295	260	305
Number to the pound	45		50	42			43	42	43	45
Whether H. E. shell carried	Yes		Yes.	Yes.			Yes	Yes	Yes	Yes
Proportion of H. E. shell.	?		20?	?			?	?	?	?
Muzzle velocity, f. s.	1640		1675	1705			1640	1640	1930§	1640
Muzzle energy, foot-tons	267		279	267	255		267	267	380	267
Nature of powder	G C.		N.G.	N.G.	G.C.		G C	G.C.	G.C	G C
Weight of gun, cwt.	6.7		6.9	6.5	6.5		6.67	7.37	7.85	6.67
Weight of gun and carriage	21.3		19.75	18.5	20.8		21.25	21	22*	21.2
Weight of gun and limber filled	35.5		33.45	32.4*	36.3		35.5	34.8	38.5	35.3
Max. elevation, degrees.	16		17	16.5*	17.5		16	16	16.75	16
Traverse each way, degrees.	5		3	3	2.5		3	3	2.75	3
Length of recoil, inches	50		57	?	44		50	54	40*	50
Height of wheels	4'4"	4'3½"	4'3½"	4'7"	4'3½"		4'4"	4'3½"	4'4"	4'4"
Length of trail, feet	9	8.75	8.75	?	9		9	8.7	9	9
Range of sight, whether independent.	Yes.	No.	Yes	No.	Yes.		Yes	No.	No.	Yes
Sights—Goniometric, Telescopic, Panorama or Ordinary.	G	T.G.	T.P	O*	G.P		G.	T G.	O P.	G.
Material of gun—steel, nickel-steel or bronze	S.	N.S.	N.S.	N.S.	S		S.	N S.	N S	S.
Length of gun, total, calibers	31.4	30	30	31	30	31	31.4	0	32*	31.4
Breech action—wedge, swinging block, or eccentric screw.	S B.	W.	W.	S B	E S.	E S	S B	W.	S B.	S B.
Thickness of shield, inches	0.2	0.16	0.16	0.12	0.12	0.25	0.2	0.24	0.2	0.2
Traverse on pivot or along axle	A	P.	P	P	P.	P.	A.	P.	A.	A.
Rounds in limber	?	40	32	24	36	36	38	24	36	38
Rounds in wagon limber	?	40	32	24	36	36	38	24	38	38
Rounds in wagon body	?	64	64	48	64	64	72	64	48	72
Rounds per gun	?	196	320	168*	236	236	258	200	228	258
Weight of wagon, packed, cwt.	37?	36.35	36	?	36.5	40.5	37.4	36	38	37.4
Number of guns in battery	4	6	4	6	4	6	4	4	8	4
Number of wagons in battery.	12	9	12	12*	8	12	8	8	16	8*
Maker	Schneider.	Krupp.	Krupp and State.	State.	St Chamond	Ehrhardt.	Schneider	Krupp	State.	Schneider.

† AMERICA—Including 4 rounds with gun. ‡GERMANY—In addition to 7 wagons per battery with light ammunition co

§ NORWAY —The shield weighs 56 pounds and is carried on the wagon. These weights do not include the gunners or their kits.

thirty-six 4-gun batteries, while the order for ammunition was divided between this firm and Armstrong, the latter getting the high explosive shell. In firing, most of the tests for accuracy and effect were carried out at a range of only 1,750 yards, which is generally regarded as too short. The test for mobility and strength of material consisted in forming the seven guns into a battery and marching over 250 miles of road, and 110 miles of rocky hillside at a walk and trot. All of the carriages suffered from the latter test. The Schneider wheels were weak, one Ehrhardt limber broke down, one Krupp shell exploded in the limber,‡ and various minor defects were revealed. Ehrhardt has abandoned the axle pivoting system and telescopic trail.

2. MOUNTAIN GUNS.

Since the Russo-Japanese War, much attention has been devoted to this class of guns.

To China belongs the credit of having been one of the first, if not the very first power, to adopt a rapid-fire mountain gun, this country having early in 1905 placed an order with Schneider for three batteries of six guns each, with 600 rounds per piece, packs, etc. The material having been found satisfactory (said to have been placed in service in the province of Tchi-li) a subsequent order was placed in 1906 for additional batteries.

