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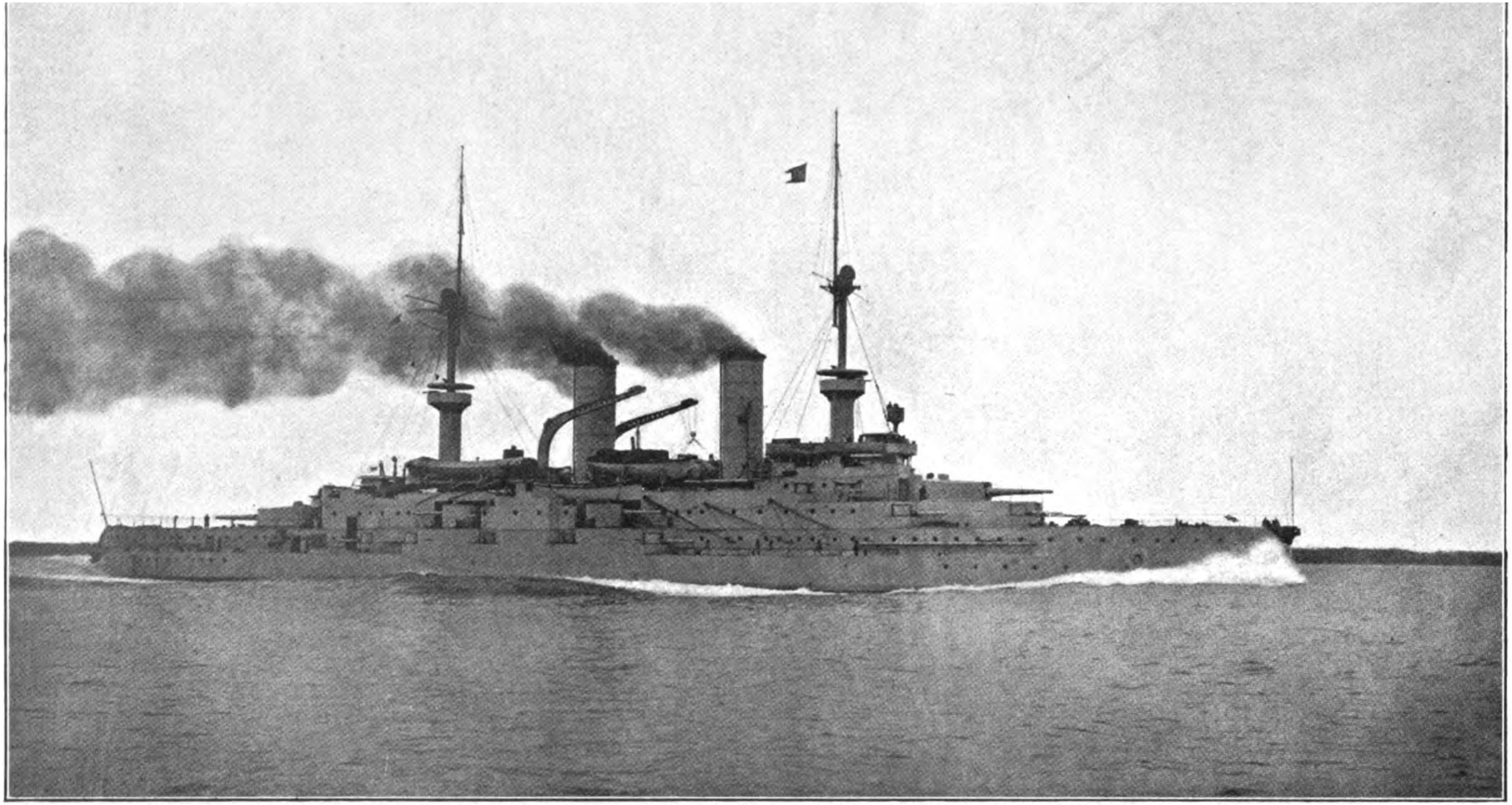

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JOURNAL

OF THE

UNITED STATES ARTILLERY.

"La guerre est un métier pour les ignorans, et une Science pour les habiles gens."

VOL. XXII. NO. 1. JULY—AUGUST, 1904. WHOLE NO. 68.

THE FIELD ARTILLERY OF ARMIES.

BY LIEUTENANT-COLONEL A. D. SCHENCK, ARTILLERY CORPS.

In view of the fact that we have in our army only thirty batteries of field artillery ; that these batteries form part of an artillery corps with coast artillery, with which field artillery has little or nothing in common ; that it is constantly claimed that, although our army is small, it is the most perfectly organized, etc., of any army in the world, it will no doubt prove interesting, in so far as respects field artillery, to present a statement of what obtains in other armies, and some conclusions that may be reached as to what we have, or should have, pertaining to this arm of the service.

AUSTRIA-HUNGARY.

The field artillery is equivalent to sixty-one regiments, fourteen corps, forty-two divisional regiments, and sixteen horse and fourteen mountain batteries. The siege or garrison artillery comprises six regiments of three and three regiments of two battalions each ; each battalion has four field companies and one ersatz company cadre. A corps artillery regiment consists of a staff and four heavy field batteries, of *eight guns each*, the ammunition park, and the ersatz depot cadre. A divisional artillery regiment has the same organization, but is armed with a light field gun. A horse battery has only six, and a mountain battery four guns.

BELGIUM.

The First and Third regiments of field artillery comprise eight batteries of six guns each, one reserve (cadre) and one battery which mobilizes three ammunition columns, and one depot battery. The Second and Fourth regiments comprise, each, seven field and two horse batteries (each of six guns), two reserve (cadre) and one battery which mobilizes three ammunition columns, and one depot battery.

ENGLAND.

The whole of the artillery is organized into one corps, the Royal Regiment of Artillery, comprising twenty-two horse, eighty-eight field and ten mountain batteries; one hundred and twenty field batteries and ninety-three companies of garrison artillery—two hundred and thirteen in all. An army corps consists of *three* divisions, to each of which is attached a battalion of three light field batteries of six guns each, under the command of a lieutenant-colonel. The corps artillery consists of a brigade of heavy field artillery, nominally two battalions, each of three batteries of six guns each. In addition there is supposed to be a battalion of horse artillery of two or three batteries of six guns each. For the corps two brigades of three battalions, each of three batteries.

FRANCE.

Field artillery fifty-three, cavalry seventy-one regiments. Has forty regiments of field artillery proper, of twelve batteries each, twelve mountain batteries and eighteen battalions of foot artillery, each of six batteries, for service in fortified places (sometimes in seacoast fortifications), ten companies of artillery workmen and three of artificers. Nineteen regiments of heavy field artillery are assigned, one to each of the nineteen army corps, as corps artillery. Nineteen regiments of light field artillery are assigned in like manner as divisional artillery. A regiment of corps artillery consists of four battalions, three of three heavy field batteries of six guns each, and one battalion of two horse batteries of six guns each, and a twelfth battery, also a horse artillery battery, which is usually detached from the regiment. The regiment of divisional artillery also has four battalions, each of three light field batteries of six guns each; each of the two divisions comprising a corps has two battalions, six batteries, assigned to it. Upon mobilization each regiment is provided with the necessary ammunition trains.

The two regiments of a corps constitute a brigade of field artillery under a general officer of field artillery, who is the chief of artillery for the corps. Garrison artillery, eighteen battalions, about nine regiments. Total, fifty-three regiments of field artillery.

GERMANY.

Field artillery fifty-eight, cavalry ninety-three regiments. The field artillery proper is organized into twenty brigades, which, as a rule, contain two regiments each, (three are of three regiments each) one of light and one of heavy field artillery, comprising the divisional and the corps artillery, respectively ; three of the brigades contain three regiments each, to meet the special requirements of the Saxon, Bavarian and Wurtemburg army corps.

The normal organization of a German light field artillery regiment consists of two battalions of three batteries each ; that for the heavy field regiments is the same, with the addition of a battalion of horse artillery of two or three batteries. The Fifth Bavarian contains two battalions of three batteries each and one battalion of two horse batteries—eight batteries to the regiment ; while the Fifth Prussian contains three battalions of three and one of two batteries, and one battalion of two horse batteries ; in all five battalions and thirteen batteries. One brigade of field artillery is attached to each of the twenty army corps, normally consisting of two divisions of two brigades each, the latter of two regiments each ; with a war strength of 24,000 muskets, exclusive of special troops, engineers, pontoniers, riflemen, etc. The batteries have six guns each.

In each field artillery regiment provision is made for batteries of the reserve (depot batteries) and batteries of the train (ammunition).

Garrison artillery, fifteen regiments of two and two of three battalions each, of four companies, twenty officers and five hundred ninety-six men to a battalion. Total, fifty-eight regiments field artillery.

HOLLAND.

Field artillery seven, cavalry three regiments.

The field artillery consists of three regiments of two battalions of four and two batteries, respectively, of six guns each, and two train batteries. Garrison artillery, four regiments.

ITALY.

Field artillery twenty-nine, cavalry twenty-four regiments.

The field artillery comprises twenty-four field artillery regiments, and one horse and one mountain regiment. Six heavy field regiments each consist of a staff, two battalions of four batteries each, two train and one depot battery; in the other six regiments of this class the organization is the same, except that the second battalion in each has three instead of four batteries. Each of the twelve regiments of light field artillery consists of a staff, two battalions of four batteries each, one train and one depot battery. This field artillery is distributed into four commands, each under a major-general of the army who is on the staff of the territorial general commanding. The horse artillery regiment consists of three battalions of two batteries each, one train brigade of four batteries, and one depot battery; six gun, and five batteries of the train—eleven batteries in all. The mountain artillery regiment consists of five battalions of three batteries each; fifteen gun batteries to the regiment. Garrison artillery, three regiments. Total, twenty-nine regiments field artillery.

RUSSIA.

Field artillery equivalent of one hundred and forty-seven, cavalry two hundred and twelve regiments.

The field artillery consists of light and heavy field, horse, horse mountain, mountain and mortar artillery.

In order to compare readily the Russian organization with that of other European nations except Austria, it must be borne in mind constantly that the light, heavy and mountain batteries each have eight guns, or two more than is the rule in all other armies except the Austrian. The horse and mortar batteries each have the usual six guns. The horse mountain battery appears to be peculiar to the Russian service.

The field artillery proper is organized into three brigades of the guards, four grenadier and forty-one line brigades, forty-eight brigades in all. There are also Turkestan, Siberian, Caucasian, Finland, Transcarpian and Cossack brigades, regiments, battalions or batteries scattered over the empire, the total number of batteries being: light field, two hundred and fifteen; heavy field, one hundred and twelve; horse, forty-eight; horse mountain, two; mountain, twenty-one, and mortar batteries, twenty-six; total, four hundred and twenty-four batteries. The number of guns, respectively, light field, seventeen hundred and twenty; heavy field, eight hundred and ninety-six; horse, two hundred and eighty-eight; horse mountain, twelve; mountain, one hundred and sixty-eight; mortar, one hundred and fifty-six; total, thirty-two hundred and forty guns.

The organization of a brigade of field artillery, as in every army, depends upon that of the army corps to which it is attached; viz., whether of two or of three divisions of infantry. Nominally, the Russian army corps consists of two infantry and one cavalry division, together with the usual auxiliary troops, etc. The corresponding brigade of field artillery consists of two "Brigades" of two "Divisons" each, of three batteries each, of eight guns, and one "Division" of two horse batteries of six guns each. The distribution of the field artillery is finally much the same as in the French army, the brigade corresponding to the French regiment; the six batteries of eight guns each of the Russian brigade having forty-eight guns, the same as for the eight batteries of six guns each of the French regiment. In other words, for the Russian "Brigade" and "Division," read regiment and battalion, respectively, always remembering the eight-gun batteries. As the services of the Russian army are much more diversified than those of any other, so are the organizations required to meet these conditions—many of which are not required at all in any other army.

Garrison artillery, fifty-six battalions of four companies each, three siege artillery battalions, twelve independent fortress companies, eighty-five sortie batteries and ten battalions of militia. The total field artillery force of Russia amounts to four hundred and twenty-four field batteries, one hundred and twenty-eight field reserve batteries, sixteen sortie batteries, fifty-two depot batteries (*mostly of eight guns each*) with sixty-three hundred and ten guns, two hundred and forty-seven fortress and siege batteries, and ten militia fortress battalions. Reduced to usual regiments and batteries, the equivalent would be about one hundred and seventeen regiments, field, and thirty regiments, siege artillery. Total, one hundred and forty-seven regiments of field artillery. Cavalry, two hundred and twelve regiments.

SPAIN.

Field artillery seventeen, cavalry equivalent to about fourteen regiments. Except in the first corps, where an artillery brigade is organized for instruction purposes, the field artillery is not organized into brigades in time of peace. The regiments are distributed with tolerable uniformity at the rate of one regiment to each mixed division, though in some cases the regiments assigned to certain divisions will be found to be detached and serving in the territory of another army corps. Each regiment has a staff and four batteries of six guns each. In time of war each regiment is to mobilize two battalions of three batteries each, six guns per battery, and also three ammunition trains. The organization comprises:

3 heavy field regiments	(4 batteries each)	12 batteries.
9 light " "	(4 " ")	36 "
1 mounted "	(3 ")	3 "
1 horse artillery "	(4 ")	4 "
2 mountain "	(4 " ")	8 "
1 " "	(3 ")	3 "
—		—
17		66

Garrison artillery, ten battalions.

SWITZERLAND.

Field artillery eleven, cavalry nine regiments.

The field artillery consists of twenty-four regiments of field artillery of two field batteries each, and one regiment of two batteries of mountain artillery. Two regiments are assigned to each division as divisional artillery, and two to each corps as corps artillery. Total, forty-eight field batteries and two mountain batteries of six guns each.

This number of batteries for the little republic, reduced to usual organization found in Europe, would give: Four regiments of light field artillery, each of two battalions of three batteries each, of six guns per battery, four regiments of heavy field artillery, each of two battalions of three batteries each, of six guns per battery, and one battalion of horse artillery of two batteries of six guns each. Total, nine regiments and one battalion—fifty batteries.

Garrison artillery, five battalions, each of two companies élite and two landwehr.

JAPAN.

There are nineteen regiments of field artillery. Nominally each regiment consists of a staff and two battalions; first battalion, four batteries of field artillery; second battalion, two batteries of mountain guns; all batteries have six guns. There is also one battalion of two companies of the train. A regiment of field artillery has one colonel (or lieutenant-colonel) three majors, nine captains, fifteen lieutenants, twelve ensigns, six special sergeant-majors, seven sergeant-majors, sixty-four sergeants, five hundred and seventy-six men; total, six hundred and ninety-three. It also has attached to it three surgeons, one chief hospital attendant, six hospital attendants, two veterinarians, eight employees, two farriers, two blacksmiths, two saddlers, ten tailors, six shoemakers and two carpenters; total, forty-four. The aggregate strength of the regiment is seven hun-

hundred and eighty-seven for the six batteries (and two companies?). At the war strength a regiment of field artillery numbers about twelve hundred. At the time of the Japan-China war there were seven regiments of field artillery organized as above. This number has since been increased to nineteen regiments, but whether or not any material change has been made in re-organization is not known. But as it here stands, it is very remarkable in its completeness of organization, which is greater than can be found in any other army however old its field artillery organization for a regiment may be.

SUMMARY.

	Field Artillery Regiments.	Cavalry Regiments.	Per cent. Artillery to Cavalry.
Austria-Hungary,	61	42	145
France,	53	71	74
Germany,	58	93	62
Holland,	7	3	230
Italy,	29	24	120
Russia,	147	212	70
Spain,	17	14	120
Switzerland,	11	9	122
U. S. should have,	19	has 15	126

NOTE.—The ratio for France and Germany should be nearly doubled, as in these armies the cavalry regiment, about six hundred sabres, is at the minimum, while the field artillery regiment, eleven or thirteen batteries exclusive of the artillery train, is at a maximum, as compared with other services.

An inspection of the foregoing reveals the fact that in every service the organization of the field artillery is based upon one and the same general plan and principle, viz.: that there must be a certain proportion of the field artillery assigned to duty with the infantry divisions, and another moiety to the command of the army corps commander; hence the "divisional" and the "corps" artilleries, the former generally being light and the latter heavy field artillery, the necessity for the two classes of guns being due to obvious and controlling tactical reasons.

It is found that the divisional artillery always comprises a battalion of three or four light field batteries, and that the battalions of the divisions in any given army corps are combined into a regiment of divisional artillery for purposes of command, instruction and administration for precisely the same reasons that the squadrons or battalions of cavalry or infantry are combined into regiments. The number of batteries assigned to the corps artillery proper is generally the same as is assigned to the divisions; the exception being the unusual one of having three divisions in a corps, as in the English service. We thus find six or eight heavy field batteries assigned as the corps artillery, which are organized into a regiment of heavy field artillery, comprising two battalions of three or four batteries each, uniform in general respects with the regiment of divisional artillery. But there must be connected with the army corps a much more mobile artillery than either the divisional or corps artillery to meet urgent tactical demands, and also to provide guns for the cavalry on occasion; hence it is almost universally found that there is attached to the regiment of corps artillery a battalion of two, or generally three, horse batteries. Furthermore, to provide for the artillery ammunition trains, there is added to every battalion of field artillery one battery for this service; also, especially in those countries where conscription prevails, there is added an additional battery called a depot battery, which remains at home during war to collect recruits, convalescents, and for many other purposes incident to a state of war. It is thus seen that a battalion of field artillery proper consists not not alone of three or four gun batteries, but has also a depot battery and a train battery—five or six batteries in all; a divisional regiment having two battalions and ten or twelve batteries, and a corps regiment of three battalions, fifteen to seventeen batteries. This fact is to be specially noted, as it, in connection with the great amount of supplies of all kinds, guns, carriages, ammunition, horses, forage, etc., is the reason why the staff, whether of a battery, battalion, regiment or brigade of field artillery, is so much more varied and extensive than is found in the other branches of the service. In the field artillery, as a rule, battalions are commanded by lieutenant-colonels assisted by one or two majors; a regiment by a colonel, the artillery brigade of a corps by a brigadier-general. The chief of artillery of a corps is a major-general, or a lieutenant-general, and the chief of artillery of an army is a lieutenant-general or a general. It is perhaps needless to say that all of these generals are officers of the field artillery service. Field marshals and field marshal generals are made as the rewards only of the most important and distinguished services to the State, generally in war; but field artillery officers, to the same extent as those of any other arm of the service, may aspire to these exalted grades.

It is thus very apparent that the organization of the field artillery of any army is predicated absolutely upon the organization of any particular army, but more particularly upon that of the army corps therein. Given this organization, that for the field artillery is at once determined. But this condition precedent does not determine the *quantity*, the number of the guns. This is determined chiefly by the number and kind of guns our enemy will bring against us, and also by the character of the terrain in the theatre of war, and the character of our own troops; whether trained or untrained soldiers; for as the gun has no nerves and cannot run away, even though the artillerymen be more or less disposed to do so, it forms a solid point of rest and support; first to him, and in turn to the other arms. Chiefly for this reason it has always been the rule to assign more guns per thousand muskets to untrained than to disciplined soldiers, even though untried in battle; for even in the latter case there are always present officers and men who have stood this test in former wars, aside from the iron bands of security which good discipline always insures. But none of these things change the character of the organization of the field artillery. If the corps, or army, commander demands more guns per thousand of his muskets or sabres, it is only necessary to add one or more batteries to each of some or to all of the battalions or regiments of the field artillery, and a wise law would make provision for such a contingency.

It is quite apparent that these organizations of the field artillery of the nations (except in England) take no account of that of garrison, or coast defense artillery. In France, for instance, the vast system of inland frontier defense is in the hands of the garrison artillery, as distinct from any other artillery, and, in like manner, the seacoast defense is under charge of the marine artillery, equally separate and distinct from the other two branches of the artillery service.

In the United States artillery we find not a vestige of this carefully and completely worked out organization of either the field or of the coast artillery, while there is no garrison artillery at all. The law simply provides for thirty batteries of field artillery, thirty forlorn artillery orphans, without any legal organization or esprit de corps beyond that of the battery. The idea was taken from the British service, but has none of the splendid organization found even there, which in all but nomenclature and strength is quite as complete as respects the battalion, regiment and brigade as can be found in any service, due in a very large measure to the sad field artillery experiences in the recent South African war. In the United States army nothing of the kind, even in small degree, can ever obtain, save through the enactment of explicit law.

In connection with the necessity for a determining law is the fact that in an army like that of the United States the law should prescribe a very different relative strength for the various arms from that which usually obtains in other armies, and which has already been so wisely provided for in the cavalry. In European armies a cavalry regiment on war footing in the field has about six hundred men; our "regiment" of twelve hundred men, therefore, actually represents two ordinary regiments, or thirty in all, the same number of regiments in fact as are provided for in the infantry, or about five times the usual proportion; seemingly an altogether useless, not to say unwise, force of cavalry in so small an army, especially when the excessive cost of maintaining the mounted arms of the service is considered. This very item of cost is one of the prime reasons why it is necessary to maintain in our army an unusual and very large proportion of cavalry (and especially of field artillery), because they are branches of the service which are utterly beyond the means of the militia to maintain, while at the same time we find that a large number of good infantry regiments can be and are maintained in the militia; first, because of the less cost to the state, and, secondly, because the training and instruction of the infantrymen is vastly less difficult of attainment, and can be acquired in very much less time. These facts were strongly emphasized by the query often heard at the beginning of the Civil War: "Who ever saw a dead cavalryman?" It took eighteen months or two years of service to make a cavalry regiment relatively equal in training to an infantry regiment after six months' service. In other words, in these days of short wars, if we have not good cavalry at the beginning of a war, the war will be over before cavalry efficiency can be attained, and we might better have none at all; an absurdity upon its face, hence the excessive proportional strength of cavalry found in our army.