During the past year, Portugal and Greece have bought Schneider mountain guns, while Russia and Switzerland have bought Krupp. What is regarded as one of the most powerful mountain guns yet produced is the Schneider-Donglais, now being made for Greece. The jacket carrying the breech-block runs only a short way down the tube, to which it is attached by a bayonet joint (projecting lugs), the tube taking all of the radial pressure. The gun is mounted on a hydro-pneumatic axle-traversing carriage, with shields extending beyond the wheels. The projectile weighs 14.3 lbs. and has an initial velocity of 1,150 f. s.

‡None of the personnel was killed. The cause of the explosion, according to one account was a base percussion fuze, while according to another account, the trouble was due to using a picrate as a high explosive charge.

The most important development recently is the French mountain gun, having a "differential recoil" mechanism, the details of which have been kept secret, but the operation is supposed to be as follows: A catch, fitted on the long recoil gun, holds it in the extreme recoil position, where it is loaded and laid; to this catch is fitted a tripper which also controls the firing mechanism; all resistance to the return of the gun in battery is removed, so that when tripped it flies forward, and is automatically fired just before its return in battery is complete; the recoil drives it back, when it is again caught and loaded. The advantage lies in the greatly reduced recoil energy, and consequent lessening of the overturning moment of the carriage. After making deductions for frictions, etc., it is estimated that for the same weight of equipment, the power of a gun can be increased by this system, about 30 per cent.*

3. HORSE ARTILLERY GUNS.

Not much development has taken place here recently, due to the more urgent need of development in other classes of artillery.

It is said that a battery of a new design† was tested in France in 1904, intended ultimately to replace the present horse artillery gun, which is the 80-mm. gun, the horse artillery of cavalry divisions never having been supplied with the 75-mm. gun, on account of its weight and time consumed in getting in or out of action, due to the necessity of anchoring. The gun tested was of 75-mm. caliber, the weight behind the teams being but 3,350 lbs., but, according to the *Internationale Revue* for October, 1906, the adoption of this piece has been postponed. The latest horse artillery gun, actually in use, is the English, the data for which are given in the table of field guns.‡

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*Lieutenant Roeggla, of the Austrian Artillery, has mathematically discussed this system in an article in *Mitteilungen uber Gegenstande des Artillerie und Geniewesens*, Nos. 8 and 9, 1907.

†*Journal des Sciences Militaire*, 1907.

‡Sir Ian Hamilton says: "It is a most beautiful weapon and excites the admiration of all who have anything to do with it."

4. LIGHT FIELD HOWITZERS.

The past four years have seen quiet, steady development in this material as in other classes of field artillery. Considerable delay was experienced in adapting the long recoil barrel to this class of ordnance, due to the fact that the carriage must admit of both direct and high-angle fire. But the difficulties have now been overcome.

The table on page 81 shows the guns of this type actually manufactured.

5. HEAVY FIELD ARTILLERY.

This recent development of field artillery is attracting considerable attention throughout the world; but much confusion exists at present between heavy field artillery, and heavy or position artillery.

Probably the most recently adopted heavy field artillery is that of the Japanese (1907), the data of which are approximately as follows:

JAPANESE HEAVY FIELD PIECES.

	Howitzer.	Gun.
Caliber	5.9 inches	4.1 inches
Length	11 calibers	30 calibers.
Weight of gun:		
Without breech block	1,702 lbs.	?
With breech block	?	?
With carriage	4,210 lbs.	5,730 lbs.
Initial velocity	902 f. s.	1,706 f. s.
Range	6,444 yds., 42°	8,533 (20°) 10,936 (35°) yds.
Maximum range	?	10,936 (35°) yds.
Fuze, shrapnel	?	50-sec. — 10,280 yds
Number of projectiles	12 + 12 × 2	18 × 2 (caisson)
Number of men	1 + 6	1 + 8
Number of horses	8	8
Weight of projectile	79.3 lbs.	39.7 lbs.
Weight of powder charge	?	3.83 lbs. (?)
Shield	None	1.18 in.
Rear sight	Telescopic.	Telescopic.

During the past year, Italy, Portugal, Russia, Servia, Switzerland and Spain have been considering or experimenting with either heavy howitzers or heavy field guns or both, with a view to the adoption of a suitable type.*

6. SYSTEM OF FIELD ARTILLERY DESIGNED FOR THE UNITED STATES ARMY.

Our Ordnance Department has kept abreast of the development of field artillery, and has designed for us a new system of guns and howitzers, of which the light three-inch field gun is the only one as yet in service. These weapons may be classified as follows:

Designation.	Caliber.	Weight of projectile.	Approximate weight behind teams.
	Inches.	*Lbs.*	*Lbs.*
Mountain howitzer	3	15	300 (packs)
Light gun	3	15	4,000
Light howitzer	3.8	30	4,000
Howitzer	4.7	60	6,000
Gun	3.8	30	6,000
Heavy field gun	4.7	60	8,000
Heavy field howitzer	6	120	8,000

An examination of this table will show that—

1. Each gun is supplemented by a howitzer of equal mobility with a projectile twice as heavy as that of the gun.

Light gun	3″	Weight behind teams, 4,000 lbs.
Light howitzer	3.8″	
Gun	3.8″	Weight behind teams, 6,000 lbs.
Howitzer	4.7″	
Heavy field gun	4.7″	Weight behind teams, 8,000 lbs.
Heavy field howitzer	6″	

2. A gun and howitzer of the same caliber fire the same ammunition, thus—

3.8″ Rifle	Weight of projectile, 30 lbs.
3.8″ Howitzer	
4.7″ Rifle	Weight of projectile, 60 lbs.
4.7″ Howitzer	

*Numerous, though incomplete, data relative to this material are contained in Von Loebell's year books.

This makes a very complete system of ordnance—leaving but two points upon which there can be any discussion:

3. Some field artillery officers are of the opinion that neither the 3.8-inch gun nor howitzer with its 30-lb. shell will prove equal to the work expected of it and that it will be well to eliminate them from the system and introduce in their stead a good horse artillery gun, with a weight of not more than 3,300 pounds behind the teams, and throwing the most powerful projectile practicable for that gun. Our 3-inch gun does not possess the mobility desirable in a horse artillery gun.

4. The 3.8-inch is an intermediate weapon between the light and heavy field gun. What will be the function of the gun? How and where will it be employed? Experience shows that guns throwing projectiles of about this weight are not up to what is expected of them and have been dropped from modern systems of field artillery. As to the howitzer, by retaining it we have two calibers of light howitzers, the 3.8-inch and 4.7-inch. Our experiments at Fort Riley indicated that the latter would be more desirable, and our limited number of field artillery regiments requires us to restrict ourselves to the fewest classes and calibers practicable.

At present the 3-inch rapid-fire gun is used by both light and horse batteries. The 3-inch mountain howitzer will be substituted for the present 2.95-inch gun, as soon as manufactured. We have no troops to take over the greater calibers when ready, although it is of great importance to get such ordnance in the hands of troops as soon as possible, in order that they may become familiar with its use before being compelled to take the field.

Experience gained in recent war has shown conclusively the necessity for these heavy field cannon. In our Army the present law contemplates their being manned by field artillery troops, but thus far no regiments have been authorized for this purpose.

APPENDIX II.

GENERAL LANGLOIS' PROPOSITION TO SUPPLEMENT THE LIGHT FIELD GUN WITH A GUN OF THE POM-POM TYPE.

General Langlois has, by a recent series of articles in *La France Militaire*,* started a new artillery discussion. The General advocates the adoption of a small caliber automatic or semi-automatic rapid-fire gun, not to replace the present field gun, but to supplement its fire.

Briefly, his arguments are as follows:

The question presents itself under these two heads—

1. The organization to be adopted.
2. The material to be adopted.

These questions are discussed in their inverse order, the General's premises being that while in recent years the gun has been greatly improved, the projectile has been only slightly so. The action of shrapnel is to cover an area, but the balls have slight penetration, hence their very effect against objectives in the open has caused the extensive use of cover; and artillery and infantry under cover are hard to find. Referring especially to the artillery protected by shields, even the most violent fire is generally powerless to silence such protected artillery. This result can be aecomplished only by either time-fuzed fire or percussion fire; as to the first, curved fire has been suggested, but the depth of area covered by the balls in range is too small; and as to high explosive shell (German), the effect is again too local, and great precision in range necessary. A shell throwing its fragments backward has also proved ineffective, on account of insufficient remaining velocity. Hence percussion fire is the only way to demolish such batteries, but, with the present gun, the consumption of ammunition renders this inadmissible.

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* Notre Materiel d'Artillerie de Campagne.

Therefore, with the present gun, there is no satisfactory way of mastering the enemy's batteries—which remark applies to the guns of all nations.

But the present high explosive shell produces an excess of energy at the point of burst; hence the idea suggests itself of using such a shell in as small a caliber as is sufficient to accomplish the desired object, and to cover a zone with these shell. Such a gun is the pom-pom in principle.