Now all of these facts and arguments obtain with very much greater force for our field artillery than for the cavalry; for the field artilleryman not only has to perfect himself to a large degree in much that pertains to the duties of both the infantry and cavalry services, but also in the far more complicated and extensive particulars which pertain to his own special arm; furthermore the cost of maintenance is several times greater than for the cavalry. That there was not also the query "who ever saw a dead artilleryman", was not at all due to the fact that the volunteer artillery was relatively more efficient than the volunteer cavalry, for such was far from being the case, but was due to the fact that it was very easy indeed for the artillery to get into a fight, and when it turned out to be a hot one, its inefficiency prevented even self-protection, and very often precluded getting out of trouble without great loss of both guns and personnel ; furthermore, the cavalry had a complete and good organization ; whereas, even to the end of that war, the field artillery had no legal organization whatever beyond that of the battery, rendering its proper handling or control tactically beyond the power of any officer, however accomplished.

As the proportion of cavalry in our army has been determined without any relation to the strength of the other arms, and for the reason that good cavalry is an impossibility in the militia, or even in the volunteers until after nearly two years' service ; so, too, it should be for the field artillery, which is more difficult to train and far more costly to maintain, and should certainly be maintained upon the same principles which have so wisely been followed for the cavalry arm of our service.

It can be seen from the summary of the relative strength of these two arms in European armies that the field artillery runs from sixty-two per cent. in Germany to two hundred and thirty per cent. in Holland. (This proportion for France, and especially for Germany, should be nearly doubled in fact, for the reason that in these armies the strength of a cavalry regiment, about six hundred sabres, is at a minimum, while that of the artillery regiment is at a maximum, eleven to thirteen batteries, exclusive of the batteries of the artillery train.) As a rule it is found that, including mountain, siege or garrison artillery, the number of field artillery regiments is more than twenty-five per centum greater than the number of cavalry regiments. With such a proportion, with our fifteen very large regiments of cavalry we ought to have at least nineteen proportionally large regiments of field artillery, probably divided as follows: three regiments of horse, six of light and six of heavy field artillery, two regiments of mountain, and two of siege artillery ; total, nineteen regiments.

This would provide a brigade of one regiment each of light and heavy field for each of six army corps, to each of which a battalion of horse artillery could be attached, each corps having one brigade of two regiments of cavalry, with three regiments to spare. The mountain artillery would find its place in the Philippine Islands and the West Indies and Panama in case of need, which is more than likely, and on the home station. The siege artillery regiments should have three battalions of four batteries each even in time of peace, with one battery of train to each battalion in war. These battalions would find their natural frontier stations at Vanceboro, Me., Plattsburg, and Niagara, N. Y., Detroit, Mich., Pembina, N. D., and New Whatcom (or Bellingham), Wash. These and other very important railroad points along this frontier should be occupied by a much greater force of siege artillery than two regiments.

In time of peace, the field artillery regiments, with the exception of the siege, should consist of, for each regiment, a complete staff and two battalions, each battalion having a staff, and three batteries of six guns each (if the guns of a battery are to be reduced to four, then the battalions should consist of four batteries each); with power vested in the President to increase the number of batteries in any or all battalions by one gun-battery and one for the train, and also to increase the number of battalions in any or all regiments by one.

The thirty batteries now in the Artillery Corps should be detached therefrom, and would provide at once five of these regiments, to which can be added annually one or more regiments until the number of regiments we should have is completed.

It is only about three years since we witnessed the so called re-organization of our army. To-day we find that the coast artillery personnel is deficient by more than 25,000 artillerymen, and hampered with an absurd and useless company organization. We find the field artillery coupled with the coast artillery, with which it will never be as closely associated as will the infantry, to whom must be intrusted the land defenses of the coast forts. We find thirty batteries of field artillery—about one-fourth the strength necessary—without any legal organization whatever beyond that of the battery, a state of affairs the like of which is not to be found upon the face of this green earth in any country having any pretense of an army, probably not even in China.

The foregoing strength for our field artillery has been deduced from a consideration of facts other than those obtaining in the English army, from which we have inherited much of our military art, and whose military traditions and practices most nearly resemble our own.

The information at hand does not show how much of the Royal Regiment of Artillery is siege, or garrison artillery, as differentiated from what is organized for coast defense service ; but that which is, strictly speaking, field artillery, as separate from siege or garrison artillery for field service, is given as follows: Horse artillery, twenty-one batteries, and one serving as a depot battery; the equivalent of three and one-half brigades of two battalions each, of three six-gun batteries each. There are eighty-seven field batteries and one depot battery, equal to five brigades of light field divisional artillery, each of three battalions of three batteries each (the English army corps having three divisions) and five brigades of heavy field corps artillery, each of two battalions of three batteries each, with twelve batteries to spare, equal to two brigades each of two battalions having three batteries each. There are nine mountain batteries, and one serving as a depot battery, equal to one and one-half brigades of two battalions of three batteries each—a total of seventeen brigades or regiments, as designated in all other armies, of field artillery proper, exactly the same number as heretofore set forth as the quota for our army, exclusive of the two siege artillery regiments, as deduced from our present strength of fifteen regiments of cavalry.

The English cavalry comprises thirty-one regiments of four squadrons each, with an average field strength on a war footing of five hundred and sixty-nine men and thirty-one officers per regiment—a total of nine hundred and sixty-one officers and seventeen thousand six hundred and thirty-nine sabres. The fifteen regiments of United States cavalry on a war footing number seven hundred and fifty officers and eighteen thousand sabres, thus the strength of cavalry is the same in the two services, except that the English have one more than double the number of our regiments and two hundred and eleven more officers. Under the conditions precedent assumed the field artilleries should also be equal. For the number deduced the number of regiments would be the same, but, exclusive of the depot batteries, there are one hundred and seventeen English batteries, while in the seventeen regiments proposed for our army there would be only one hundred and two batteries on a peace footing; unless, like the English, we adhere to three divisions of infantry for an army corps, when the above, for six army corps, would be increased by eighteen light field batteries, or to one hundred and twenty in all, with an organization of the corps artillery similar to the English.

The provision of law which insures in our army organization so large a proportion of our regular cavalry is a very wise one; that a similar provision should be made respecting our field artillery is beyond question or doubt. This comparison of our real cavalry strength with that of the English army illustrates very clearly that it should be rated at thirty-one instead of fifteen regiments; a brigade of two regiments of our cavalry having more sabres than one of four regiments of English cavalry, or of French or German cavalry. It would then appear that nineteen regiments of field artillery is not so disproportionate to thirty-one regiments of cavalry, which our fifteen regiments are really equal to.

Certain it is that the nineteen regiments of field artillery indicated are not in excess of our present requirements in the event of war. It will suffice for six army corps, which would require one hundred and eight regiments of infantry with three divisions to a corps; thirty of these regiments will be found in the army, and seventy-eight fairly good regiments can be furnished by the militia, but from this latter source neither cavalry nor field artillery can be supplied. As to the possibilities of war, our past history indicates very clearly that another war will be about due as soon as we could conveniently organize this number of field artillery regiments and render them efficient for war purposes, if they were now authorized by law.

FORT STEVENS, OREGON,
June 1, 1904.

COMMENTS ON THE ARTICLE "PROPOSED SYSTEM OF FIRE DIRECTION."*

By Major E. M. WEAVER, Artillery Corps.

There are one or two points in Captain Hearn's admirable article which appear to require modification.

Page 148, line 20, he makes the statement that the Fort Monroe system of fire direction could "only be used with Case II." This is thought to be an accidental lapse, as the method in use at Fort Monroe is susceptible of being used with both Case I. and Case III. as well as with Case II., and had often been so used by me before the more general use of the system by others. This is further made clear by referring to page 266, volume XVII. of the Journal, where will be found the first published enunciation of the essential principles of the Fort Monroe method of continuous observation, continuous prediction and continuous posting at the guns of corrected range and deflection (or azimuth).

In view of the error made by Captain Hearn and by others in referring to the workings of this system, I beg leave to quote the following extracts from the article published in the May-June, 1902, issue of the Journal (volume XVII.):

"The work of the range division is considered a *continuous* operation. Once the target is taken up by a position finder in 'tracking,' its locus is determined as a continuous operation at regular intervals of time; the proper 'corrections' are made for the plotted points by the range division and the 'corrected' range, deflection or azimuth is supplied to the gun; that is, the function of the range division is considered to be to turn out a *finished* product, not an incomplete one. By this method the men at the guns know constantly the 'corrected' range and the 'corrected' azimuth or deflection, not only for the present instant but for a time *in advance* of the present time, always sufficient to allow for accurately setting the range and deflection scales for the firing instant."

"Those at the guns being thus relieved of the necessity of making 'corrections' for range and azimuth or deflection have the simpler duty to perform of keeping the scales set merely for the 'corrected' determinations of the range division, which are clearly exhibited before them, together with the *corresponding time relation*. The gun may thus be aimed or laid *accurately* and fired as rapidly as it can be loaded, or it may be aimed or laid,

* See Journal U. S. Artillery, March-April, 1904.

just as accurately, for any predictive instant in advance. It may be fired in salvo or by single gun, at the gun itself or from the position finder station, or from any other point. The arrangements and method obviate in large measure the difficulties which beset the battery commander, the gun commander and the gunner in attempting to work out 'corrections' and 'allowances' for range and azimuth or deflection while their attention to some extent must be given to other matters connected with the service of the gun."

"The same method applies practically for Case I., Case II. and Case III. The only changes in the duties of any importance being those of the gunner, and consist of only one in each 'Case'; in Case I. he gives elevation and deflection, in Case II., deflection only, and in Case III. azimuth instead of deflection." —p. 266.

It was well understood that modifications would be introduced in plotting boards and in the materials pertaining thereto, and in the material employed in displaying the corrected range deflection and azimuth on the gun platform, and this expectation was mentioned in the paper. Several such modifications were tried by me in my company and with the class of student officers in the course of artillery at the Artillery School; also by other officers at Fort Monroe. Among these modifications may be mentioned Frohwitters' shifting-center plotting board, Bartlett's use of cross-section paper and stop-watch for time-range indication, Butler's and Thornton's use of the set-forward point, Hatch's graphic relocator, separation of relocation from prediction, modification of the prediction and set-forward ruler, Hain's azimuth difference plotting board, Hatch's modified time-range-relation board, Tilton's sliding range arm and auxiliary azimuth circle, and others, all of which had for their object expediting the work of the range division at the plotting board and on the gun platform, but, in all cases, preserving the fundamental features enunciated in the above quotation, viz., continuous observation, continuous use of plotting board, continuous computation of corrections for range and deflection, continuous applications of corrections for range and deflection in the plotting room, continuous transmission of *corrected* range and deflection to the gun platform and the continuous display of this corrected range and deflection before those charged with giving the gun its direction and elevation.

The effect of these progressive steps was to reduce the prediction interval and the interval between the receipt on the gun platform of the announced corrected range and deflection, and thereby to render unnecessary the actual tracing on the plotting board of the target's course. At first the range was sent to the gun *every minute* giving the corrected range and deflection of the set-forward point for a time *two minutes* in advance of the instant of last observation. The effect has been to reduce both of these intervals step by step until now the corrected range is announced every ten seconds for a time ten seconds in advance of the instant of last observation.

Great credit is due to Captain Hearn for devising apparatus for use on the plotting board which has been instrumental in accomplishing this reduction of the working interval, but it is submitted that these devices may hardly be credited with introducing a new *system*, different in any essential principle from that which has been in operation at Fort Monroe; especially it is erroneous to assume that the Fort Monroe system, as it was practiced before the introduction of Captain Hearn's devices, was incapable of being used in Case I. and Case III. as well as in Case II.

Governor's Island, N. Y., May 21, 1904.

THE LAND DEFENSE OF COAST DEFENSES.

From an article By Colonel R. F. JOHNSON, C.M.G., R.A., in Proceedings Royal Artillery Institution, April, 1904.

After an examination of the origin of the land defenses of Portsmouth and Plymouth and of the principles involved in the case of these fortresses, the paper is confined to the consideration of the land defenses of sea fortresses with regard to their simple duties of protecting naval bases or commercial centres in a general and not particular manner.

No one can contend that security for its bases is not of supreme importance to the navy in enabling it to devote all its energies to offensive action, which is the only certain method of maintaining superiority ; and no one, except a naval enthusiast, will deny that fortification is necessary.

As it is possible to make sea defenses impregnable to the attack of ships, it is clear that any attack beyond a mere insult will be by land, generally with a landed force, though in the cases of some fortresses the assailant might not be obliged to use sea communications. It is beyond dispute that any form of fortification, from the shelter trench to the armored cupola fort, if properly applied, is a source of strength to the defense. It is therefore simple folly, if you have sea defenses, not to take the advantage of preparation against the certain form of attack. In fortress warfare preparation has far more value than in field operations, because, whereas every field position has flanks to be turned and communications to maintain, the attack on the defenses of a fortress must always be frontal.

Land defenses cannot be made impregnable ; they can only delay the final struggle or surrender. Therefore when deciding on the scale of land defense to be given, the following four questions must be answered in each case :

Question 1. How long will it be necessary for the garrison to hold out?

This depends on the strategical conditions ; on the time that may elapse before the force, naval or military, requisite to relieve the garrison and to drive off the assailants, can arrive ; and on the value of possession.

With naval superiority on the side of the defense, it is clear that, if the enemy has to depend on sea communications, the time at his disposal will be short, but if he can live on the country or establish land communications, then the only effect of the naval superiority will be to afford facilities for supplying and reinforcing the garrison. In the latter case the preparations for land defense must be more than in the former.

An invested naval base must quickly lose its value as a refitting station, because the necessary material cannot be introduced. Therefore the justification of the expenditure requisite to put one into a state capable of sustaining prolonged investment lessens as the number of bases in the same region increases. It may be of the greatest importance to maintain a distant isolated base, though its investment may make it useless during the whole of the war.

Again, an answer to this question cannot be definitely given without a knowledge of the general strategical plans for naval action. The object of sea fortresses is, of course, to give the navy freedom, but trade routes, the position of the enemy's bases, &c., must always cause more naval force to be kept in some regions than in others; and the greater the naval force at hand the less the chance of a land attack and the shorter the time for its execution.

Question 2. What force, with regard both to numbers and equipment, any possible enemy may be able to employ for the attack?

This depends chiefly on the distance from the enemy's base, especially if his communications are by sea, for, although sea carriage of guns and stores is far the easier, the interruption of the transit is still easier. A raiding force of a very considerable number of infantry with light artillery might be possible, where it would be impossible to employ a much smaller force more heavily equipped for operations requiring time.

The answer to this question, perhaps, affects the nature of the preparations for land defense rather than the extent, as the latter is principally governed by local conditions.

Question 3. What garrison and equipment is necessary in consequence of the answers to questions 1 and 2, and having due regard to the tactical conditions of the place?

The longer the defense required the greater the garrison necessary, other things being equal, because all war is exhausting, and without doubt in siege operations the proportion of casualties increases as time passes.

If the time a garrison has to maintain itself is short, mere passive resistance may suffice, and much artillery is not wanted, because impression on properly prepared entrenchments by artillery, even if unopposed, cannot be obtained without a large expenditure of ammunition and time. To carry on a long fight the defense must be able to counter-attack ; the assailants' guns must be kept at a distance ; and for these purposes the artillery must be in proportion to its opponents' in power and amount.

The extent of front that must be held is of course a primary factor in the calculation, but the actual extent measured in yards does not effect it to the same degree as the lie of the coast line and of the possible landing places.

The nature of the ground on which the fighting will take place must be considered. It is is clear and affords good fields of fire it can be held by a smaller force than if it is broken and has many lines of approach more or less tactically separate.

The fact that the water supply of the place comes from a distance, and cannot be made secure with a reasonable expenditure may be sufficient cause for deciding not to defend it, even though to do so is desirable and otherwise possible.

The facilities for internal communication ; the training of the troops, and their knowledge of the ground ; the number, characteristics, and attitude of the inhabitants ; are, too, all points to be borne in mind, which prevent the application of any fixed principles to the solution of the problem.

Question 4. What garrison and equipment can be maintained, having regard to the value to the Nation of that which is defended? In other words—Is the defense worth the cost ?

At some places it may be possible to lessen the cost by the employment of cheap local troops, while at others the whole garrison may have to be regulars, and to be strong enough to perform police duties as well as those of the defense proper.

In estimating the value of a place its *rôle* in naval strategy is the chief item ; indeed, it is the only military one when it is looked on, as it should be, as including the supply of coal to merchant ships and the general maintenance of commercial traffic ; but in many cases considerations of political sentiment and prestige are also involved. No doubt the inhabitants and trade connections of every port would like it fortified, and theoretically it would be nice to have all made impregnable. The loss, which with naval superiority can only be temporary, of a purely commercial port, unless it seriously interferes with traffic on main trade routes, can only be of local consequence, and form an item to swell the compensation, which the enemy will eventually have to pay provided our energies are strictly directed towards obtaining naval victory.

It may be thought that the land defenses of sea fortresses might be discussed without such reference to the general policy of coast defense, but it is really germane to the subject, because to defend any place with works or garrison inadequate to the strategical, tactical, or political requirements is sheer waste of money and of, what is with us of more moment, men. No fortress is adequately defended unless its land defense is provided for, and the troops for the land defense must always form the larger portion of the garrison, and consequently in the end form the larger item of expense.

What has been said may be useful, too, to emphasize the danger of trying to apply principles, to deduct the requirements of one place from those of another. In no other branch of military science have so many different influences to be taken into account, or is it necessary to bring so free a mind to the consideration of each individual case.

Forts and batteries with complete bomb-proof cover for their garrisons and with their guns mounted in armored cupolas are far too costly and have much too limited a sphere of action to be admissible, except under very special conditions. Forts and batteries of any other kind are now unfightable, are only impediments to the defence and shell traps, and form aiming points for the attack. A very high authority tells us in the latest edition of the "Encyclopædia Britannica," that the result of some French experiments in bombarding "was the formation of two opposite schools of thought, whose differences have not yet been reconciled. Most of the older school decided in favor of bomb-proof cover for the guns in the forts. A few, chiefly of the younger engineers, proposed to take the guns out of the forts and work them from concealed positions in the intervals. In any case the majority of the guns would have to be in the intervals for want of space in the forts. So far the bomb-proof school decidedly preponderate on the Continent of Europe, both among theorists and in the designs accepted by Governments." Quite so! And as no change in the conditions can occur to alter the opinion of the younger engineers, we may hope that in time the preponderating opinion of engineers will agree with that of the artillery, who have to fight the guns.

It is practically impossible to conceal a fort. If not fired on itself it marks a position and can serve as an auxiliary aiming point. It supplies the only sort of target that howitzer fire can injure with certainty. Its guns are restricted in their arcs of fire. The necessity of holding it may affect the general plans. At Pretoria, in order to cover the 30 mile perimeter with the few guns available, we had to take them out of the works ; the existence of West Fort extended the perimeter to be held in a manner that was useless, and might have been dangerous.

We do not in nine cases out of ten want any forts. The guns should be movable, and they should fight in concealed emplacements, and the infantry in entrenchments. But these emplacements and entrenchments with their communications and other necessary complements must be prepared in advance and not neglected.

There are several reasons. To make the best use of the ground it must be studied carefully, and plans for its occupation made and tested. If the execution of the works is left until the occasion for use arises, the plans will most certainly be incomplete or impracticable, and one of the principal advantages of the defensive will be surrendered. The actual construction, especially of the communications, takes time, and attacks on sea fortresses are to be expected with scarcely any warning. Concealment has become with smokeless powder possible, and, with modern arms, of the highest importance, and, if as is likely the guns of the defense are not of the latest pattern, it is imperative ; concealment of freshly made entrenchments is in many places extremely difficult, and generally defective. Again the ground may be rocky and require blasting, or marshy and require draining, and if the work is left till the last moment, these and similar peculiarities are apt to escape notice. Lastly but chiefly, because it is extremely unlikely that authority will be given by the civil power to carry out preparations, which must involve some invasion of private rights, until it is too late.

The only objections, besides that of expense, which can be raised against preparation, are that entrenchments will perish and that possible enemies will learn their positions. Entrenchments are only a small portion of the preparations advocated, and can be repaired by the troops with advantage to their training. There should always be several alternative positions, so the enemy would not know for certain which was held, and even if he did, knowledge of the whereabouts of entrenchments or emplacements on a plan will never insure effective shooting with rifle or gun when the target is invisible. Prepare, and you will have effective works ; let things slide until the occasion arises, and you will have no works at all or some that are worse than useless.

Having, it is hoped, made clear the lines we think should be followed, we can now proceed to a fuller consideration of the data that will supply an answer to question 3, as far as land defenses are concerned.

Of course both works and garrison should be kept at a minimum, and as large a proportion of the latter as possible should be free from any trammels to its action, especially such as may arise from the existence of the former.

If it is in any way possible to effect a landing within reasonable distance, and there is any chance of reaching the batteries, it is as certain as anything is in war that any attack on coast defenses will be of a combined nature ; and, whereas the ships will scarcely ever attack without the assistance of landed parties, * separate attempts may be made by the latter simply for the sake of the prestige a small measure of success will give, seeing that repulse in the face of the risks run will count for little.

Therefore the first thing is to make the sea works secure against landed parties. As the attack must be hasty and can seldom be made except by night, it is not necessary to provide against artillery fire, but for the latter reason the rear of several works cannot be secured by a single guard centrally placed. The artillery detachments of the heavy and medium guns, if provided with bullet-proof cover, should be able to defend their works, but the R.F. batteries must have infantry guards, which should be in trenches or block houses outside, but near the works, so that they may not be confused or distracted by the firing.

At places where the advantages to be gained by the assailant are small, or the force he can use insignificant, this securing of the rears of the seaward works will be all the land defense required, though, if there is a mobile garrison available, it should be disposed and equipped in a manner to enable it at any rate to attempt to prevent a landing or complete the punishment of a repulse.

It is a difference between sea and land fortresses that the mere masking or containing of the garrison, which may do all that is necessary for the enemy in the case of the latter, is of no good in that of the former. Sea fortresses must be captured ; the operations against them must sooner or later be active. Consequently, after making the individual seaward forts safe, the next thing is to occupy the ground, on which you mean to resist more serious attacks, in such a way as to secure it, with as small a proportion as possible of the garrison, against capture by a rush.

* Unless the sea defenses are inadequate to prevent effective bombardment of the object defended, which is a condition which makes the maintenance of a sea fortress criminally stupid.

It is desirable to deny to the attack any ground whence it can bombard *with observed fire* the object protected, but this desirability lessens with the time at the enemy's disposal, and as the range increases, and in all cases economy in men is more important. If the time will be long and a position certain to be used special arrangements must be made, but the main line of defense should never be unduly extended.

The infantry entrenchments should protect the gun emplacements from nocturnal enterprises. Concealment and a flat *open* field of fire are of much greater importance than actual "command" over the front; indeed, the attack may without injury be conceded some "command," as long as movements in rear of the line are not disclosed.

The guns, which replace the armament of forts, will be heavy guns of position, movable but not mobile. Their emplacements must afford concealment, and where necessary to achieve this, which will be rather the rule than the exception, the aiming must be by indirect methods. The guns should be grouped as far as circumstances admit for the purpose of fire control, but the intervals should not be too small, and each piece should have at least two emplacements. These position guns are chiefly for the purpose of fighting those of the attack, as its infantry should be dealt with by the mobile armament of the reserve. In cases where the attack can bombard from covered positions heavy howitzers will be wanted as well as the guns.

Topographical features and tactical conditions will divide the line of defense into "sections." Topographical features and administrative considerations often tempt to a division which must be avoided because unsuitable for fighting. A fortress might be named where the sections were once so arranged, that an enemy in his advance from one of the most likely landing places would have driven the defenders of two into a third, and the confusion of the garrison in the decisive struggle would most certainly have been very great. It is in every way desirable that a fortress shall be divided into as few sections as possible, but the actions of the sea and land defenses are so different, while they will generally take place at the same time, that it seems necessary for them, contrary to the general practice at present, to be kept quite separate. How can an artillery fire commander engaged in fighting his forts attend to the guns of the land defenses? The man who has to fight the guns should have full responsibility before as well as during action. Besides, the fighting of sea forts is a very technical matter, in which any possible interference is dangerous.

In some cases it may be sufficient to prepare only the flank sections, because a small force or one pressed for time will be unable to move any distance inland. It will often, however, indeed perhaps generally, be desirable to control the passage through the rest of the line. For this purpose moderately sized blockhouses, placed out of artillery fire, or concealed by being sunk or otherwise, afford an efficacious means economical in men; and, if they can be placed on inner slopes of the ground, which can be commanded by guns from a central position in rear, they may form a fairly strong defense.

The preparations in each fighting section should be made for the whole force it may be possible to employ in it to repel an attack, or to make a counter-attack. They should not be only for the garrison of the section itself, which only forms the outposts of the defense in that direction. It must be remembered, too, that a place is not taken, that permament damage to the object defended cannot be done, until the last works of the garrison have been carried, and that consequently depth of defense is of the greatest importance. This should in the first instance be attained by the forward action of the mobile reserve in front of the main line, and that may be assisted by a certain amount of preparation; but plans for prolonged resistance in rear of the main line should be made, though the execution of the works may have to be deferred in order to avoid interference with the amenities of the inhabitants, or for other reasons.

Often the communications, to enable a section to be reinforced and to facilitate the movements of its own garrison, will be of even greater importance than its trenches and emplacements. Roads cannot be improvised, but when made form the greatest advantage of the defense over the attack, which may be enhanced by judicious treatment of those the latter will have to use. What is required cannot be decided until the plans of defensive action have been drawn up, but it should be the first item of the defenses to be executed, unless the time for preparation is short, which it should never be. In planning the communications, the great importance of concealing all movements must not be lost sight of, and to secure this the judicious planting of light timber trees and hedge screens is without doubt the most efficacious means. Such take time to grow, but with good arrangement the maintenance of infantry trenches, where the soil is easy to work, may, when they are established, be to some extent dispensed with; the gun emplacements, however, should always be prepared whether concealed or not, because firmness of platform is essential.

The signalling staff in fortresses is always small compared to the requirements, and the demand may cause a serious drain on the ranks of the best troops in garrison. The organization of telephonic communication to fit in with the tactical plans takes much thought and time. At least the main lines should be kept laid, and there will be economy in men and increased security, if those required to gain early information of the enemy are also kept ready, and the transmission of information practiced.

An advantage the defense should always have is an unlimited and handy supply of ammunition for rifle and gun. On the other hand, the means of transport in fortresses are always limited. Therefore magazines must be placed near the spot where ammunition will be wanted. Each section should at least have one central magazine well forward and expense stores near its gun emplacements. The allowance should admit of a free use of long range fire, which is demoralizing and may materially delay the close attack ; this with the wide distribution may often necessitate a larger proportion than the present regulations sanction. It is only another example of the impossibility of reducing such matters to rule. It is cheaper to increase the allowance of rounds than to supply transport to make a smaller allowance suffice, and it is a surer method of securing the advantage.

Although the attack and defense of a sea fortress may be a matter of hours, it will often be necessary to keep their garrisons alert for months at a time. It is therefore necessary for their health and *morale*, two things intimately connected, that they should be properly housed. One or more defensible barracks are desirable in each section, or at least preparations should be made in hygienic and other matters for defensible camps. These barracks or camps should of course be under cover from the enemy's fire. If the troops are raw, or the period of waiting long, it may be advisable to supplement them by blockhouses in the vicinity of the line of picquets. These defensible posts may be used for the security of the magazines and expense stores previously mentioned, and for that of the guns at night ; they will, too, close depressions in the ground, which might form covered approaches.

There can be no definite principle of fortification laid down, but the following seem cases in which there may be found justification for the expense of modern forts.

The first is where ships can co-operate on the flank of the advance. It is rare, but may occur. Sometimes an ordinary sea battery on a high site will suffice, in others when the only site available is low, an armored work may be necessary.

The second case is where there is a position incapable for various reasons of being included in the main line of defense, but such as will obviously be occupied by the attack, and from which it will be able to inflict really appreciable damage on the object protected. Here a self-defensible work will probably be an economical form of defense. Under this head may also be included the protection of water supplies coming into a fortress from a distance, or of a line of communication with the outside, which there is a chance of keeping open.

Thirdly, when the defense must be capable of considerable duration and the forces engaged are of considerable strength, one or two works placed well forward may serve to break up the attack into defined divisions, and may act as *points d'appui* for counter-attacks of a more or less flank nature on those divisions.

Fourthly, there are very rare cases where the existence of such works will considerably limit the possible directions of the attack, or make a very decided reduction in the amount of garrison required.

The garrisons of sections should not be employed in front of the main line of defense, because it is desirable to use the less trained troops for their duties in order that the better trained may be available for the mobile reserve, and it is important not to subject such troops to the trial of having to retire in face of the enemy. The active defense should be carried out by the reserve. This should in the first instance delay the attack by action in front of the main line, then meet it in the selected and prepared positions, and afterwards exact the fullest penalty for the assailants' temerity by following them up and preventing, or harassing their re-embarkation. In some cases it must also perform police duties to keep the inhabitants in order.

It is clear that the first essential of the reserve is mobility. It must have sufficient transport to be able to operate within a moderate distance, and its artillery must be of a thoroughly mobile character.

Whether the artillery shall consist of field or mountain guns, or of howitzers, or of a combination depends on the local circumstances.

Probably local corps will supply the best officers and men for the guns, because they are unchanged and can be thoroughly taught the ground, and will have some connection with the transport, which must be drawn from local resources in most cases.

It may be said that the requirements laid down for the reserve point to the employment of regular troops.

At first sight the prevention of landing seems to be obviously the first move of the defense, and much stress is always laid on it. The prevention of landing is decidedly the most efficient action of the reserve ; unluckily, owing to the initiative resting entirely with the assailants, it will be so seldom possible, that it cannot be counted on at all. Nevertheless the commandants of fortresses must remember that, as we know from the testimony of experienced naval officers, the fire of a few field guns, or even of rockets, can be very efficacious against a force in boats, and a few lucky shots may bring about a retreat. Trees should be planted, or other measures taken, to afford concealment to the guns engaged in such enterprises from the fire of the ships covering disembarkation.

In exceptional cases the action of the reserve may be supported, especially in the resistance to landings, by heavy or light guns on railway mountings. Arrangements were made at Pretoria, by laying down curved sidings, &c., to take a 6-inch gun so mounted into action against attacks either from the west, north, or east, and it served to fill rather marked gaps in the artillery defense. Emplacements on sidings off the main line must be prepared, and to ensure thorough efficiency the engine drivers and other railway men concerned should be regularly exercised with the gun.

The reserve should have some mounted troops, or at any rate a corps of cyclists, for scouting duties. Local troops will probably be the only ones available.

What we want to establish is, that prepared land defense is essential to the efficiency of coast defenses, and that the efficiency of the land defense depends in the end on the mobility of the reserves of the garrisons, which is chiefly a matter of the mobility of their artillery. The heavy guns of position can replace economically and effectively the fixed armament of land forts, but they cannot be counted as part of the mobile reserve ; and the lighter guns are also deficient in mobility under a system, which leaves their transport to be improvised when the occasion for their use arises. It is not necessary to maintain permament transport for them, but their transport, of whatever nature it is, must be previously registered, organized, and trained as far as it can be. The mobile reserve of a garrison should be as like as possible to a "column" of the field army. Column is a vague term, but the South African war is not so far behind us for it not to be understood, and the local conditions of fortresses vary so much that it serves better than a stricter definition.

An attempt has been made to treat the subject broadly, but attention must be drawn to a few details, although we need not go so far as the medical officer who carefully recorded in the defense scheme for one of our home ports, "the soil in the neighborhood of——— is suitable for interment, so it will be unnecessary to make arrangement for the cremation of the dead."

The stores necessary for the completion of the preparation for defense, such as entrenching tools, barbed wire for obstructions, materials for the destruction of the enemy's communications and for the repair of one's own, rails for the roofs of temporary magazines, &c., should be ready and stored so as to facilitate issue. Those wanted in sections liable to early attack should be in the sections, and where possible in charge of the troops who will have to use them.

A great desideratum in entrenchments is cover for the head and shoulders of the defenders. This is difficult to improvise, now concealment is so necessary, but there can be no difficulty in storing light bullet-proof shields in fortresses near the places where they will be used ; and their possession must give the defense an advantage it is absurd to forego on the score of the initial expense.

Where investment, or interruption of communication with the outside, is possible full arrangements will have to be made to ensure the food of the inhabitants as well as of the garrison. Our civil authorities have so little idea of what war means that it is impossible to leave the matter to them, and even efficient co-operation in previous preparation can scarcely be expected. It is not improbable that the difficulties brought to light by a serious investigation of this problem may make the policy of defending some places, otherwise desirable, doubtful.

The arrangements generally should be such as to entail the minimum of change in routine when passing from peace to war organization.

Whatever may be the nature of the land defenses, it is indispensable that all the plans shall be thoroughly known by every officer, who is responsible for their execution, and tested by peace maneuvers. Without the first condition a large part of the advantage of preparation will be lost ; without the second the preparations will always be defective.

Every officer, who becomes section commander, should be called upon at once to make his remarks on the scheme for his section, stating where he thinks the preparations deficient and what alterations in plans he should feel bound to make when responsible for the defense. Of course frequent changes of commanders are inevitable, but some special arrangements, such as associating an acting staff officer of another corps with the commander, might be made to meet special cases. In order that fortress commanders may be able to meet the views of successive section commanders, the plans in the defense schemes should not be detailed. New buildings, &c., will always necessitate minor changes at more or less frequent intervals. The defense scheme should be the chief business of a staff officer, and the appointments of section commanders and staffs should be kept up-to-date, and published in garrison orders. What is wanted is that the subject of defense shall form one of the routine duties in garrisons.

Practice is absolutely necessary, or impractical arrangements will get into the plans. Entrenchments will be designed for the section garrisons without any provision for the reserve. Buildings, such as schools, will be assigned as quarters for troops, which will not be available before a state of siege is declared, which means in many cases not until the attack is made. Tactical and administrative arrangements will be laid down that must lead to confusion. These examples are not efforts of the imagination, but have been discovered in actual schemes.

Such defects in details may be brought to light by maneuvers carried out by the garrisons themselves, but for the discovery of larger ones in the general scheme, the co-operation of the navy is indispensable.

It may not be necessary to employ ships of war, but troops must be landed from seagoing ships, as that is the only method of securing the uncertainty of the attack, which is a certain factor in the problem to be solved. To begin with we want to know what are the possible landing places and what force it would be possible to land at each. We have no data to guide us, and have to ask naval officers ; not having to prove their opinions, their answers are as a rule most irritatingly vague ; probably they have no data either. If this one question were definitely answered, it is not improbable that much economy would result at several places.

It must be a duty of the navy to carry out disembarkation of troops, and a little practice might lead to the ships destined to be our transports being fitted for this service in some such way as those used by Japan are, which is far in advance of anything we have got. Surely in war the seizure of, or damage to, our enemies' isolated ports would be as obvious a part of our navy's action as it was at the end of the eighteenth and the beginning of the nineteenth centuries? Jane's naval history records over 36 instances of such operations in the 22 years from 1793 to 1815. They cannot be carried out without the use of landed troops.

In conclusion, we submit that it is pure waste of men and money to maintain any coast defenses without an adequate preparation for their land defense.

NEW FORMS OF ARMORED FORTS.*

By VICTOR TILSCHKERT, Colonel in the Austro-Hungarian Army.

Translated from the German† by Major John P. Wisser, Artillery Corps.

III.

The armored turrets, serving keeps or redoubts in the interior of the field and semi-permanent works, also have some fire effect in the direction of the gorge, provided the latter is kept lower than the line of fire of the cupola. Moreover, it is also possible to fire from the two turrets arranged for flanking the gorge ditch over the low gorge into the work, the interior of which is thus commanded by four cupola guns and four casemate guns.

Therefore, as long as the armored turrets within and without such a work are intact it will be impossible for an attacking force to occupy it. It cannot, consequently, be taken, even if it should be without an infantry garrison. The infantry posted therein could, therefore, abandon it in the event of a successful attack, and leave its defense to the armored turrets. Casemate troops should not be permanently stationed in the work, and the temporary garrison should be often relieved to give them better rest in barracks farther to the rear.

In figs. 6, *a*, *b* and *c*, such an infantry work, with two armored turrets in the interior and four in the outer corners, is represented. The cupola guns, with a height of the line of fire of about thirteen feet, fire over the ten-feet high crest into the foreground, and can fire over the six and one-half feet high gorge parapet and the rear portions of the flanks. The entrance lies in a ditch six and one-half feet deep. In front in the ditch at the corners are placed two more turrets, which, with a line of fire ten feet high, fire over the six and one-half feet high glacis into the foreground. They command the front and flank ditches with one casemate gun and the cupola guns.

The ditches of the front and gorge are therefore under the fire of four guns, and each flank ditch under the fire of two guns. In the casemates 4.7-inch rapid-fire howitzers could be placed (Gruson's construction). Since this gun can fire ten shots a minute, and a shrapnel contains 450 bullets, the two howitzers could sweep the ditch with 9,000 bullets in one minute.

* See JOURNAL, January-February, 1904, p. 66.

† Neue Formen der Panzer-Fortification. Von Victor Tilschkert, k. u. k. Oberst. Wien: L. W. Seidel & Sohn. 1902. Price 3 marks (90 cents with postage).

The 4.7-inch howitzers will probably also be placed in the cupolas whenever the terrain conditions will permit of it (diameter of Gruson cupola 7.2 feet).

The gorge turrets are a little to one side of the flank ditch. Against an enemy attacking the work in its front, therefore, six guns in cupolas can be brought into action, and when he arrives on the flanks three cupola guns can still be brought to bear on him, and in the gorge or the interior of the work at least four cupola guns can always fire on him, to which can be added in the interior the fire of four casemate guns.

Without the capture or demolition of the greater part of the armored turrets the earthwork cannot be held by the enemy. Even assuming the destruction of the cupola guns in the inner turrets of the work, the latter will still remain in the hands of the defender as long as the two guns and the machine guns in the casemates of the turrets, or the infantry posted there, remain intact.

In the wide terreplein, or area, other ditches for cover, with temporary bomb-proofs, may be constructed. I would suggest for use in these structures arched pieces of armor, 2 inches thick, about ten feet wide in the clear, covered for temporary shelters with earth to resist the 5 or 6-inch shell, or for permanent shelters with from 3 to 5 feet of concrete to resist the 8 or 10-inch shell. They should be only 10 feet long, so that they can accommodate two rows of men sitting down, or $2 \times 5 = 10$ men, and should be scattered along the front or a middle parapet, and close up against the latter. Ten such bomb-proofs will accommodate 100 men, and when arranged in two rows can be placed sixty feet apart. The attacker can hardly undertake to cover the entire area of 10,760 square yards with shell. If he could be induced to try this it would be a great advantage to the defense, since only a part of the defender's force would be quartered in the iron bomb-proofs, which could, moreover, be deserted in turn as the projectiles struck them. Moreover, forty men can easily be accommodated in the two armored turrets in the interior at any time.

If we assume a garrison of 100 infantry and 150 artillery, 120 of these will find accommodation in the six turrets. Of the other 130 men, 100 can be sheltered in the bomb-proofs at night —since the shell fire will probably cease then—while the rest will be required on outpost and patrol duty. Shelters constructed of wood and corrugated iron can supplement the accommodations in the work, but, of course, will not be used by day, or when there is danger of heavy shell fire. During very heavy fire more men are crowded into the turrets, where they can remain temporarily, and where—leaving the cupolas out of consideration—nearly 2600 square feet of casemate floor space are available, which could hold the entire garrison if necessary.

Isolated armored turrets make possible the construction of comprehensive earthworks, which, on account of their extent, are not subject to a destructive, heavy shell fire, and in which, consequently, scattered temporary bomb-proofs secure against 5 or 6-inch shell, will be the best solution of the question of quarters and shelter for the garrison.

Ditches, which are not revetted, involve but small cost of construction, and, if well swept by gun-fire along their length, constitute a more serious obstacle than wire entanglements not so swept. In order to have such obstructions, which require much material, not too extensive (since the immense amount of wire required may not be obtainable in time of war, or may not be available where it is needed), it has been customary to contract modern works into a very small space, by which, although they possess the advantage of offering a small target to the enemy, they also have the disadvantage of compelling the garrison to move about in too narrow a space in the interior, a circumstance which makes it difficult to avoid shell fire. On the contrary, in an area, or terreplein, 175 yards long, which cannot be taken under fire in all parts at the same time, it is very easy to get out of the way of shell fire. Finally, in the branching ditches to be laid out for protection, the garrison will be as secure as in the *approaches* used in the attack of fortifications, in which, as shown in sieges, the losses are always very small, since only the batteries of position usually suffer from the enemy's fire. Good flanking ditches are, therefore, the simplest and most economical obstacles. But with the isolated armored turrets we attain, besides the flanking of the ditches from their casemates, the sweeping of the foreground from the cupola, from which last, moreover, the ditch can also be swept.

By this use of the armored turrets for the double purpose of commanding the foreground and the ditch, it is also made possible to construct *two* ditches in front of these closed works for their better security against assault, so that the attacker, after passing the first well-swept ditch, in which he will be thrown into confusion, must cross a zone of ground about 66 yards wide, also swept by gun-fire (during which each gun can fire six shots, each machine-gun 300 shots in the half minute of time required to cross this stretch of ground), and after that another ditch swept by guns. It is hardly possible that through all three of these phases, in which accurate and effective flank and in part also cross and reverse fire can be brought to bear on the storming columns of the attack, success will crown the efforts of the latter. But even if he succeeds in penetrating into the interior of the work he will still have to face the fire of the redoubt (or keep) turrets, and of the cupola guns of the gorge side, which fire over the gorge and over a portion of the low flanks. As long as these turrets are not put out of action it will be out of the question to hold the position or its immediate vicinity.

In the siege of Vicksburg in 1863 in the Civil War in the United States, after the failure of the first attack a second was attempted, which was preceded by a bombardment lasting two days. Some 30,000 men, formed in three storming columns, forced their way into the interior of the works, but were unable to maintain themselves there *because the interior was swept by fire from the rear*. The assault cost 3,000 men. After this attempt a regular siege was begun.

The use of turrets, therefore, avoids the difficulties of providing and putting in position the immense quantity of wire heretofore required to furnish the necessary obstacles, because the little required in the limited space around the turrets suffices for all purposes. A work with double ditches requires, without an inner redoubt turret, and when the sweeping of the area or terreplein of the work by means of gorge turrets is preferred, seven armored turrets; and, with a redoubt (or keep) turret, eight or nine such turrets. These will preferably be of the smaller diameter, and hence capable of accommodating twelve men; therefore, the seven turrets will serve to quarter eighty-four men. Even with a length of ditch of 2,200 yards for each work, the cubic contents of which would be 78,500 cubic yards, the labor of removing the earth would cost about $14,400; a small cost compared with that of the eight turrets, which amounts to 8 × $38,000, or about $304,000.