Now the General showed in his great work, *L'Artillerie en liason avec les autres Armes*, that for two guns of the same type but different calibers, there is a range greater than that of equality of remaining velocity, when effects of projectiles are proportional to the weights, and that *for the same weight of ammunition*, at less ranges than this, the effects of the small caliber are greater, while at greater ranges the effects are less. But ballistic improvements have so increased the remaining velocity of the small caliber that the range of proportional effects now exceeds, however small the caliber, the limits of visibility on battlefields with a climate similar to that of France.

Hence the introduction of such a gun is logical.

The General then takes up possible objections to this introduction and replies to them.

1. The complicating ammunition supply. But all nations in all wars have had several calibers; in Manchuria, at Mukden, the Japanese had nine, while the Russians had seven types of gun of five calibers. Moreover, this is a serious drawback only in the case of hastily organized armies, and not in the case of those armies where there has been sufficient time to previously organize an ammunition supply. Moreover, with guns of 75 and 40 mm. calibers, there is less danger of injuring our own troops by a mistake in using the wrong ammunition than there will be by using two kinds of ammunition of the same caliber.

2. The inability of the pom-pom to adjust its fire. This is refuted by history, especially in South Africa, where the bursting charge was but 22 grammes of pistol powder, while the General proposes a large and smoke-producing

charge, and the gun was used at 5,500 yards, a much longer range than the General proposes.

3. The slight effect, moral and material. But the English in South Africa feared it more than any other gun. At 3,500 yards, it could prevent the infantry crossing open ground; all cavalry movement under its fire terminated in flight.

The General then makes some deductions as to the material to be adopted.

1. The weight of the caisson and not the piece determines mobility, hence the gun carriage can be made of any satisfactory weight, limited only by the fact that it should be easily moved by hand.

2. A large sweeping angle is necessary in order to easily follow cavalry.

3. It should be provided with large shield, possibly side and roof also.

4. The projectile should weigh from 1 kg. to 1½ kg. (2.2 to 3.3 lbs.), the bursting charge should be about $\frac{1}{20}$ and the projectile should admit of systematic fragmentation.

5. The bursting charge should be powerful and smoke-producing.

6. The fuze should be extremely sensitive and light, and cheap.

This material, when realized, will not suffice to fill all the present missions of field artillery, though the General is of the opinion that in a more or less distant future the gun will fill all needs. But at present the close union of the 75-mm. gun and pom-pom is necessary, in order to assure to the infantry, under all circumstances, the necessary support.

Against batteries completely protected in a defiladed position, the 75-mm. gun will "nail" the pieces to the ground, its rafales preventing all movements of limbers or any displacement by hand; the pom-pom by its projectiles piercing the shield and bursting in rear will destroy the personnel and aiming appliances. In addition, the destruction of pieces and men in the first encounters will have a subsequent great moral effect. Against moving infantry the pom-pom will reach the swarms, even lying down, and its effect, local but very violent, will prevent the men from remaining grouped, cause them to deploy, thus offering a very vulnerable target for the 75-mm. gun.

Against light and slightly visible trenches, the small percussion projectile, *employed in a systematic fire* will pierce the thin earthwork, and strike the hidden men with its fragments. If the line covers itself with strong works, the latter become visible and permit the adjustment of the fire of the 75-mm. gun, which without wastage then uses percussion fire.

In the cavalry fight the pom-pom, by its extreme rapidity of fire, and by its numerous bursting shell in the middle of the ranks, will quickly break up the enemy's squadrons. The General does not approve of a compromise solution of adopting a caliber of 60 or 65 mm., as the projectiles (8 to 10 lbs.) would be unnecessarily heavy and would require to beat a zone, an excessive expenditure of ammunition. He points to the compromise made by the Germans, who have twice had to transform their equipment in ten years. Again, referring to organization, he is opposed to forming separate batteries of pom-poms, as it would be impossible to secure thus the unity of action between the captains on the battlefield. A better way would be to add a platoon of 2 pom-poms to each 75-mm. battery now existing, as this would require no change in organization nor methods of fire, the expense would be reduced to the minimum, and finally, if under exceptional circumstances the fire of the pom-poms could not be adjusted, the 75-mm. gun would furnish it with the elements of fire for effect.

The General calls attention to the fact that in the wars of the Revolution and Empire, batteries contained four guns and two howitzers, and that a captain controlled the fire of these two classes. He closes by remarking that the intimate union of the gun he proposes and the 75-mm. is indispensable, and that the time is particularly opportune for France to adopt it now.