But with a ditch 2,200 yards long it is possible to enclose a rectangle 985 yards long and 115 yards wide, which, with two turrets on each of the longer sides, will protect the emplacements for from fifty to ninety battery guns, making them secure against assault. In this case the ditch encloses 22¼ acres; the works of Antwerp cover from 12 to 17 acres.

The earth from such ditches should be deposited along the near side of the latter, on the front over which the battery guns are to fire, but only so high as to constitute merely a mask for the latter. In case of ground rising towards the interior, sloping say about 1:40, the gun platforms placed 40 yards back would have with a one-yard high parapet, an elevation of two yards over the edge of the ditch. They will, therefore, in many cases be able to overlook the ground across which the attack must take place (about 1000-2200 yards distance), in case there is a parapet of three to five feet high along the ditch, with a glacis three to four feet high in front. They will, moreover, thereby have a good cover or mask, which will render the exact estimation of the distance, or the observation of the effects of fire on the battery gun, very difficult. Behind the above-mentioned parapet (or breast-height) infantry marksmen may be posted, for whom shelter trenches may also be provided.

At the rear ditch the breast-height at the side of the battery can be made ten feet high. This height is also given to the parapet of the front ditch at the two points where the armored turrets are to be placed ; the glacis at the points where the two turrets for flanking the ditch are located is made seven feet high. The two turrets of the rear parapet, which fire over the latter (for which reason only seven feet is allowed here) are placed in the ditch and flank it. To effect this the flank faces of the turrets will not make an angle of 90° with each other, but in the lower tiers will be made perpendicular to the line of the ditch. Their casemate guns in this case also have some action into the foreground, provided the glacis is not over twenty inches high.

The batteries of the defense (from 12 to 22, of 4 pieces each), in the arrangement just described, are located in their own *noyau*.* The variety of plan applicable to this system of fortification by means of isolated turrets, is evidently unlimited, and the different constructions required may all be put off till the outbreak of war, perhaps with the exception of the concrete foundations, which last, however, may also be built after war begins, if need be.

The fortifications in the colonies of a nation can receive the main structures—the turrets—from the mother country, and, when no longer needed, these may be taken down and used elsewhere. In this way the buildings used as Consulates could be protected with a simple, narrow parapet of earth and concrete, and a ditch swept by isolated turrets within and without.

* secondary line of forts in modern system of fortified camps.

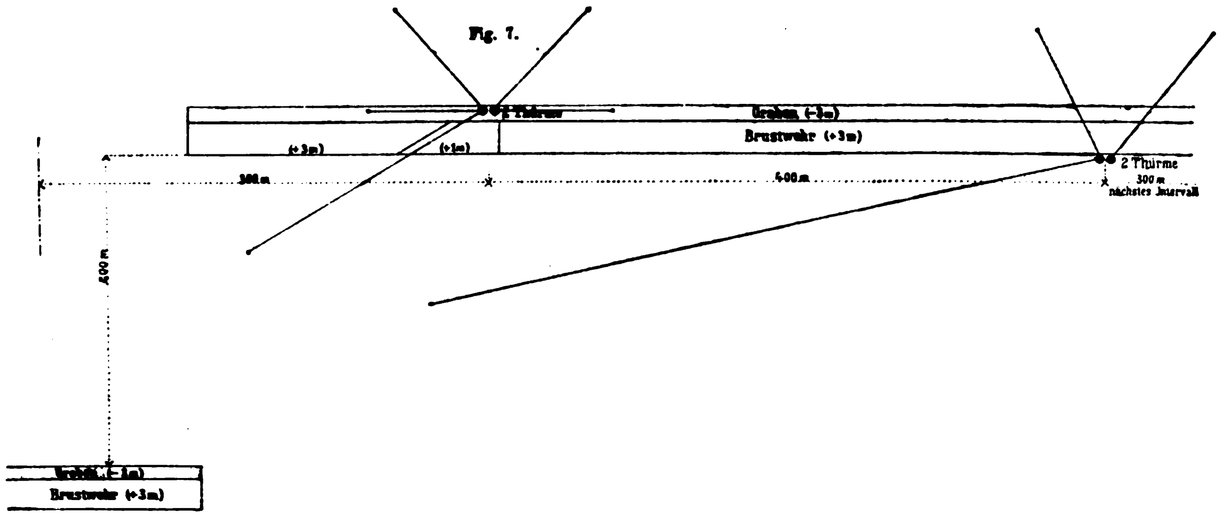
In the preceding, only such strong armored turrets for the points of support were considered as would also resist the action of high explosive shell, and could not be disturbed by them in their armored and concreted foundations. For the fortification of the *noyau*, and for various secondary purposes for which a few armored turrets may be required, such great strength is not required. These may be built in a simpler way, and are therefore cheaper.

In the construction of the *noyau*, consisting of a low parapet about ten feet high, and a ditch ten feet deep, the armored turrets constitute the points of support, and not only have fire-action to the front, but are also designed to flank the long lines of the *noyau*. If they can cover the foreground, the ditch, and even the interior of the parapet in this way, they will add considerably to the strength of the fortification, and will be very effectively utilized.

Fig. 7 shows the plan of a *noyau* of this kind. Straight polygonal sides, about 1100 yards long, are assumed. Where the ends of these sides approach each other they leave an interval of about 220 yards (see fig. 7), for the advance of the reserves, who are to move offensively to the attack and take the enemy in flank. Each polygon side receives four armored turrets, in two groups of two each, so that a *noyau* sixteen miles long will require 96 turrets. With a diameter of girdle of outer works of eight miles and a diameter of *noyau* of five miles, the latter is only one and one-half miles from the former, and can, therefore, as is so much desired by many military authorities in Germany and Austria, directly oppose with its guns any attempt to break through the interval in the line of forts, and, therefore, support the *girdle* points of support in their combat. Even with ten miles' diameter of *girdle*, or two miles' distance between the lines of forts, this is still possible, although not so effectively. At all events, the nearer position of the *noyau* to the *girdle* is a greater security against any attempt to break through, which will hardly be risked by the enemy because so little apt to succeed.

Within this *noyau*, when placed at a proper distance from the edge of the city, convenient room for camp grounds for the troops will be found, and in many towns this space will constitute a last standing place to be defended in a retreat. The enemy who has passed over the parapet of the *noyau* will probably have to face the defender inside without artillery at first,

Fig. 7.



Offensive Interval.

Swept by 4 turret guns, 1 casemate gun 1 casemate machine gun.

Noyau (Second Line) Front.

1 km. long, with 2 gun turrets in the ditch and 2 gun turrets behind the breast height.

and will have a hard struggle to make headway against the latter, who still has his field artillery available.

As long as the outer and inner armored turrets, established in the *noyau* next to the *offensive interval* (220 yards wide) are not put out of action or taken, the artillery of the attack cannot possibly be brought through. Of the four turrets in each front two are in the ditch, 330 yards from the end, and two at equal distances in the interior behind the parapet.

Figs. 8, *a* and *b*, show the arrangement in a ditch ten feet deep,—the profile and plan of a single turret. Two, however, are placed so that one flank lies perpendicular to the line of the ditch; from its casemate the ditch is swept by a rapid-fire gun, on one side for 330 yards, on the other for a distance of 750 yards. Since the attack carries only field guns along in the assault, the lengthening of the weak flank wall towards the front is permissible. The turret can also be given the profile with the armor cornice on the projecting flank. The two turrets can, moreover, be connected by an armored gallery.

The cupola gun fires into the foreground or to one side into the ditch. If the parapet, generally ten feet high, lying behind these turrets, is made for a short distance only three feet high, the cupola gun can also sweep the interior side of the interval, which is therefore covered by the fire of four cupola guns at 330 yards, as well as by the casemate guns of the turret group 750 yards away. Without silencing the turrets, therefore, the attack cannot pass through the interval.

The gun group behind the parapet is arranged as in fig. 9. It commands the foreground with the cupola guns, and the interior of the *noyau* with two casemate guns and two machine guns, thus constituting at the same time the redoubt, or keep, of the *noyau*, from which the enemy advancing against the interior of the city or town to be defended will be taken in rear. The effective flanking of the *noyau* ditch by armored guns permits of dispensing with the almost impossible problem of laying wire entanglements over a distance of sixteen miles. If the *noyau* is standing in time of peace, thorny bushes may be planted in the ditch, behind which one or other of the lines of wire is drawn. (The barbed wire of the British lines of block-houses in South Africa was often sixty-five miles long).

The armor of the foundation can be dispensed with in these turrets, and the concrete foundation can be made lighter. This lighter turret construction can be taken advantage of in all cases where these structures receive application in isolated cases for

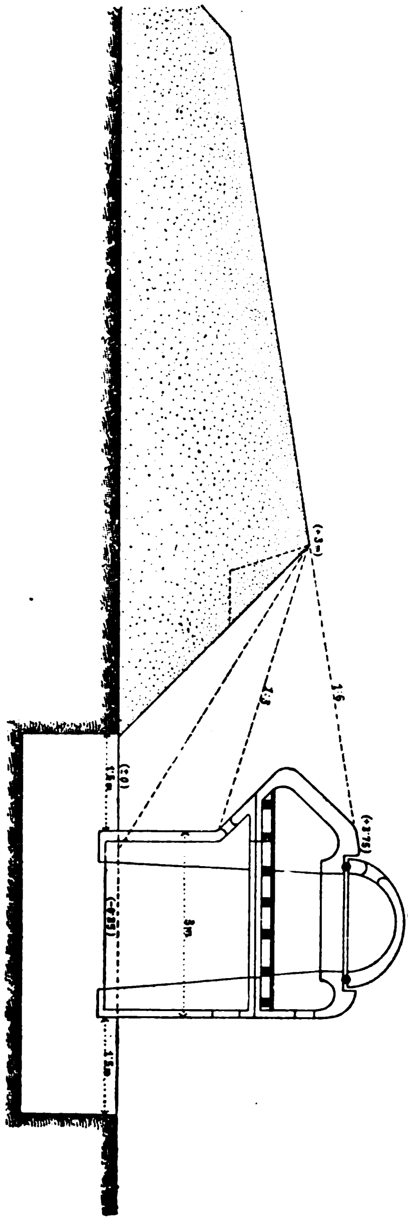


Fig. 9.

Gun Turret behind the Noyau (Second Line) Breast-height.

With 1 gun and 1 machine gun in casemates.

secondary purposes, and where it may be assumed that heavy shell fire (particularly of *high explosive* shell) is not to be feared. For example, they may be scattered over the foreground of the points of support, in order to command with flank fire steep slopes which cannot be reached by direct fire. In these positions they are sunk so deep that their port hole projects only 10 inches, and the embrasure of the cupola only 39 inches, over the 10-inch glacis, and are therefore readily masked. Their small size also admits of their being easily located in favorable positions, even on steep slopes, where the smallest earthwork would not find sufficient room. In mountain forts such armored turrets will greatly facilitate and simplify the plan of defense, since they can be placed squarely across the entire valley to be closed, either singly or in groups, and even on the cliffs and steep slopes, or the small mounds of talus at their foot.

In view of the possible dangerous position which the enemy might take up, the angle of 90° enclosed by the armored sides can be increased to 180°, or the profile all around (360°) may be made like that of the front. In very restricted localities the lower part of the turret, instead of being protected by thick earth parapets, may receive thin concrete walls, which are faced with granite at an inclination of 45° towards the enemy, thus making the expenditure of a large amount of ammunition necessary for their destruction. To economize space, the ditch wall and the interior slope of the glacis, in front of the turret are revetted with stone or concrete. With a width of ditch of 13 feet, 10 feet of concrete wall and 10 feet revetment, the turret will require a space about 50 feet wide, which will not be difficult to find, or to clear off and prepare, even in rocky or mountainous ground.

The above described turret weighs about 198,500 pounds, and costs about $10,800 ; or, set up in place, about $12,000. Consequently, the 96 such turrets, required on a *noyau* 16 miles long, would cost about $1,152,000. A circumvallation railroad of full gauge, over a 16 mile arc (which would certainly require 20 miles of road), in hilly country, would also cost about $1,200,000 ($60,000 per mile). The cost of the fortifications of Josefstadt (a bridge-head over the Danube near Vienna, constructed in the old way) amounted to 4½ or 5 millions, though much smaller in extent.

As regards the details of construction, it may be remarked that each turret is composed of a separate part for each floor, or tier, and each of these, according to its size, is formed of from 2 to 4 pieces. Thus the large type of turret, in its casemate floors or tiers is composed of a front, a rear and two flank pieces, which are fastened together along vertical and horizontal flanges by means of countersunk iron bolts. Since the flanges are about 2 inches thick, the bolts have to be $2 \times 2 + 1 = 5$ inches long. They are made of soft iron and prevented from falling out by flattening out the head. In certain places, to facilitate mounting, screw bolts may be used.

The elements of which the turret is composed, will weigh respectively 33,000, 44,000 and 66,000 pounds. These weights can be readily transported on the 4-truck field-railroad car used in the railways of fortifications.

The time required to remove a turret from the local storehouse of a fortification, transport it to its emplacement and mount it, is about 9 working days. Ten working parties could therefore mount about 20 turrets in 16 days, or 40 in 32 days. Those of lighter construction could be mounted in half the time.

The greater number of the turrets should preferably be mounted in time of peace, and could be used as store-houses, or magazines, instead of requiring storage room themselves. But a certain number should always be held in reserve in the store-houses.

In order not to make known the system of fortification of a place in time of peace by placing the turrets in position, and thus exposing them to the view of every passer-by on the roads near the fortification, it will be best to store the armor plates in depôts near the emplacements, and to lay only the concrete foundations, hiding them afterwards from view by covering them with earth ; the mounting of the turrets can be begun in the period when war seems inevitable. Such critical periods, often lasting for months, will suffice for erecting the turrets, and the latter, when no longer required, in order not to expose them to observation for years can be dismounted again.

If each point of support has two walking cranes at the emplacement and one at the depôt, the 14 turrets can be set up in 42 days. But since the men of the detachments mounting the turrets gradually improve by experience, the mounting of each successive turret will require a shorter time, and in all probability 21 days will suffice for a point of support.

In the *noyau*, where the turrets are not so much needed, their erection can be postponed till war is inevitable.

If the erection of all the turrets in the entire fortification is dispensed with in time of peace, only the ditches, parapets (breast-heights) and concrete foundations remain to be constructed at once.

With a *noyau* parapet 16 miles long, and $22 \times 14 = 308$ yards parapet for each point of support, or, in case of extensive entrenchments with double ditches, a length of ditch of 1 mile for each point of support, the 12 points of support would require the construction of 12 miles of ditch, or the entire fortification $12 + 16 = 28$ miles, involving the removal of a volume of earth equal to 1,648,000 cubic yards, the cost of which would be about $240,000. The $14 \times 12 + 4 \times 24 = 264$ armored turrets require about $264 \times 800 =$ $211,200 worth of concrete foundation. The complete work will therefore cost about $450,000, which would represent the loss in case the fortification is abandoned.

Herein, in my opinion, lies the principal advantage of dismountable iron turrets, secure against direct assault. They permit of the timely circumvallation of cities and towns without preventing the development and growth of the latter, as do the present *fixed* fortification fronts, which, having cost millions, are not willingly given up in order to extend the enceinte which may have become too contracted in the meantime.

Take the fortifications of Magdeburg, for example, where, in the late seventies, enormous polygonal fronts, with caponieres, cavaliers and one-story casemates for quarters and shelter, were laid out far beyond the old city limits, and room was left for the railroad freight station ; nevertheless, within ten years the city, which had rapidly grown and developed, began to feel too confined in its fortifications. And so it has been with many a fortified city.

In using the dismountable armored turrets it is only necessary gradually to move the parapet farther out as may become necessary, here and there, the new buildings erected being made to pay the cost of the newly constructed parapet. If the turrets are in position they are dismounted and carried to their new positions.

Changes in artillery material, involving the removal of the forts to other emplacements, cause no great inconvenience since it is only necessary to carry the turrets of the points of supports to the new emplacements, where the earth and concrete work has to be reconstructed, but this will not involve any appreciable cost. In the same way, changing views in regard to the position and scope of fortifications will not necessarily affect the state treasury.

Von der Goltz expresses himself thus in regard to the mobile fortification system of Schumann, with transportable armored turrets, which, however, are not as strong nor as secure against assault as those proposed by me:

"By this means we are able to remove from fortifications their one great weakness, namely, that, after being constructed at enormous cost, and garrisoned with an army, they are after all not where we want them in time of war. It is remarked with justice, to be sure, that the places of strategic importance can be determined beforehand; but their number is so great that they cannot all be considered. Moreover, the fortune of war has many remarkable surprises, and often confers on seemingly insignificant places a high significance. What would the French in 1870 not have given if Orléans had been an intrenched camp, secure against assault or capable of being rendered so in a short time!"

Schumann's turrets will probably serve to supplement and complete the system of points of support formed of *armored turrets* secure against assault.

As regards the resisting power of the armored turrets, it must be remembered that, as shown above, even small armored cupolas of hardened cast-iron, or even of ordinary iron, can withstand a very great number of impacts, close together, from 6-inch steel shot and shell striking normally; that the visible portion (the cylindrical part) of the armored turret, the profile of which is quite as advantageous, but which is much more massive, has the same resisting power; and that a breaching of the armor that is not visible (the lowest portion of the turret) and only attainable under a considerable angle, is entirely out of the question. The *new* hardened cast-iron, however, has a far higher resisting power. At all events these turrets have greater resistance than those of Schumann on the Sereth lines (in Rumania).

If the armor plates with 10 to 8 inches thickness in the upper, inclined portion, 6 inches in the lower, vertical parts in front, and 4 inches on the flanks and rear, are not deemed sufficiently strong, these dimensions can be increased, say 50 per cent, giving 15, 12, 9 and 6 inches, respectively, when the armor will certainly have nothing to fear, and will still be reasonable in price. It will probably be sufficient to effect this strengthening in the front only, and on the middle 60° sector, hence over ⅔ of the surface.

It is probable that the peculiar form of the isolated turrets will appear strange to the conservative engineer, nay, even fantastical. This impression could, no doubt, have been avoided, had I put a parapet in front of the turrets and on their sides, instead of taking it away from them. But the construction with earth piled up around the turrets has many disadvantages, because it deprives the separate turrets of their independent security against assault, which would have to be attained by other means; for example, by surrounding them with obstacles, which again would require a closer grouping of the turrets in order to reduce the cost of the obstacles; whereas, according to my projects, they can be scattered like skirmishers over the favorable points in the terrain in concealed positions difficult to recognize.

In this scattering of the armored guns the system resembles that of Lieutenant-General Sauer, who characterizes it as follows:

"In the same way as the fort resembles the old infantry square, the *girdle* of turrets resembles the line of skirmishers; the 1,000 men enclosed in the fortified square or fort are here simply divided into so many single, but very small targets, difficult to hit. The same idea is in the modern custom of occupying the skirmish line with defensive batteries, which offer the enemy no greater target than his own. In the *girdle* of turrets this is not only similar, but there is also the additional advantage that the target offered by the attack is far more vulnerable than that of the defense, a fact which appears to solve one of the problems usually set for the art of fortification. If the turret target can be made small in every sense and sufficiently screened from observation, while its cupola, moreover, is so constructed that flat trajectory as well as high-angle shots against it do not promise any favorable effect, the taking of the *girdle* of turrets will cost the attack far harder work than the silencing of the second gun position of an intermediate line."

In the turrets proposed by me, which are to be arranged in groups of at least two, there are two long-range and four medium-range guns, hence six combined; whereas Sauer has but two guns in an isolated turret. Freeing the turret of the earth-mound around it gives it not only the important quality of security against assault, but also confers greater resisting power against high-explosive shell, which break up sooner on the free armor, glance off more easily, and find no tamping for the gases of explosion.

Long before Sauer, both Montalembert and Archduke Maximilian (at Linz) had suggested a system of fortification with isolated turrets, but they were not able to give them the necessary resisting power with stonework, the only material then in use. The use of iron enables us to vivify these old ideas, as has been attempted in the mode of construction above described.

Perhaps I may succeed as well in my proposition to bring about the construction of simple iron, movable points of support for fortifications, as I did in 1886 in Austria in the introduction of cast-iron as an excellent armor material for fortifications, which led to the general use of armor for this purpose. Armor, according to my construction, made of cast-iron or of American face-hardened, cast-iron, will by competition of many iron works probably become very cheap, and thus its use in fortification will soon become more extended.

The forms proposed are by no means final; but like everything new can only be brought to the the shape conforming best to the requirements of the use of the turret and its resisting power by extended experiments.

My work is nothing more than an embodiment of the ideas of the celebrated artillery general, von Sauer.

THE EMPLOYMENT OF R. F. ARTILLERY IN THE FIELD.*

By Captain C. HOLMES WILSON, R. F. A.

The adoption of rapid-fire guns of necessity entails some alteration in the details of the existing drill. These guns have been adopted abroad ; they have not, however, been issued to our own army yet. As, however, it is likely that our artillery will soon be rearmed, the following general remarks may possibly be of interest to those who have not already studied the subject for themselves.

FIRE EFFECT.

The special characteristic of the rapid-fire gun is, of course, the rapidity of its fire. The rate of fire has been increased, but the character of the effect so produced has not been changed. It happens that the adoption of rapid-fire guns coincides with a period in which there have been general modifications in the tactics of all arms. The changes so produced cannot, however, be mixed up with those necessitated by the employment of these guns. It is clear that, though the rate of fire of the gun has been increased, its power has only been added to in regard to the special areas with which it may have to deal. The increase in the rate of fire makes it possible for a battery to produce a greater effect against a given target than it formerly did. It does not, however, make it possible for this effect to be transferred to another target that is at a totally different part of the field of battle. It is true, of course, that it may be possible for one battery, armed with the new gun, to produce as great an effect as, say, two armed with the old gun, and that one may thus be set free to act elsewhere. On the other hand, presuming the conditions to be dealt with to be constant, if we adopt such a line of reasoning we shall be asking one of the new batteries to do what was formerly expected of two of the old. There would then be no increase of power !

Various theories have been adduced as to why rapid-fire guns should be more powerful than ordinary guns. For instance, it is said that a great effect may be produced in a short time. The truth of such a statement must, however, largely depend on the nature of the object shot at. It would be an easy matter to draw

*United Service Magazine, May, 1904.

up a system to deal with fixed conditions; unfortunately, however, it is the conditions to be dealt with, and not the systems dealing with them, that vary, consequently we must be ready to adopt ourselves to circumstances. Does such an adaptation, however, mean the adoption of a system in which more is to be thought of covering an area in which an enemy may appear, than of hitting the enemy when he does appear?

Systems are too frequently considered from the point of view of the firer without due consideration being paid to the feelings of the object fired on. It is true that demoralization may be produced by sudden and effective action, and that sudden and effective action may be secured by a surprise. To effect a surprise, however, (1) the range must be known, or (2) the batteries must range rapidly. This at once raises the question of rapidity as opposed to accuracy. If the range is known, a rapid fire can be opened at once. If, however, the range is not known, a long bracket must be used, and if a long bracket is used, effect can only be looked for through distribution. It has been said that distribution for depth was attempted through the use of the ricochet of the shot in the days of smooth-bore guns. The greater precision of modern weapons then led to an attempt to gain effect by accuracy.

The French have now adopted systems in which they seek effect through distribution. Cases will, of course, arise in which systems embodying distribution must be used. On the other hand, if it were always possible to open direct fire, at once, on any part of the field, there would be no need for distribution. The enemy could be followed by an overwhelming fire, the effects of which would be greater than those produced by any *rafale*. This would, however, necessitate rapid and accurate ranging, and the constant alteration of the range when found. If this were feasible we should then have what we may call a "direct-firing *rafale*." I believe it to be possible, but as the questions involved are intricate, I shall discuss them in detail later.

The power of the rapid-fire gun lies in the rapidity of its fire and the fact that it can deal with any situation quickly. If, however, the gun is placed behind hills and cannot be used without the manipulation of various instruments, a large proportion of this power will be lost. Consequently, excepting certain circumstances in which an observing station must be used, everything should be sacrificed to the possibility that may occur at any moment of having to open a direct fire over the sights on any part of the field. Such a procedure cannot possibly involve any risk. Shields have been fitted to the guns to protect the detachments.* Thus as far as safety is concerned, the guns may be placed near the crest. From such a position they can be run forward when the moment for decisive action arrives. Whereas if they are at the bottom of a slope they must adopt indirect laying and distribution, by which no effect may be secured, whilst a large proportion of the ammunition fired must be wasted.

There are, however, occasions on which other methods must be used. For instance, speaking generally, it is clear that the best fire is that which produces the maximum of effect in the minimum of time. Arguing on this assumption, there is a growing tendency to seek results through sudden bursts of a rapid fire. The points in favor of this procedure appear to be these—

1. The opportunities offered for obtaining decisive results will be few and far between.

2. If they are to be made the most of, they must be dealt with rapidly.

We have already said that when the range is not known the best means of doing this is by using a long bracket, and distributing for length and breadth within the limits of the bracket so found. The question as to whether the same procedure should be adopted when the range is known has already been discussed.

It is, however, evident that most of the foreign systems have been framed with a view to firing on moving objects. Again, it is clear that as far as standing targets are concerned, there will be little difference in the method of dealing with them, except in regard to effecting a surprise or attempting to obtain great results in a short time. Thus, though we need not adopt the French regulations in their entirety, some change will soon be necessary. Then, again, there are other points at issue; thus, though the advantages of a direct fire are great, it may, in certain cases, be undesirable to place the guns too near the crest. In addition to this, if a surprise is to be effected, the guns must evidently be concealed. If such cases the only means of dealing with an area that the enemy is likely to cross, will be to cover it with a storm of shells. To do this some method embodying distribution must be used. Then, again, woods or cover can only be searched by distributing the fire over the area where the enemy is supposed to be. In all cases, however, the greatest effect will be produced by opening a carefully prepared

* Unless the protection thus afforded is likely to prove effective, there can be no object in adding to the weight behind the teams.—C. H. W.

fire suddenly. Consequently, to sum up, a long bracket and distribution will be required—

1. When ranging rapidly.
2. When, with a view to effecting a surprise, it is not found practicable to lay over the sights.
3. When the guns are too far down the crest to be run up on an emergency.
4. When searching woods or cover.
5. When for any reason it is not desired to expose the guns.
6. When observation is difficult.

To do this it may be necessary to keep batteries in observation of areas. It is, however, evident that there will be few modifications in many of the systems already in use. It would be foolish to attempt to lay down rules to deal with every emergency that may occur. Given a few general principles, the officers on the spot must be left to deal with the situation as they think best. Thus rules must only be looked on as a guide, or there will be a return to the red tape, from which all are so anxious to be free.

CONCENTRATION.

No regulations can deal adequately with every situation that is likely to occur in war. The tendency of the age is to decentralise responsibility. When a great battle is likely to become a series of small actions, it is impossible to say that the artillery should do this or that when the front involved may be a matter of several miles. The adoption of rapid-fire guns and the extension of the line of battle has, however, led to a cry for the dispersion of the artillery. As we have already said, the increase in the rapidity of the fire of the gun cannot be made an excuse for the distribution of its fire over an area on which it cannot possibly have any increased effect. The fact that it has become necessary to extend the infantry over a wide front cannot be made an excuse for a similar distribution of the artillery. Such action presumes the adoption of a semi-defensive attitude. In fact, it differs from the pure defensive only in this. The commander of the force that has distributed his troops and scattered his artillery is uncertain of his own intentions, and can only hope to win the action by a counter-attack. Such an attack must be supported by a mass of guns, and unless a reserve artillery has been formed, there will be no guns to support it. Then, if we recommend the scattering of our guns where we know that the enemy may concentrate his, we expose them to the risk of being beaten in detail. It may, of course, be necessary to hold one portion of a long line, whilst the remainder is pushed forward to make a decisive attack; under no other circumstances, however, should preparations be made for the adoption of a purely defensive attitude, such as dispersion infers.

The general points at issue, however, appear to be as follows:

1. The rate of fire of the gun has been increased.

2. The nature of the fire, however, remains the same.

3. Consequently the means of its application cannot be changed.

That is, if we wish to produce a decisive effect we must aim at obtaining a concentration of fire. Is this primary principle then at variance with the dispersion of the guns? In the eighteenth century battalion guns were used in the intervals between brigades. The artillery so employed produced no effect, because, on account of the the short range of its guns, its fire could not be concentrated on any particular part of the field. Now the range of the gun has been increased, and the line of battle has been extended. The extension of the fighting line has, however, increased out of all proportion to the range of the gun.

Consequently the conditions remain the same. The following conclusions may thus be reached:

1. The degree of dispersion must depend on the nature of the ground.

2. The artillery must, however, retain the power of concentrating its fire on a given spot for the decisive attack, and no cry for dispersion should interfere with this.

However strong or however long a line may be, it is bound to be broken at the spot against which the enemy concentrates a superiority of fire. If the artillery is scattered along this line it will run the risk of being destroyed in detail.

It may be argued that the concentration of the artillery will leave the other arms without guns, and that they will run the risk of being overwhelmed. This is undoubtedly true, but the danger would be the same, if not greater, if the guns were scattered. Speaking generally, any force adopting a semi-defensive attitude must run such risks. A battle can only be won by offensive action, and in this action the mass of artillery, or a greater portion of it, must be concentrated for the decisive attack. In these days an attack cannot be developed hurriedly, the force attacked has, consequently, timely warning of what to expect, and the guns can be moved under cover to concealed positions near threatened points. To take up positions from which enfilade fire can be brought to bear on the enemy is, of course, most desirable. But this will evidently not always be possible, especially when the line is one of great length.

CONCEALMENT.

Definite results can only be secured by decisive action, and this action may frequently be accompanied by a great loss of life. Consequently, as far as cover is concerned, it should only be used when it confers an advantage on those using it in regard to the main object in view, viz., the annihilation of the enemy. It is, however, of course true that the adoption of some form of protection may prove the surest road to success. Before the adoption of rapid-fire guns and shields, batteries sought protection by hiding behind the folds of the ground. With the use of rapid-fire guns, fitted with shields, cover will be used as a means of concealment with a view to effecting a surprise; the protection will be given by the shields. In this connection we must, however, recollect that the shield will not protect all the *personnel*, and that it will be necessary to find a place of safety for the teams, etc. The rapid rate of fire of the gun makes it possible for artillery to attempt a surprise. If batteries are to effect a surprise, a certain amount of concealment must, however, be presumed. The necessity for this concealment is accentuated by the fact that it will be impossible for artillery to come into action in the open, in the presence of guns already in position. Consequently, the use of cover has a twofold advantage in the earlier stages of the fight. It has been rightly said that this phase of the action may be divided into two periods, both critical, namely :

1. The period during which the guns are unlimbering and coming into action, and

2. The time intervening between the moment at which the first shell is fired and that at which an effective fire is established.

It is evident that the risk attending the first period can be decreased, if not removed, by concealment, whilst in the second the risk may be diminished, though not removed.

The principal question involved is, however, where should the guns be placed? It is clear that if they are to be concealed they must be behind the crest. Are they, however, to be in a position from which the target can be seen over the sights, or are they to be so far down the slope as to necessitate the use of an observing party? There are three points to be considered.

1. A moving target can only be dealt with by direct fire.

2. It may, consequently, be necessary to push the guns on to the crest line at any stage of the fight, to repulse a counter-attack. If this means moving them a great distance it will involve considerable risk and a great loss of power.

3. If changes of target are to be made, the danger angle must be observed, the line must consequently be preserved, which will mean that some guns will be exposed more than others.

The question consequently resolves itself into this—

1. The guns must go forward to the crest at the decisive stages of the action. Thus the nearer they are to it the more readily will they be moved.

2. How are they to be brought into action?

3. At the present time we have no rapid means of effecting a change of target from concealed positions.

By the use of the reverse slope we must presume that the guns will ascend an incline. It is thus evident that the position most easily occupied will be that in which a man on a horse cannot be seen from the target. Such a position will, however, usually be found some distance behind the crest, and from it a rapid change of target will be difficult, if not impossible. This difficulty is said to have been solved in France by the use of the *collimator*. If such is the case, this will probably become the normal position for guns when concealed.

Much will, however, depend on the nature of the ground. As the power of the gun depends on the rapidity of its fire, its use must be as direct as possible. Too much emphasis cannot be laid on this. Consequently the choice of positions involving the use of observing parties should be avoided. Then, again, it is very unlikely that ground will be found which will afford facilities for concealment to both sides, and give an observing station to each.

In the future, the risks run by the *personnel* will be minimised by the use of shields. For instance, the French system with caissons up, taken in conjunction with the shields, forms a small fortress for the detachments, and largely eliminates all need for seeking other cover, beyond that necessary on coming into action. In fact, this method of employing the caissons may be said to be the direct outcome of the use of shields. The shields protect the detachments, but they would not protect the numbers that had to supply the ammunition from the caissons, if the latter were placed in rear of the guns. This difficulty is, however, overcome by placing the caisson which is bullet-proof alongside the gun. That the necessity of having a large supply of ammunition with the guns, is also recognised in principle by the Germans, will be seen from the following. In paragraph 357 of their regulations we read: "In preparing positions a most extensive use is to be made of earth cover. . . . It is of the greatest importance to place a large supply of ammunition in readiness in the immediate vicinity of the guns." Thus the strength of the position is increased through the use of cover, and the supply of ammunition is facilitated by previous preparation. The guns then practically form a small redoubt, and have sufficient shells at hand to produce a decisive effect. By the time that this reserve of ammunition has been expended, the batteries will either have secured some great advantage that will facilitate the bringing up of further supplies, or they will have suffered so heavily that it will be a question as to whether it would be wise to reinforce them by giving them more ammunition. If, then, for "earth cover" we substitute the shields and caissons as used by the French, we have the system, in its simplest form, available for use in either the attack or the defense. It is, however, evident that the details must depend on the nature of the equipment used.

EMPLOYMENT OF ARTILLERY FIRE.*

Résumé of Articles Published in the "Revue d' Artillerie" from June, 1899, to March, 1900, by Colonel Percin.

Translated by Captain ERNEST HINDS, Artillery Corps, for the Second Division, General Staff, U. S. A.

OBJECT OF THIS ARTICLE.

In this article are summed up the ten articles published in the Revue d'Artillerie from June, 1899, to March, 1900. Begun under the title of "Distribution of Artillery Fire," this study has gradually led the author to touch upon the different questions relating to the preparation for fire, the reconnaissance and occupation of positions, the supervision of the battlefield; in short, everything that pertains to *the employment of artillery fire.*

CHAPTER I.

DISTRIBUTION OF FIRE.

Individual fire and collective fire.—For the distribution of fire artillery may employ two different methods, both prescribed in the regulations; there was lacking only a name to differentiate them.

In individual fire, the objective is cut up into as many parts as

* Emploi des feux de l'artillerie. Second edition. Berger-Levrault et Cie. Paris, 1901.

In view of the early issue of the new rapid-fire gun to our field artillery this article is believed to be of great value and interest to artillery officers, because it gives an elaboration of the latest French system of artillery fire instruction. Inasmuch as the French have been working upon their system for a number of years, and our own gun and sighting apparatus are very similar in principle, it will, doubtless, serve as a model for us; or, at least, we may profit largely by their experience.

General Rohne in his recent book, "Die französische Feldartillerie," refers frequently to Colonel Percin, saying that many of the principles of the French field artillery drill regulations were adopted without change from Percin's work. In fact, he refers to those two eminent French artillery officers, Generals Langlois and Percin, as the authors of the new artillery methods.

It is understood that our methods are to follow the French quite closely so that this article may be of benefit in starting field artillery officers to thinking along these lines.—Ed.

there are guns; each pointer notes the part of the objective that is assigned to him, and directs the fire of his piece upon the desired part of his particular target.

In collective fire, the pointer receives from the chief of piece only the indication of the aiming point and the deflection allowance. The elements of fire are the deflection allowance of the right piece, and the deflection difference. From these two elements each one deduces the deflection allowance for his piece, according to the position he occupies in the battery.* Whether these two elements be determined correctly or incorrectly the four shots of a salvo form in any case a group whose points of burst are equi-distant from each other. If one of them be out of its proper place in the group, the chief of that platoon verifies the deflection allowance, the aiming point, the inclination of the piece, etc.; he orders, if necessary, the correction required to bring the point of burst, not in front of the particular target for that piece, but to the place it should occupy in the group. In this manner must be interpreted that requirement of the regulations by which the chief of platoon is charged with regulating the fire of his platoon in direction.

It is for the captain to determine whether the group of bursts is too far to the right or left, too far apart or too close together; he orders such changes in the deflection allowance of the right piece, and in the deflection difference as he deems necessary. In his hands the battery is a sort of spray of fire which he controls, and whose movements and size he regulates with more or less mathematical precision. In short, he is in complete control of his fire; whereas, when a portion of the target is assigned to each gun, he is obliged to place the laying in direction in the hands of the pointers.

Individual fire is clearly indicated in the case of a target plainly visible, whose extremities are sharply defined; for example: the wall of a park, the edge of a wood or village, the front of a body of troops near at hand. This kind of fire will be employed in the decisive phases of the struggle.

Collective fire is to be used whenever the target is not clearly visible. The necessity for its use lies in the difficulty, sometimes the impossibility even, of designating such an objective, of dividing it into parts, of pointing out to each gunner the portion assigned to him, of requiring the latter to find again his own portion after each shot.

* The French F. A. Regulations of 1903 prescribe that the chiefs of platoon do this.—TRANSLATOR.

This assignment of a target by portions was an easy matter when the fighting was done at a few hundred yards, when the targets were very plainly seen, when the opposing pieces could be readily recognized. It has become very difficult with the great increase in ranges, more difficult still with masked fire, almost impossible with smokeless powder; quite impossible with intermittent fire. Whoever has seen the firing of a battery whose presence is revealed only by intermittent flashes must admit that against such a target collective fire alone is practicable.

Choice of an aiming point.—It is not sufficient that the aiming point be more clearly visible than the target; it is necessary that it be one of the most plainly visible points on the field of battle; that its designation may be made in a few words, and be understood without hesitation; that the pointer may find it again readily after each shot. For example, a church steeple, however plainly visible, is not suitable if there is near it another steeple with which it may be confused; whereas, a less prominent object, such as a house or an isolated tree, would be an excellent aiming point if it is the only object of its kind.

If to these various conditions is added also one that the aiming point be found in the vicinity of the target, the chances are that many times a satisfactory one will not be found. Methods of collective fire should therefore permit the utilization of aiming points situated at a distance and in any direction whatever from the battery, in front, on either flank, or in rear.

Calculation of deflection allowances.—Let us suppose that the pieces of a battery have been laid upon a common point of the target, for example, its right extremity; and that the collimators are then directed upon a common point of aim. If now the deflection readings of the collimators* be noted, it will be found that the deflections form an arithmetical progression whose common difference depends upon the distance to the target, the distance to the aiming point, and the interval (supposed to be regular) between the pieces. The common difference of this progression is the *deflection difference for converging fire.*†

* See Journal U. S. Artillery for March-April, 1903, p. 165.

† In the official documents which have recently appeared that which we have designated in this work under the name *deflection difference for converging fire* is called *correction for convergence.*

This new term is shorter, and will simplify the language. For example, it will be said that if the observer is situated *n* platoon fronts on the right of the piece, the measured deflection allowance must be increased by *n* corrections for convergence.

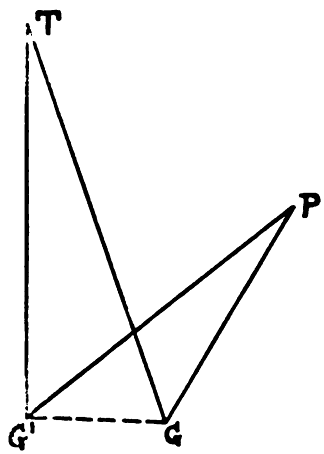
The word *correction*, moreover, seems more appropriate to an element whose object is to correct, whether it be the deflection allowance of the right piece, or the deflection difference. It is preferable to *complementary* deflec-

To distribute the fire over the whole front of the target, the deflection difference for converging fire must be increased by the quotient obtained by dividing the width of the target expressed in *millièmes** by the number of pieces. This quotient is called the *apparent deflection difference.*

The true deflection allowance is therefore the sum of the apparent deflection difference and that for converging fire.

Without designating it by this name, the regulations give a method of determining experimentally the deflection difference for converging fire. After having measured by direct sighting the deflection of the right piece, the deflection for the second piece is measured in like manner. The excess, positive or negative, of the second deflection over the first is the deflection difference for converging fire.

This method presupposes that there exists in the objective a point sufficiently visible, so that it may be kept in sight while moving from the position of the first piece to that of the second. This is easy for the wooden targets used on the target range. It is very difficult for a masked target, almost impossible in the case of artillery whose presence is revealed only by intermittent flashes, wholly impossible if the objective has not yet appeared, which constitutes the problem for artillery in a position of observation (*position de surveillance*). Another method is therefore necessary; it is here that the idea of parallax presents itself.



Theory of parallax.—The parallax of a point is the angle, expressed in *millièmes,* which the front of a platoon would subtend at the point in question. This defined, let us consider two pieces, G and G,' converging upon a target—T, and let P be an aiming point situated at a distance, and in quite a different direction. The following relation exists between the angles: $G+P=G'+T$, from which we have: $G'-G=P-T$. The first member of the latter equation is the excess of the deflection of the left piece over

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tion difference, which is sometimes employed, because this word carries with it the idea of an addition; whereas, the correction for convergence may be positive or negative.

But the term *deflection difference for converging fire* has its merits. It calls to mind a characteristic property of the correction for convergence. Nothing need prevent the use of either one or the other, according to circumstances.

* See Journal U. S. Artillery for March-April, 1903, p. 164.

that of the right ; it is the deflection difference for converging fire. The second member is the excess of the aiming point over that of the target. From which we have the following formula :

The deflection difference for converging fire is the excess, positive or negative, of the parallax of the aiming point over that of the target.

This formula is general on condition that the angles be measured in the same direction as the pointing apparatus is graduated,* and that the minus sign be given to the parallax of points situated in rear of the line joining the guns.

Calculation of parallax.—If the point is situated in a direction normal to the front, or approximately so, its parallax is obtained by dividing the width of the front of the platoon (normal interval 16 meters) by the distance to the point in question. This is a problem which one must be able to solve on the ground, to the nearest unit, without paper or pencil, by a mental calculation. For example, the parallax of a point 1800 meters distant is 16 divided by 1800, equivalent approximately to 18 divided by 2000, or 9 *millièmes.* After a few exercises, the parallaxes corresponding to the principal distances used are known by heart.

If the point whose parallax is to be determined is situated in a direction not approximately normal to the front, a correction must be applied to the quotient obtained as above. This correction will be given later.

Concrete signification of parallax.—Let us suppose that the pieces have been laid for parallel fire by the regulation method, and then registered † upon the aiming point P ; the point T in this case being at an infinite distance its parallax is zero. The deflection difference is then equal to the parallax of the aiming point. [T in the formula becoming equal to zero.—Tr.] So the parallax of the aiming point is the deflection difference for parallel fire. It is the deflection difference for a battery beating a front to its own ; it is the deflection difference which would be adopted by one battery opposed to another.

In his work upon "Field Artillery in Co-operation with the other Arms," General Langlois in 1892 wrote as follows: "Objectives in war have quite often a front equal to that of the battery ; consequently, if, by any method whatever, all the pieces be laid parallel to each other, the battery will sweep at all distances a

*See Journal U. S. Artillery for March-April, 1903, p. 170.

† The French "collimator" is used for laying in direction only. The French "repérer" (nearest English equivalent is "to register") means to refer the laying of the gun to an auxiliary aiming point, noting the deflection, as shown by the collimator reading, and the elevation as given by the quadrant.—TRANSLATOR.

front equal to its own. Let us lay down, then, as a desideratum, the adoption of a simple instrument which will premit the guns to be placed parallel to each other. Several propositions have been made already ; the solution is not doubtful when we shall have the *fixed determination* to find it."

The solution is now found ; it consists in the calculation of the parallax, and the instrument by which it is done is the goniometer graduated in *millièmes*.* The introduction of the *millième* into angular measurements for artillery will permit us to obtain in a few seconds, parallelism of the pieces, the accomplishment of which requires several minutes by the ordinary method.

Applications of the deflection difference for converging fire.—The theory of the deflection difference for converging fire affords a solution for all problems dependent upon the following :

One piece being laid upon a given target, to lay another for converging fire upon the same target.

The solution consists in increasing the deflection allowance of the first piece by as many times the deflection difference for converging fire as there are platoon fronts between the first piece and the second.

It may happen that the losses suffered by a battery having forced the personnel to take shelter, and to cease its fire, the neighboring battery on the left receives orders to take the place of the former. This substitution will take a long time if the battery commander is compelled to calculate anew the elements of fire ; but it is sufficient for him to adopt the deflection allowances of the battery on the right, increased by five times the deflection difference for converging fire, because there exists between corresponding pieces in the two batteries an interval of five platoon fronts.

Several batteries of the same group may have to distribute their fire over a continuous front. In such case it is not necessary for each captain to calculate the deflection allowances; it is sufficient that this calculation be made by the commander of the group, or by the captain of the battery on the right. The individual calculation of the deflection allowances would require, moreover, a previous subdivision of the target, and assignments of portions to the separate batteries, which is generally very difficult.

* A *millième* is 1/6400 of the circumference=1/1600 of the quadrant=very nearly 1/1000 of the radius. See Journal of the U. S. Artillery for March-April, 1903, p. 164. To be exactly 1/1000 of the radius, the number of graduations in the entire circumference should be $2\pi \times 1000 = 6283$, instead of 6400 ; but the error is only 1.8 per cent., which is negligible ; and the graduation into 1600 parts per quadrant is much more convenient.—TRANSLATOR.

The deflection allowance of the right piece, and the deflection difference having been determined as if the pieces formed a single battery, the captain of the second battery takes the deflection allowances which are next in series to those of the right battery, and augments them by one deflection difference for converging fire, because there exists an interval of one platoon front between the position of each piece, and that which it would occupy if the series were continuous. The increase would be *n* times this difference if there were an interval between the two batteries sufficient for *n* pieces to be placed therein at regulation intervals.

An analogous calculation would enable us to allow for irregularities in the intervals between pieces in the same battery; to modify, for example, the distribution of the fire of a battery of which one piece has been put out of action.

One of the most curious applications of the theory of deflection difference for converging fire is in the determination of the distances to prominent points. It will occur, indeed, quite often that we may use a point in the field the distance to which is known from the map or otherwise. In order to determine the distance to another point, we will consider one as a target, the other as an aiming point, and by moving a few platoon fronts to the right or left we may determine experimentally the deflection difference for converging fire. The amount of this deflection difference is the difference between two parallaxes, one of which is known; the other may then be deduced, from which the corresponding distance becomes known. In short, the theory of deflection difference for converging fire is extremely fertile in applications of all sorts.

Answers to some objections.—There will be attached to the word *parallax* its scientific meaning, which is scarcely admissible on the field of battle. We have found no name more satisfactory. To express the same idea a circumlocution would be necessary. In place of saying "the parallax of the point A," it would be necessary to say "the deflection difference for parallel fire corresponding to the point A taken as an aiming point." The word parallax is moreover more more appalling than the thing itself.

When we say to a non-commissioned officer: "Your piece is firing at 2300 meters; move the shot to the left 16 m." He should answer imperturbably, without taking paper or pencil: "I increase the deflection allowance by 16/2300, which is equivalent practically to 14/2000, or 7 *millièmes*."

This is the calculation of the parallax. An operation cannot be considered as difficult, which may readily be required of a non-commissioned officer by a mental calculation on the ground. We would comprehend fully this objection if it were a question of having to calculate the parallaxes at the beginning of each firing by all the officers of the batteries which constitute the mass of artillery. But the deflection difference for converging fire is a thing the calculation of which will be made in advance, and whose value once determined may be used by all the batteries which subsequently will come into line beside the first, on condition that the aiming point remains the same, and likewise the range. Its determination will be the duty of an *orientation officer*, of a *specialist* who will work with a cool head before the arrival of the pieces; perhaps before the target appears. It could not be claimed that there would be difficulty in calculation under those conditions.

Let us suppose on the contrary that under pretext of simplifying the task of the orientation officer, an aiming point in the vicinity of the target is sought at any cost, thus sacrificing the conditions of visibility and facility of designation, which interest all the subordinate personnel. The pointers will thus be beset with difficulties which will be none the less troublesome because they are not of a mathematical character. It will be necessary that the pointers understand the designation of the aiming point which will be given to them at the critical moment of going into battery; that they never confuse this point with those which might resemble it; that they find it again after each shot, and these difficulties, besides affecting a numerous personnel, will be continually recurring so long as the firing lasts. This pretended simplification will be the course of inextricable complications.

Besides, if the aiming point be chosen before the appearance of the target, it may not be found to be in the vicinity of the target. Again, it may be objected that the formula for deflection difference for converging fire requires a knowledge of the distances to the target and to the aiming point. But it is proper to remark that at ordinary fighting range quite a large error is necessary to effect appreciably the parallax of the target. If, for example, it be known that the distance of the target is between 2000 and 2700, it may be affirmed that its parallax is 7 to the nearest unit.

It is not the same with respect to the parallax of the aiming point the variations of which are much more obvious at short distances. But the aiming point will most often be a prominent point of the terrain ; it will be plainly visible ; its distance may then be estimated by sight, from the map, or by the method which has been indicated above.

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To conclude this chapter we will give, free from all theoretical considerations, as it would appear in a drill book, a statement of the rules to be applied to the distribution of fire.

RULES FOR USE IN THE DISTRIBUTION OF FIRE.

When the aiming point is near the target, the deflection difference is obtained by dividing the *apparent* front of the target expressed in *millièmes* by the number of pieces. This quotient is the *apparent deflection difference.*

If the aiming point is not in the vicinity of the target the *apparent* deflection difference must be increased by a certain correction. This correction, positive or negative, is the deflection difference which must be given to the pieces to cause their fire to converge upon one point of the objective. This is the *correction difference for converging fire.* Its value is indicated below.

The *parallax* of a point is the angle expressed in *millièmes*, subtended by a platoon front at the point in question. It is the quotient of the interval between pieces measured from axis to axis of the guns by the distance to the point.

If the direction of this point differs notably from that of the normal to the front there must be applied to the quotient a certain correction which is given below.

If the point be in rear of the line of the pieces its parallax is negative.

The deflection difference for converging fire is the excess, positive or negative, of the parallax of the aiming point over that of the target.

If there is in the objective a point which is visible while changing position over a platoon front, the deflection difference for converging fire is obtained experimentally by taking the difference of the deflection allowance measured from two stations separated by a platoon front.

The total deflection difference is the sum of the apparent deflection difference and the deflection difference for converging fire.

An aiming point on the flank is equivalent to a more distant aiming point situated in the direction of the normal to the front.

The distance of this more distant aiming point is what we will call the *virtual* distance as opposed to the *actual* distance.

The *virtual* distance is the quotient of the *actual* distance by the cosine of the angle which the direction of the aiming point makes with the normal to the front [or by the sine of the angle which the direction of the aiming point makes with line of the front of the pieces.—Translator.]

In order to make this mental calculation, each one may formulate such empirical rules as he may think most convenient.

For want of an empirical rule the calculation is made by taking the intervals, not in the direction of the front, but perpendicularly to the direction of the aiming point.

To determine the deflection allowance for the right piece, the angular distance from the right extremity of the target to the aiming point is measured from the position of the right piece, and this is transformed into readings of the sighting apparatus.

If from the position of the right piece, the right end of the target is not visible, a position is chosen *n* platoon fronts to the right or left. The measurement made at this point must be increased or diminished by *n* times the deflection difference for converging fire.

The same method is employed if the position to be occupied by the first piece is not yet known when the observation is made.

If the place of observation is not on the line of the pieces, the deflection difference for converging fire is taken with respect to the line joining this point and the position of the right piece.

A battery receiving orders to substitute itself or another adopts the deflection allowances of the latter, modified by as many times the deflection difference for converging fire as there are platoon fronts between like pieces in the two batteries.

When several batteries distribute their fire over a continuous front their deflection allowances form an arithmetical progression, which is continuous if the pieces are at regular intervals throughout, interrupted if the pieces are not so. The interruption is equal to as many times the deflection difference for converging fire as there are unoccupied gun emplacements at regulation intervals between the two consecutive batteries.

The theory of deflection difference for converging fire affords a method of solving all problems dependent upon the following:

One piece being pointed, to lay another for converging fire upon the same target.

CHAPTER II.

SUPERVISION OF THE FIELD OF BATTLE.*

The regulations relative to the supervision of the battle-field, require the superior officers who are charged with the direction of the firing, to seek to discover the important points of the terrain, in the neighborhood of which there is a probabilty of seeing more or less important objects appear ; to determine their approximate distance, and to determine in advance the elements of fire with respect to these points in order to be able to obtain rapidly an efficacious fire, should the case require it.

Reconnaissance of important points.—By *important points*, according to the exact wording of the regulations, must be understood the points in the vicinity of which there is a probability that more or less important targets may be seen to appear.

The artillery appears behind crests. The crests mask the depressions of the terrain in which the enemy moves under cover. How to recognize crests must therefore be known. It will be acquired by close observation of the different objects whose contour is interrupted by the crests, or by which the contour of the crests is interrupted.

The infantry progresses from cover to cover, utilizing hedges, the edges of woods and villages, sunken roads, road embankments, the least accidents of the ground. All these accidents are *important points*, whose presence must be divined, and whose distance we must seek to measure.

But it is not sufficient to be in readiness to strike a deployed enemy, we must seek to surprise him while on the march. Now artillery, and often also other arms, will take the roads rather than go across the fields. So it is necessary to be able to recognize the roads and highways, which the least embankment, the least cultivation, will often be sufficient to mask.

Important roads are usually marked by a line of trees, which renders them easily recognizable. It is not so in the case of ordinary roads, whose existence must be conjectured from the movements of a passing pedestrian, horseman, or carriage, from

* "Surveillance du champ de bataille." There seems to be no single English word to express all that the French mean by "*surveillance*." It includes a careful reconnaissance and study of the battlefield, the selection of important points, the determination of the elements of fire for these points, the assignment of zones of fire to each battery or group of batteries, and the careful watching of the battlefield for the appearance of targets in the various fields of fire; in short, the complete preparation for bringing any part, or all of the artillery to bear without delay upon their respective targets.—TRANSLATOR.

the dust raised by a body of troops, from piles of sand or stone placed at intervals along the roadway for repairing it, sometimes from telegraph poles; in short, from certain indications which one must know how to interpret.

For example, an isolated tree is scarcely ever in the middle of a field. It is on a road where it has been left to mark the line between two pieces of property or two parishes. It is therefore a point *in the vicinity of which there is a probability of seeing more or less important targets appear;* it is an *important* point whose range should be determined.

An *isolated house* is, still more than a tree, an indication of the existence of a road. Likewise stacks of straw or hay, if suffitiently numerous, will suffice to mark the trace of roads.

An isolated group of trees hides generally a cross or a fountain, situated nearly always on a road very often laid down on the map.

Trees planted in regular order indicate an orchard, and, consequently, the vicinity of inhabited places. Hedges, numerous hay-stacks, smoke, or lights likewise indicated habitations.

Rivers and brooks are generally fringed with very bushy trees, canals with poplars, ditches with willows.

With a guide taken from the vicinity, who is made to talk, all these probabilities become a certainty.

Determination of the ranges of important points.—The measurement of ranges by means of the telemeters in use is a very delicate operation, because without other data than the knowledge of a very short base, the distance to a point relatively very far away must be determined. But if the distance to another point is already known, the problem is a different matter; there are, so to speak, two bases instead of one. This abundance of data permits the use of angular measurements less rigidly precise than the telemeter requires, permits the use for these measurements of the instruments at the disposition of the artilleryman on the battlefield: the battery telescope, the graduated ruler, in case of necessity the fingers of the hand.

Now, there will be seen often in the field an auxiliary point whose distance is known quite accurately. This knowledge may result from an examination of the map, from telemeter measurements, or from previous firing, from the time required to pass over the distance, from information furnished by the inhabitants, etc. It might even be the result of an estimation by sight; it will be shown later that if the distance to the auxiliary point is considerable, it is not necessary to know it with great exactness.

The principle of the method has been laid down in the preceding chapter. This is the manner in which it is convenient to solve the problem using paper and pencil, for this is not an operation to be carried out under the fire of the enemy.

The auxiliary point is a church steeple whose distance has been estimated to be 6,000 m. The problem is to find the distance to a windmill not so far away from the position of the observer; the mill appears 98 *millièmes* to the left of the steeple. The observer moves five platoon fronts to the left (about fifty double paces) and finds it is then only 77 *millièmes*. The difference is 21 *millièmes*, one-fifth of which is 4.2, which is the deflection difference for converging fire. This deflection difference is the difference between the two parallaxes, of which one is 2.7 *milliémes*;* the other is therefore 6.9, dividing 16,000 by 6.9,† gives 2,320, which is the distance required.

Suppose now that the true distance to the steeple is 7,000 m. instead of 6000. The range to the mill is 2460 instead of 2320; the error made was therefore only 140 m.

So the approximation obtained is greater in proportion as the distance of the auxiliary point is greater. It depends also on the interval between the two observing stations; it depends, in short, upon the exactness of the method employed in measuring the angular distances. It is known in all cases what exactness can be counted on with the means employed, while the ordinary telemetric methods expose the most skilful operator to errors of observation whose magnitude cannot be reckoned upon.

Firing Memoranda. (*"Bulletin de surveillance."*)—From the distances of the important points are deduced by interpolation, those of the intermediate crests. All are noted on the "*Firing Memoranda*" of the form shown below.

Upon this form are noted also the values of the parallax and the deflection difference for converging fire, then the angular distances of the important points from the aiming point previously chosen. These data shown, if a target appears the elements of fire are very rapidly determined. There is no need of pointing out the objective, of remaining permanently near the piece, of moving over to the left to determine the deflection difference for converging fire.

If no estimate of the distance to the target can well be made, it may be taken as 2300 m., whose parallax is 7, and the proba-

* Platoon front 16 m. divided by 6000 m. = 2.7 millièmes.

† Or 16 m. divided by 6.9 millièmes $= \frac{16}{.0069} = \frac{16000}{6.9} = 2319$. —TRANSLATOR.

bilities are that the error is less than 2; because the parallaxes 5 and 9 correspond to distances of 3200 and 1800 m., respectively.

FIRING MEMORANDA.

AIMING POINT: PARALLAX:

Names of important points.	Distances.	Parallaxes.	Deflection difference for converging fire.	Angular distances from aiming point.	Deflection allowances.	Remarks

Turning the fire from one target to another.—However rapid the calculation of the elements of fire may be, thanks to the *Firing Memoranda*, it is incontestable that the calculation will take a certain length of time. There are cases in which it will be necessary to intervene more quickly still, even sacrificing somewhat exactness of distribution of the fire. Upon a marching column which will be visible only for an instant, upon a battery coming into action whose cannoneers are not yet covered by the shields, upon a battery limbering up and about to disappear behind the crest, a lucky shot will sometimes suffice to produce indescribable confusion.

The method consists in disposing the pieces so that their fire constitutes a fan whose angular divergence is so calculated as to cover at ordinary fighting ranges the front usually assigned to a battery, a fan which the pointing apparatus permits us to prepare in advance. The battery is thus ready to open a well distributed fire upon an objective which might appear at that distance with that extent of front, in the direction fixed by the axis of the fan.

If the enemy presents himself in a direction other than this, it is sufficient to measure, by means of a battery telescope, a calibrated field glass, a graduated ruler, or the fingers of the hand, the angular distance between the two directions in question, and to modify all the deflection allowances by the measured amount. And if the angular distances between the important points of the terrain have been determined in advance, and noted upon the "*Firing Memoranda*," or upon a perspective sketch, such measurement at the moment of appearance of the target is anticipated ; the target is interpolated at a glance between two known azimuths. The distribution is then corrected, when necessary, from the results observed.

The desideratum, laid down by the regulations, of a preparation for fire pushed as far as possible, is then realized. But in order that this preparation may be complete, the officers must make a profound study of the surrounding terrain.

From what wood may the infantry appear? Behind what crest may the artillery come up? Where may the reserves be sheltered? What are the ranges to these different points? What are the angular distances between them? What would be necessary to open rapidly an effective fire upon a body of troops appearing in the vicinity of these points?

Such are the questions which officers of batteries in a position of observation should ask themselves. It must be admitted that these are questions upon which, until now, very few have reflected. The reason is clear: The lulls in the firing which henceforth will usually occur, were formerly the exception. And then the small deflection scale did not lend itself to this preparation for fire, to the fire being switched in any direction whatever ; the opening of fire upon new targets could only be done by a new designation of the target, the choice of a new aiming point, sometimes of several aiming points, a new calculation of deflection allowances ; everything had to be started again from the beginning.

By artillery in a "*position of observation*" must not be understood simply artillery in battery with everything yet to be done, but artillery whose preparation for firing has been pushed as far as possible ; to which nothing more is needed for action except the last element of execution, the direction of the target to be fired at, indicated by a figure to be given to the pointers and by virtue of which the fire will immediately be turned upon the new objective, and be distributed in a fairly satisfactory manner.

It matters little whether the front of the objective be exactly that for which the distribution has been prepared. After fire is opened, if it is observed that the extremities of the target are not reached or that the fire overlaps them, it will be an easy matter to open or close the fan ; but first of all it is necessary to fire ; because to a material effect already appreciable, this instantaneous action will add a considerable moral effect.

Displacements of the fan.—The fan once formed is thrown to the right or left by a general modification of the deflection allowances so that its axis coincides with the direction in which the enemy is expected to appear ; or, if the probable direction is not known, with the axis of the zone which is being observed.

The axis of the fan is the prolongation of the direction of the natural line of sight of the third piece. The direction of the third piece is taken because the sweeping is executed to the left ; if the sweeping were to the right, that of the second piece would be taken.

This direction is fixed by referring it to any point whatever ; if no suitable point is found in the prolongation of the natural line of sight, the latter is displaced the necessary amount. If now the enemy should appear in a direction different from that in which he was expected, the angular distance between the axis of the fan and the center of the target is estimated by sight,—all the deflection allowances are changed by this amount, the guns are laid upon the aiming point and fire is opened. To make this estimation, the captain places himself near the third piece. If from this position he cannot see clearly the ground which he has to watch, or if he wishes to go elsewhere, he must take into account the distance to the point of reference and the distance from the third piece to his new position. The calculation is then an application of the theory of the deflection difference for converging fire.

Modifications of the fan.—Fire having been opened, if it is seen that the extremities of the object are not being covered by the fire, or that it overlaps them, or that one is overlapped while the other is not covered, the difficulty is either that the range and the front of the objective are not exactly those for which the deflection allowance has been calculated, or an error has been made in the angular displacement. The captain then must consider the question as to whether it is best to continue the fire with an imperfect distribution or to modify the deflection allowances. The matter is a question of judgment.

If the result is fairly satisfactory, it is best not to change. In general, any change in the distribution of fire once opened should be avoided ; but if circumstances require it, the captain will open or close the fan, or swing it to the right or left such an amount as he judges proper from the results observed. For this purpose, the personnel should be trained to execute the command : "Open (or close) the fan so much."

The increase or decrease of the deflection difference for the fan is calculated so that the ends of the target are slightly overlapped if the range is known, not quite covered if the range is not known.

If the angular divergence of the fan is good, but the fire is too much to the right, the captain commands: "Increase the deflection allowance so much."

Finally, if the front of the target differs too much from that for which the fan has been prepared, the captain, before opening fire, may cause the fan to be opened out or closed up such an amount as he thinks proper.

CHAPTER III.

EMPLOYMENT OF THE FIRE OF A LARGE BODY OF ARTILLERY.

Number of batteries to engage in the firing.—The first duty of the commanding officer of a large body of artillery arriving on the line must be to estimate the extent of front to be swept and to deduce from it the number of batteries to be brought into action immediately, taking as a basis of calculation the numerical data contained in the Firing Manual. The practical rule to be applied is the following: *Engage in the firing line as many times six pieces as there are hand-breadths in the front to be swept. Increase or decrease the resultant number to the nearest multiple of 4, according as the distance is greater or less, and according to the number of guns available.*

The batteries not engaged in the firing are placed in a *position of observation*, or left at a short distance to the rear, ready to be brought to bear upon another point of the field of battle.

It would be useless and dangerous to put into the firing line a greater number of pieces than the front to be swept requires; useless, because the rule contained in the Manual allows decisive results to be obtained; dangerous, because a greater number than is necessary would be exposed.

To bring into the firing line in the beginning all the batteries at hand would be as much more imprudent, as the preparation for firing has become still more delicate than formerly. If then a new objective be presented in another direction, either during the firing, or during its preparation, it would be necessary to begin again the distribution of the fire, and the opportunity to act might perhaps be lost. Moreover, it is to be anticipated that the enemy also will have artillery in observation. The opening of fire by the first batteries taking part in the engagement will cause the adversary to send additional batteries into the line. The batteries in observation will be the ones to respond. The first will cease firing upon the old objective only when a decisive result shall have been obtained.

Therefore there will no longer be any changing of objective in the sense in which the term was formerly understood. With the slow firing gun, number was necessary ; every available battery was then engaged. If a new objective appeared in another direction, it was necessary in order to oppose it, to abandon, at least for the time being, one of the objectives already being fired upon. Hereafter this mission will be incumbent upon the batteries in observation which will operate not by *change of observation*, but by *swinging the fire to the right or left.*

Replacing batteries engaged.—It may happen that the batteries first engaged are worsted in the artillery struggle and are obliged to shelter their personnel and to cease firing. It is again the observation batteries which will replace them. We have seen the advantage that may be taken of the theory of the deflection difference for converging fire, in making this substitution of batteries.

Let us insist upon the fact that it is a question here of a *replacing* and not of a *re-enforcing*, in the sense in which this word was formerly understood, with new distribution of the objective among the re-enforcing batteries and those already in position, and, consequently, a change of objective for the latter. These changes in the distribution of the fire, already open to much criticism with the old material could not be considered for a moment at the present time.

Artillery on the lookout.—A particular case of the observation position is that in which the extent of the zone to be observed is confined to that of the front to be swept, The problem in such a case is not to explore a region of a certain extent and to be prepared to turn the fire in any direction whatever, but to be in readiness to direct a rapid, effective fire against a target whose location is definitely known. Such artillery is said to be *on the lookout.*

Let us suppose, for example, that, in order to escape the destruction which menaces it, the enemy's artillery ceases firing and shelters its personnel behind the caissons and the shields. What purpose will be served by continuing against it a fire which is producing no effect ? It has been rightly said of modern artillery that it must be miserly with its fire in order to be prodigal with it at the proper time. Therefore we also must cease firing but must make our dispositions to prevent the enemy from opening up again. For this purpose, the bracket will be narrowed to 50 meters, an officer or non-commissioned officer will be stationed at the telescope, and, if the adversary is seen to stir or to make preparations for opening fire again, a *rafale* of sweeping fire will be turned loose upon him with lightning-like rapidity.

In such a case, it will not be necessary to keep upon the front to be swept the number of pieces indicated in the rule of the Manual. To keep down artillery which has been silenced, a battery can watch a more extended front by increasing the sweeping.

A simple rule is necessary to determine without calculation the number of shots to be fired in the *rafale* depending upon the extent of the front to be covered. The following rule, which is rigorously true for 2500 m., may be adopted :

Sweep by 4 and cut the fuzes of as many projectiles as the front contains finger-breadths.*

The same method will obtain against infantry lying down in its shelter trenches and which we wish to keep down so that it will not be able to fire, or against the edge of a village that we are preparing to attack.

Distribution of the zones of observation.—In a large body of artillery the proportion of the batteries engaged to the batteries still in hand will vary according to circumstances. Sometimes a single battery will be placed in observation ; at other times, there will be more ; they may all be there. Such being the case, it would be imprudent to divide up the zone into as many sectors as there are batteries available, because this division would be subject to incessant changes.

Moreover, it might happen that in the sector of a particular battery, there would appear an objective with a front greater than the battery can cover effectively, or that two distinct objectives should appear simultaneously. For these various reasons, the commandant of a large body of artillery should sometimes reserve to himself the control of the fire, if not entirely, at least of a part of the batteries in observation. This control being incompatible with too great a separation from the commander-in-chief, it seems that in general, the zone of observation should be divided up among the groups, each commandant of group having the control of the fire within the zone assigned to him.

Use of the hand for measuring the front.—The measure of fronts and angular distances is the basis of all calculations relating to number of pieces required to engage in the firing, and to the determination of the elements of fire.

Several times in the course of this article, it has been indicated how, in default of a battery telescope, a calibrated field glass, or a graduated ruler, the fingers of the hand may be used in these measurements. The rule to be applied is the following :

* "Sweep by 4" means to take 4 turns of the traversing hand-wheel between consecutive shots in the sweeping fire. —TRANSLATOR.

Place the right hand in the position used in taking an oath. A finger covers about 30 *millièmes*. More exactly the first and second fingers each cover 35 *millièmes*, the third 30, the little finger 25, the thumb 40. The first, second and third fingers cover together 100 *millièmes*; a hand-breadth, not including the thumb, covers 125 *millièmes*. Angular distances less than 25 *millièmes* are estimated by dividing by sight the front covered by a little finger. To render these measurements very exact, each operator can, by placing himself at a suitable distance from a wall upon which are two vertical lines at the desired distance apart, determine by personal experience whether the ends, the middle, or the base of the fingers must be used for the measurements in question.

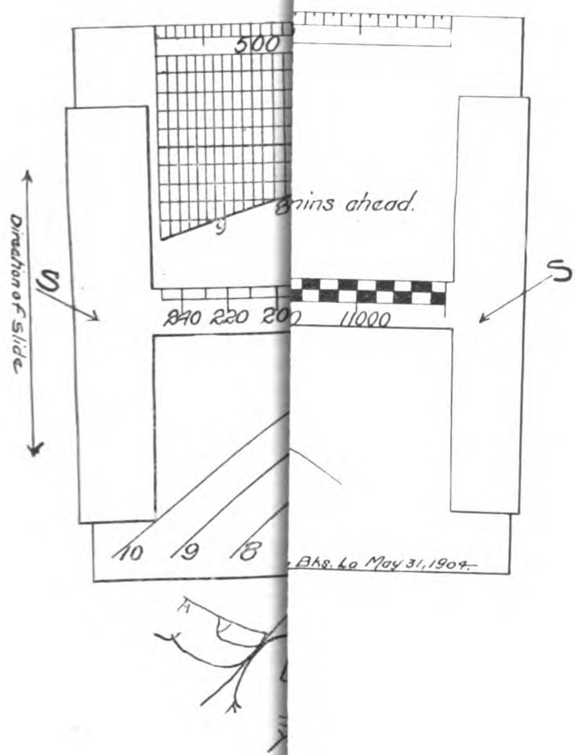
The use of the hand is very convenient on horseback, even while in motion ; the graduated rule, *a priori* more exact, often gives rise to considerable errors in reading.

It should be observed that, for the setting of the sighting apparatus, it is the angular extent and not the front in meters which it is important to measure. However, it is useful to know the number of meters ; by means of it the strength of the troops which occupy it may be estimated ; it is obtained by multiplying the angular extent by the distance to the target.

Importance of distribution.—To obtain effective results, it was formerly necessary to have recourse to the concentration of the fire of a great number of pieces over a relatively narrow front ; some error in the distribution was then permissible. The sheaves partly overlapped each other.

To-day, rapidity of fire produces all the effects of concentration ; there must no longer be engaged in the firing more pieces than are strictly necessary to cover the objective without overlapping or gap. Distribution of fire has therefore become an operation of the greatest importance. Every error would cause on the front to be swept either troublesome gaps or useless overlappings. A good distribution of fire will generally be the result of a thorough reconnaissance.

[To be continued.]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9
8
Bks. La May 31, 1904.

PROFESSIONAL NOTES.

Semi-Automatic Predicting and Set-Back Ruler.

BY CAPTAIN P. C. HAINS, JR., ARTILLERY CORPS.

The predicting and set-back ruler shown on the accompanying cut will be found useful for rapid, convenient and accurate work at the plotting board when using Case II.

The principle of construction is similar to that of my ruler, a description of which was published in the ARTILLERY JOURNAL, September-October, 1902, and is sufficiently simple to need no explanation here.

The trouble found with the ruler constructed at that time was the difficulty in rapidly tracing the intersecting lines of the graphic multiplication table.

This has been obviated by introducing the slide SS with the set-back and range scales marked upon its left and right portions, respectively, and a silk thread fastened at O to represent any desired diagonal line. The operation of the device is best illustrated by the following example.

The target at time one is plotted at the point A, one minute later, at time two, it is plotted at the point B.—Required the predicted point two minutes thereafter and the set-back or set-forward point.

Solution: Place the ruler with the zero at B. It is found that the target has traveled three hundred and ninety yards in one minute (going from A to B).

Using the predicting side of the ruler the target is at once predicted at the point C. Under the point A count the divisions down to the speed curve (six and one-half divisions); it is found that the target is moving at the rate of six and one-half yards per second. Note the range of the predicted point C from the directing gun. In this example it is assumed to be seven thousand yards. Move the slide SS until its right hand scale (range scale) cuts the time of flight curve at seven thousand.

Grasp the silk thread fastened at O and hold it midway between the "six" and "seven" radial lines (the speed of the ship was six and one-half yards per second). The silk thread cuts the set-back scale at about eighty-two, hence the set-back point is at X, eighty-two yards back of C, or the set-forward point is at X^1, a similar distance to the other side of C.

The dots between the graduations on the predicting scale of the ruler are merely for convenience in estimating distance. The space between a dot and the next scale mark being ten yards on the plotting board.

A graduated scale of seconds is put on the ruler at the line 0-5-10-20-25, to enable the time of flight curve for any velocity or gun to be drawn in by hand.

It is apparent that this ruler may be constructed to any scale or for any scale of plotting.

Another ruler built in reverse order may be used to plot the target when moving in the reverse direction.

The principal difficulty in the home-made ruler of this type lies in getting the long slide SS to work without tilting or binding.

A metal slide with a spring at one end of it, working in grooves at the end of the ruler, similar in principle to the sliding target of a Manheim slide rule, will be found to overcome the difficulty very well.

Range Scale for Difference Chart for Mortar Battery.

By Corporal FRANK W. WINTER, Coast Artillery.

The accompanying plate (page 77) shows a sketch of a range-scale for difference chart for mortar firing.

The objection to the range scale as used heretofore was that the range differences could not be applied because the predicted point can be reached (generally) by two powder charges whose elevations are different, and that the value of the range difference correction changes with them.

I think I have overcome this objection with the range scale now used at the mortar battery at Fort Miley, Cal.

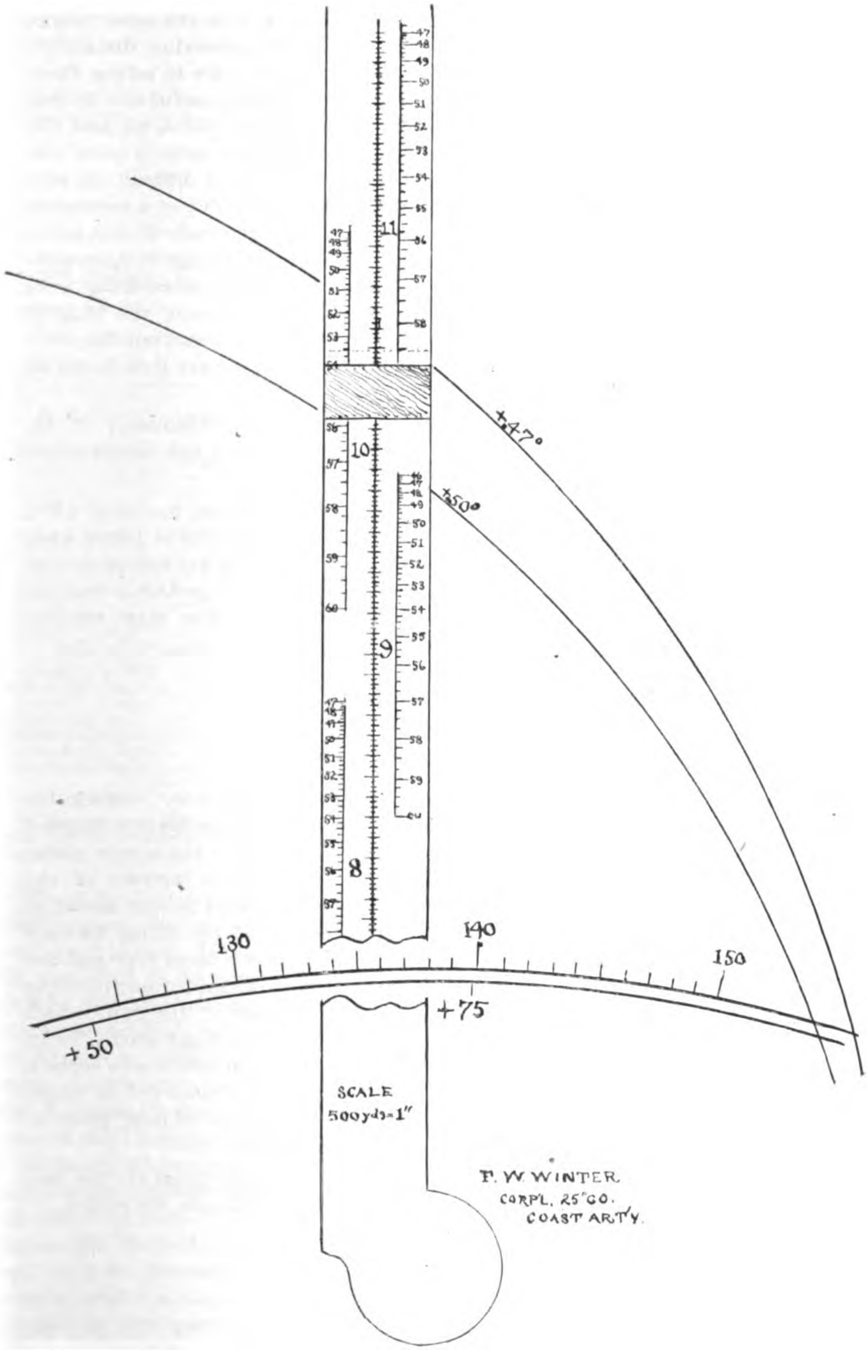
The powder charges and elevations are transferred to the range scale, which also carries the range graduated to 25 yards, and a slide to enable the man using it to determine accurately the elevation for his pit from that sent for the directing point. The difference chart and range-scale should be drawn to a scale of about 300 yards to 1 inch. This scale would be practicable and not too large as there would be one man specially detailed to work it at each pit. He will call out the azimuth corrections to a man at a blackboard near him, who adds or subtracts them, and also calls out the new elevation. The gun commanders and gunners take their data from the blackboard.

Example.—Powder charge for predicted point from directing point—10, Azimuth 138°00′, Elevation 54°00′. The range scale is set to read the azimuth, the slide is placed at powder charge 10 with upper edge at 54°00′. The azimuth difference is applied; from range difference scale take correction (in this case plus 75 yards) move slide forward 75 yards and read off new elevation, equals 53°30′. The shaded part shows slide in its first position, the dotted line the upper edge of slide when reading new elevation for range difference.

If the powder charge were 11, Azimuth 138°00′, Elevation 58°45′ the new elevation would be 58°30′. In the first example the correction for range difference for 75 yards is 30 minutes, while in the second it is but 15 minutes.

Russian Seacoast Firing at Port Arthur.

The remarkable action of the Quantoon (Port Arthur) fortress artillery, as manifested during the repulses of the Japanese fleet, leaves nothing to wish for in what concerns the shooting at middle and short ranges. But when the ranges are ten or twelve thousand meters, this artillery does not shoot at all, or fires without results. If it were otherwise, it could never have happened that the bombardments of Port Arthur, lasting sometimes several hours without interruption, were without results, when, under such circumstances,



×470
×500
11
10
9
8
130
140
150
+50
+75
SCALE
500 yds = 1"
F. W. WINTER
CORP'L. 25th CO.
COAST ART'Y.

every minute ought to have caused the loss of some ship, small or big, losses of lives not reckoned. Evidently it is impossible for our artillery to drive the assailant away and prevent his remaining a long time on the same place. The reason is to be found in the existing system of measuring distances, which does not permit the artillerists to concentrate their fire in salvos from all batteries, upon a single target. This system is the only useful one in this case, as it makes it possible to take good aim from such distances, and observe the fall of a number of shots, while the fall of single shells is quite unseen. Moreover, the chances of hitting are greater, as it is difficult to presume that out of the great number of shots fired, in a volley at a measured range, not one should reach the point aimed at. The drawback of this salvo shooting consists in its comparative cost; though the advantage is incontestable in the better and quicker results obtained. Therefore, salvo-firing is in the end rather economical, as one or two salvos from all guns of the biggest size must force the enemy to retreat quickly instead of bombarding the fortress for hours, causing the fortress to do the same, as we are now doing at Port Arthur.

For such concentrated fire by salvos the apparatus (telemeter) of De Charriere could be of great service, if the system were not too complicated, costly and delicate.

Much more convenient would be the fortress range-finder, model of 1904, mounted on an azimuth circle. The experiments made in 1899 in Libau gave very good results, showing the perfect adaptability of this apparatus to concentrated shooting by salvos at an invisible target. The experiment was repeated in the fortress Ust Dvinsk in 1900, giving the same good results.

—*General of Artillery Martushev in the Rousskii Invalid.*

Development in Guns, Armor, Etc.

Although the year 1903-04 has not been signalized by any very remarkable discovery in the way of projectiles or armor plates, there has been a decided advance in the attack, whilst the defense, as represented by the armor plate, remains as before. The attack has profited by the gradual increase of the velocity given by the gun and by considerable improvement in the metal of the projectile. It is some three years since the design of the King Edward class was got out. In these three years the velocity of the latest type gun has gone up about 150 f.s., and the factor of penetration of the armor-piercing projectile has also improved by 10 to 15 per cent. Moreover, the cap, which was then in the experimental stage, has now been universally adopted. From these considerations it results that a 12-inch gun, which in 1901 under certain conditions of range and obliquity of impact might be considered as fairly matched by a 12-inch plate, can now deal with a 15-inch or 16-inch plate on much the same terms as its prototype did with the thinner one.

With regard to the piercing power of the guns to be supplied in the near future, if we take the velocity at 2800 f.s., not a high estimate, we get:—

Penetration of Krupp Steel by Armor-piercing Shot or Shell.—Normal Impact.

Muzzle Velocity 2800 f.s.	2000 yards.		3000 yards.		4000 yards.		5000 yards.	
	Old Type Shot. Uncapped.	New Type Shell. Capped.	Old Type Shot. Uncapped.	New Type Shell. Capped.	Old Type Shot. Uncap.	New Type Shell. Capped.	Old Type Shot. Uncapped.	New Type Shell. Capped.
	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.	Inches.
12-inch (850 lbs.)	18	22	16	20	14	18	13	16
9.2-inch (380 lbs.)	12	15½	10	13	8½	11	7½	10
8-inch (250 lbs.)	10	13	8	10½	6½	9	5½	7½

And the penetrating power of secondary guns, assuming 2800 f.s. velocity:—

	2000 Yards.		3000 Yards.		4000 Yards.		5000 Yards.		Remarks.
	Old Type Shot. Uncapped.	New Type Shell. Capped.	Old Type Shot. Uncapped.	New Type Shell. Capped.	Old Type Shot. Uncapped.	New Type Shell. Capped.	Old Type Shot. Uncapped.	New Type Shell. Capped.	
	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	
9.2-inch (380 lbs.)	12	15½	10	12½	8½	11	7½	10	British.
8-inch (250 lbs.)	10	13	8	10½	6½	9	5½	7½	American.
7.5-inch (200 lbs.)	9	11½	7	9½	6	8	5	6½	British & French.
7-inch (165 lbs.)	8	10½	6½	8½	5½	7	4½	6	American.
6.7-inch (154 lbs.)	7½	9½	6	7	5	6½	4½	5½	German.*
6.4-inch (135 lbs.)	7	8½	5½	6½	4½	6	4	5	French.
6-inch (100 lbs.)	5½	7	4½	5½	4	5	3½	4	British.

* The German gun is only 40 cals. (over all), all the others are 50 to 52 cals. It is unlikely that 2800 f.s. will be obtained, and its power is therefore really the same as the French 6.4-inch.

There is only one nation, namely, Germany, that has not adopted the 12-inch gun, so that this may be regarded as the weapon which the new ships will have to face. If the armor be expected to give security from this weapon at, say, 3000 to 4000 yards, this is surely not asking too much. The table shows that the belt abreast the King Edward's engine-room, with 9 inches Krupp + a 2-inch mild steel sloping deck + a coal bunker (worth 1½ inches of Krupp), and a total resistance equal to 12 to 13 inches Krupp, can be pierced with the greatest ease by the old type 12-inch shot at over 5000 yards, whilst the 9.2-inch or the German 9.4-inch would, if it hit exactly normal, send a capped shell into the engine-room or barbette at between 3000 and 4000 yards.

Hitherto it has always been the object, in armoring a first-class battle-ship, to keep the enemy's shot from piercing engine-rooms and big gun positions till the ships closed to about 3000 yards. This was accomplished in the Royal Sovereign, Majestic, Bouvet, Indiana, Formidable and others. But at present, both in England and abroad, the armor provided for first-class ships, costing nearly a million and a half, will barely keep out capped shot from the 9.2-inch at moderate ranges, whilst the 12-inch gun pierces easily at considerable obliquity at, say, 5000 yards. Twelve years ago every ship had 16 to 18 inches of armor, and now, although ships have increased in size, we are content with 12 to 14. The practice of the day is most unreasonable in view of the great improvement of guns and projectiles. We are likely to get some useful object-lessons during the present war, and one will almost certainly be, that armor, to be effective, must keep out both shot and shell until the ships come into really close quarters.

The reason for the reduction of the thickness of present-day armor seems to be that there is more anxiety to keep the ship afloat, by spreading out the armor so as to keep out common shells all along the water line, and less consideration for the safety of the men who fight the guns and keep the engines going. By the time these words are printed and published, we ought to have more data from the Far East, but it should not be forgotten that, in previous wars, it is always the protection of the personnel that has been found to be most important. It is no use having a ship sound and seaworthy if her gun crews are out of action,* or if the cutting of steam-pipes has rendered the engine-rooms and stoke-holds untenable. Such a ship would form a useful prize for the enemy, but she would only be a burden to her friends. It is perfectly evident that in order to safeguard what is essential, we must sacrifice what is non-essential, thickening the armor in certain parts, and reducing or abandoning it elsewhere.

There has been no material advance in the designs of guns manufactured this year, nor has the performance of the latest types been much improved by changes in the propellants. Moreover, in some directions it has been necessary to reduce the velocity.

Far the largest charges are those estimated to be used in the new American guns, namely, 350 pounds for a 12-inch, 40-caliber gun giving 2800 f.s., and 46 pounds for a 6-inch, giving 2900 f.s. in a 50-caliber gun. With cordite M.D. we shall probably use about 290 pounds in the 40-caliber 12-inch, and, say, 34 pounds in the 45-caliber 6-inch, with velocities 2700 f.s., and 2800 f.s. respectively. The French do not apparently use much over 250 pounds in their 12-inch, which would give about 2600 f.s. to 850-pound shell, but this may have been increased for the new ships. The Germans claim to get 2900 f.s. with 600-pound shell, corresponding to 36,000 foot-tons energy in their 40-caliber 11-inch, with only 198 pounds of powder. As the Vickers 45-caliber 10-inch, using German nitrocellulose, only gets 28,000 foot-tons energy with 210-pound charge, either the energy of the German gun must have been overstated, or a larger charge must be used. However, if we take 300 pounds as the standard charge for the 12-inch gun, and put the strength of the propellant as two and a half times that of ordinary powder, this means that we have an equivalent of 750 pounds brown powder, or fully double the gunpowder charge of a 12-inch gun of 10 years ago. It is this enormous increase in the power of the propellant that has given the gun of the present day its enhanced value. There seems no essential difference this year in the form of the latest type guns. In all countries alike the fore part of the gun has to be made very thick, so that the exterior of the gun tends to become more and more cylindrical. The earlier American guns had no muzzle swell, but the recent accidents, due to the yielding of the chase of various guns, point to the desirability of strengthening the guns forward, and there is no doubt that a muzzle swell is desirable for this reason ; it also tends to reduce vibration, and thus improves the shooting.

* The case of the Variag.

Although no fresh invention has been made during the last twelve months which will enhance the power or increase the ballistics of guns, and though there have been some actual set-backs, because in certain cases the higher velocities obtained in old type guns by the use of slow-burning propellants have had to be abandoned, it must not be assumed that no improvement is going on afloat. Although it is as long ago as 1899-1900 that guns of new type, using larger charges of slow-burning propellants were being rapidly developed, the effect is only just beginning to be felt at sea. The next year or so will see a decided change as new ships come forward with the new weapons, and the improvements of the last five years begin to bear fruit.

The propellants in general use for guns may be divided into three classes:

Class (*a.*) A combination of nitroglycerine and nitrocellulose, with a high percentage of nitroglycerine.—Type cordite.

Class (*b.*) A combination of nitroglycerine and nitrocellulose with a low percentage of nitroglycerine.—Type cordite, M.D.

Class (*c.*) Pure nitrocellulose.—Type U. S. Navy smokeless powder.

Hitherto, Great Britain, Germany and Italy, Japan and the Scandinavian powers have used Class (*a*). France is supposed to have used Class (*b*) at one time, but is now using Class (*c*), in which she is followed by Russia and the United States. None of the Powers seem quite satisfied with the smokeless powder first adopted; thus Great Britain has now definitely decided to abandon cordite in favor of cordite M.D. France is said to be inclining towards a nitroglycerine powder, whilst in Germany, on the other hand, private makers have made great progress with the (*c*) type of propellant, which, it is said, may be adopted by the government. Italy and Russia seem to be fairly content at present, but very little is known as to what they are doing The United States has made no secret of their difficulties with their (*c*) type.

Germany's hesitation with regard to the adoption of a (*c*) type powder may be due to similar experience. That the German nitrocellulose powder gives very high ballistics there can be no doubt, and the notable performances claimed for the Krupp guns by the manufacturer must be in great measure due to the excellence of the propellant from the ballistic point of view. But high velocity without regularity is fatal to the efficiency of long range firing, and as the gyroscopically guided torpedo forces ships to longer ranges, the importance of regularity in the powder is enhanced.

In all countries a certain proportion of shells are now filled with high explosive. France took the lead by issuing melinite shells more than 10 years ago, whilst the United States brought up the rear, so that in their war with Spain in 1898 not a single high explosive shell was fired. But although it is admitted on all hands that the high explosive shell is far the most formidable projectile where the target is not protected by armor more than $\frac{1}{3}$-caliber thick, large numbers of common shells filled with powder are still issued. The reasons are not very clear, but the following may be cited as having some influence:

(*a.*) The greater risk to the gun when using high explosive, as a faulty fuze or defective shell may cause a premature which will burst the gun, whilst with a powder-filled shell no harm would accrue if the shell does burst in the gun.

(*b.*) The superior penetration of a powder-filled common shell.

Neither of these reasons can be accepted as sound. The experience at the Cape showed that with regard to (*a*) when using well-made shells and efficient fuzes the risk is very small. As to (*b*), although a 9.2-inch common shell filled with powder might pierce a 5-inch plate, whilst a lyddite shell would be hardly equal to piercing more than 4 inches, both of these projectiles would be much less effective for attacking men or *matériel* behind such plates than armor-piercing shell. Apart from gun shields there are hardly any thinner plates than 3½ inches in any ship. Thin, unbacked plates, such as gun shields, are more vulnerable to high explosive than to common shell. The ordinary side plating of 1 inch or less is an ideal target for the high explosive. The following shows roughly how the case stands for 6-inch, 9.2-inch and 12-inch guns:

Best projectile to use against plates as under:

H=High explosive.
C=Common.
A=Armor piercing.

Plate.	6-inch Guns.	9.2-inch Guns.	12-inch Guns.
0 inch to 1 inch	H	H	H
1 " to 2 "	H	H	H
2 " to 3 "	H or C	H	H
3 " to 4 "	A	H or C	H
4 " to 5 "	A	A	H or C
5 " to 6 "	...	A	C or A
6 " to 7 "	...	A up to thickest plate penetrable.	A up to thickest plate penetrable.

Briefly, the high explosive does best against the thin plating and the armor piercer against thick, and there is very small scope indeed for the common shell, which is only superior when the high explosive shell is beginning to fail and the plates are hardly thick enough to employ profitably the armor piercer. The question of the best explosive for use with armor-piercing shell is a difficult one, and no general solution has been arrived at. If a high explosive be used, there is, first, the risk of reducing the penetration by a too early burst, and, second, the liability for the shell to burst in the gun through some defect in the base fuze. Base fuzes must be used for armor piercers, and they are more liable to cause prematures than nose fuzes. The Americans have had a premature burst destroying a 12-inch mortar with what is believed to have been a base fuzed high explosive shell, and the French also burst a 12-inch gun with apparently something of the same kind. For the present, therefore, powder will probably be adhered to for armor-piercing shell, and the projectiles in general use will be:

Nose fuzed (thin walled) shell filled high explosive,
Base fuzed armor-piercing shell filled powder,

whilst the powder-filled common shell, whether pointed or otherwise, will disappear. The armor-piercing shell will be used whenever the armor is readily penetrable. Otherwise the high explosive shell should be used to destroy unarmored portions of the ship, and in the hope of getting one or two into the ports of guns shielded by impenetrable armor.

The Firth Sterling Steel Company has developed a new type of shell with capacity for a relatively large bursting charge. The test for this type of shell is that it passes unbroken through a plate of hard-faced armor one caliber in thickness. This is a great advance on anything hitherto achieved, and assuming the velocity to be about the ordinary standard of 2000 f.s., it means that the penetration of these new projectiles is some 15 per cent. greater than that of those hitherto used. The discovery of this new material, or new process, will decrease the value of armor considerably, and greatly enhance the power of the big gun. It does not seem likely that the 6-inch gun can ever become an armor-piercer as against 6-inch plates, because at 3000 yards the velocity falls to 1900 f.s. in even the latest type of gun with the heaviest charge ; but the 7.5-inch and 9.2-inch guns become much more formidable, and the 12-inch almost irresistible. The shells are capped.

No information is to hand as to whether similar projectiles are being introduced elsewhere than in the United States, but, as was the case with the Harvey and Krupp processes of improving armor, it is practically certain that all nations will presently adopt the new shells. It is far easier to supply a gun with new projectile than to make any other change, for none of the fittings are seriously affected as in the case when an increased charge increases the strain on the mounting, and gives trouble with reference to the loading arrangements. The next few years will see considerable changes in the projectile supply, the new type armor-piercing shell superseding armor-piercing shot, and high explosive shell taking the place of common.

Progress is being made in enlarging the capacity of shells of all kinds ; but owing to certain accidents with shells filled with high explosives, powder bursters are generally adhered to. In order to enlarge the capacity of armor-piercing shell without weakening the projectile the Bethlehem Company have introduced a shell with ribbed interior. The capped projectile is used for all armor plate tests. It is not considered that it loses its efficacy at low velocities, in fact, the following reports of trials show what very low striking velocities are now employed for the service test of plates :

TESTS OF BETHLEHEM PLATES BY CAPPED PROJECTILES.

Plate.		Gun.	Projectile with Cap. Weight	Mean Striking Velocity.	By Tressider's Formula.		Remarks.
Nature.	Thickness.				Penetration. Wrought Iron.	Figure of Merit.	
	inches.		lb.	f.s.	inches.		
Harveyized casemate for St. Louis.	4.0	4-inch	33	1418	5.8	1.45	3 Midvale shot. All broke on face. Penetration less than 1 inch.
Nickel steel casemate for Pennsylvania.	5.0	5-inch	50	1558	7.4	1.48	2 Midvale, 1 Carpenter shot. All broke on face. Penetration 1.7-inch.
Krupp steel barbette of Nebraska.	7.5	8-inch	257	1584	13.7	1.83	1 Wheeler-Sterling, 1 Carpenter shot. Both broke on face. Penetration 1.8-inch.

In every instance the plate passed the test. The low figure of merit required as compared with that attained by plates of three years ago, which were only assailed by uncapped shot, is most notable. Thus the standard test for British 4-inch and 6-inch plates in 1901 was that they should have a figure of merit of 1.9 and 2.25 respectively. The resisting power has declined 20 to 25 per cent. It is not that the plates are inferior, but the capped projectiles are better. Whatever the reason for the decline, there is no doubt of the fact that the plates will give much less protection than was expected when the ships were designed.

The trials do not in themselves show that capped shot are effective at such low velocities, but it is not to be supposed that experts who supervised the test of the plates would have used capped shot at the velocities recorded unless they were thoroughly satisfied of their efficacy. We have, besides, the dictum of that high authority, Mr. Meigs, of the Bethlehem Company, who states positively that capped shot are efficient at low velocities. Mr. Meigs also somewhat upsets our previous ideas as to the inefficiency of capped shot for oblique impact by forwarding an account of a trial of a capped 6-inch shot against a hard-faced plate at an angle of 45°, in which the shot did very good work.

ATTACK OF INCLINED PLATE AT BETHLEHEM, MARCH, 1904.

Plate.		Gun.	Projectile with Cap. Weig't	Striking Velocity.		By Tresidder's Formula.		Remarks.
Nature.	Thickness.			Actual.	Resolved Normal to Plate.	Penetration. Wrought Iron.	Figure of Merit.	
	inches.		lb.	f.s.	f.s.	inches.		
Special Bethlehem for inclined armor.	4.5	6-inch.	100	2137	1511	9.0	2.0	Piece of plate punched out. The shot broke and remained in front.

The result is said to be fairly representative of other trials. If this is so we must admit that the improvement of the metal of the projectile has extended the usefulness of the cap. In any case the projectile is gaining rapidly on the plate, and it will be necessary to increase the thickness of the armor.

—*Naval Annual*, 1904.

New Guns, France.

A new design of gun of various calibers has been approved for the French navy, and orders have been issued for the manufacture of weapons of the new design for the ships now being constructed. This new material will be designated as Model 1902. It differs from that of Model 1893-96, which preceded it, in improvements in construction, in ballistic qualities and in the ammunition and service of the piece. The notable feature is the higher velocity to be developed—over 3035 feet feet per second, while it is not so many years since 2000 feet per second was considered the greatest realizable. The new guns will have a length of 50 calibers, making the 6-inch weapon 25 feet long, and the 12-inch guns 50 feet. Changes are to be made in the structure of the gun to increase the support of the muzzle end, the principal improvement being in the form of tubes joggled together and extending to the breech end. The chamber is to be increased in size, and thus the charge may be greater. By reason of the longer barrel, the explosive will have more time in which to exert its expansive propelling force. The 6-inch gun will be increased in weight from 8.1 to 9.5 tons, as compared with the British service weapon of 7.4 tons; while the 12-inch gun will be 60.8 tons, as compared with 44.4 tons of the existing weapon, and with the 46-tons gun in the British service. There will, however, be a very considerable increase in muzzle energy, equal to 15 per cent in the case of the 6-inch gun and 40 per cent in the 12-inch weapon. In other words, a gun of 10.78-inch caliber will equal a 12-inch, while a 9.45-inch weapon will prove as effective against armor of the latest quality as the old 10.78-inch. A considerable reduction in weight must follow, or a greater number of guns be installed for the same weight. This is a matter of the highest importance. The result is due in part to the adoption of an explosive composed of greater power and yet of less erosive effect than that adopted in the British navy. Exact figures for these new guns are given only for the two calibers 30.5 and 16.4 cm. These are shown in the following table in comparison with corresponding data of guns of the same caliber, Model 1893-96.

	M 93/96	M. 1902		M. 93/96
Caliber .... cm.	30.5	30.5	16.4	16.4
Length of gun .... cal.	45	50	50	45
Weight of gun .... tons	44.4	60.8	9.5	8.1
Weight of charge .... lbs.	216			42
Weight of projectile .... lbs.	750	750	115	115
Muzzle velocity .... f.s.	2560	3035	3035	2840
Muzzle energy .... ft-tons	33,970	47,845	7,328	6,394

—*Internationale Revue.*

Coast Defense Guns, Japan.

It is probable that in the near future the Japanese will be independent of foreign makers in the provision of large guns for coast defense, just as they expect, with the increase of their naval gun-making establishments, to be eventually able to supply their new warships entirely with pieces of home manufacture.

The earlier coast defense guns were made largely by the celebrated Schneider-Canet Company at Creusot, France. The gun is mounted upon a disappearing carriage. The gun and mount are normally contained in a circular excavation. The gun is carried upon the upper ends of a pair of arms, which hold the gun trunnions. The lower ends of the arms are pivoted to a rotating carriage. The breech of the gun is supported by another pair of arms, and the mechanism is such that the gun can be lowered out of sight below the parapet for loading, the gun and crew during the operation being out of sight of the enemy, and sheltered from shell fragments by a horizontal circular overhead shield. The gun rises to battery through this shield, and recoils, on firing, back and down through a slot in the shield for reloading. The 10.5-inch gun weighs $21\frac{3}{4}$ tons, the mount $61\frac{1}{3}$ tons, and the projectile 475 pounds. The muzzle velocity is 2198 feet per second, with a charge of 90 pounds of smokeless powder.

Of late years, however, the Japanese have abandoned the disappearing gun in favor of guns mounted "en barbette," the gun appearing permanently above the parapet. These are also built at Creusot. It is carried on a gravity-return barbette carriage. The gun, by its trunnions, rests in the bearings of a massive cast slide, each half of which carries half a dozen steel rollers on which the gun moves in its recoil up the inclined paths of the lower rotating carriage. The usual recoil checks are provided and the gun returns to battery by its own gravity aided by the action of coil springs. The whole gun carriage is carried upon a circle of steel rollers, and the gun is elevated and traversed to right or left by crank arms operated in the usual manner. The Japanese forfications are armed with this type of heavy gun in various sizes.

Explosives Report for 1903.

The following abstract relating to Dr. Dupre's research work during the past year is taken from the report of H. M. Inspectors of Explosives for 1903 : "During the past year research was confined to the beginning of an investigation into the various processes which have from time to time been proposed to test the stability of nitro-explosives. Professor Will's test, although it is, in my opinion, the most important process proposed, since the introduction of the heat test for the examination of nitrocellulose, has not as yet been examined. Firstly, because it has already received a good deal of independent investigation; secondly, because it has, to us, the drawback of being applicable to only one kind of explosive, and to that, apparently, in one particular form only. Our confidence in the present heat test, as a guide to safety, based on many years' experience, is unshaken. The Home Office has now controlled, mainly by the heat test, the purity of all nitro-explosives manufactured in, or imported into, this country for a period of over 30 years. During that time many thousands of samples of explosives have been examined, representing a large number of different manufactures, and no case is on record of an explosive having been passed which subsequently turned out to be in an unsafe condition.

"There are, however, some reasons for believing that, under certain conditions, especially if the explosive has been kept for any length of time in a warm place, our heat test may be rather more severe than public safety imperatively demands. In such cases some relaxation may be desirable, and it is mainly with a view to meeting such cases that the present research has been undertaken. The application of the test, no doubt, requires a certain degree of skill and knowledge on the part of the operator, and without such knowledge the test will give results of little or no value. Persons not possessed of this requisite skill and knowledge had better leave this test alone.

"I need not give details of all the work done during the year, this will appear in due time, in the full report to be submitted to the department. As, however, two of the processes have never before been described publicly, I should like to put some short account of each on record. The first of these consisted in heating a given weight of dry guncotton (usually 2 to 2.5 grms.), contained in small weighing bottles, to a temperature of 130° C. Two equal portions are taken and heated for ½ hour, the bottles fitting fairly well into copper tubes immersed in an oil bath. Next the bottles are carefully weighed after cooling, and replaced in the tubes. One of the bottles is then reweighed after the lapse of two, the other after the lapse of four hours. The loss in weight will, it is anticipated, give a measure of the stability of the explosive. A third bottle, similar to the other two, is used as a counterpoise, and is always heated with the others.

"In the second test the explosive, 2 to 2.5 grms., is introduced into a glass tube about 12 ins. long, 0.6 in. diameter, and of about 50 c.c. capacity. This tube is connected, airtight, on the one hand with a receiver which can be kept exhausted down to about 1 m.m. mercury, and, on the other hand, with a barometer tube dipping into mercury. When the oil bath has attained the desired temperature (130° C. usually) the tube is exhausted, cut off from the receiver, and immersed in the oil bath, by raising the latter. Soon the mercury in the barometer tube begins to fall, and, after the lapse of ¼ hour, the vacuum is restored by putting the tube, for a few seconds, into communication with the exhausted receiver. This process is repeated after the lapse of another ¼ hour. The results of the first ½ hour, although always noted, are usually not included in the subsequent records. After this, however, the real test begins, and the number of m.m. the mercury falls every ¼ or ½ hour is carefully measured and recorded, the vacuum being restored after each observation. The time allowed to elapse between the observations is governed by the amount of gas evolved, the object being to retain a moderate vacuum, say from $\frac{1}{100}$ to $\frac{1}{50}$ of an atmosphere, throughout the experiment.

"This test was first applied to guncotton only, but when, by a simple cooling arrangement applied to the upper part of the heating tube, the nitroglycerine was condensed, and made to run back, it became applicable to nitroglycerine preparations such as cordite, gelignite, blasting gelatine, etc., and even to nitro-glycerine itself. A similar contrivance could be applied to the weighing bottles.

"It is too early yet to draw any definite conclusions, but, so far, it would appear that both the above tests are capable of distinguishing between samples of guncotton of slightly different degrees of purity at least as definitely as Professor Will's test. —*Arms and Explosives*, July, 1904.

Norwegian Rapid-Fire Field Artillery, Ehrhardt System.

The Norwegian artillery was the first to follow the example of France by adopting a rapid-fire field gun with long recoil on the carriage. The Ehrhardt model was selected. The gun is of 75 mm. caliber, has the Nordenfelt eccentric screw fermeture and is mounted on a telescopic-trail carriage. This material was definitely adopted July 8, 1901, after competitive tests and extended trials of models submitted by various competitors. The Rheinische Metallwaaren und Machinenfabrik received an order from the Norwegian government for 132 guns with 500 rounds per piece and for 72 caissons. This material was issued to the troops in July, 1902.

As with the French field gun, rapidity of fire, over 20 rounds per minute, is the essential feature of the Norwegian gun. Its principal points are the following:

1. The carriage remains very steady during firing, not only on level ground but also when the ground slopes to the rear. The telescopic arrangement for lengthening the trail ensures this stability in cases when a trail of ordinary length would not be sufficient. There are no shoes to lower under the wheels. The road brakes can be applied when firing is executed but it is not necessary to do so.

2. The gunners, seated or kneeling at their posts, can carry on the service of the gun continuously.

3. The detachment is protected by detachable shields proof against shrapnel bullets and infantry fire.

4. Derangement of aim during firing is suppressed. The gun does not possess the "independent line of sight."

5. Fixed ammunition is used.

6. The shrapnel weighs 14.3 lbs. and contains 280 11-gram bullets. The fuze is a combination one; the limit of time-fuze fire 6100 yards. Explosive shell has not yet been adopted.

7. The muzzle velocity is 1640 f. s.

8. The Ehrhardt process for producing weldless and non-rivetted tubes has been extensively employed in the construction of the gun, the cradle, the trail, the axle, the projectile bodies, the sockets, etc., thus ensuring great strength and lightness.

The gun is of nickel-steel, with a jacket, the joint being covered by a screw collar. It rests on the cradle and is fixed to the brake-cylinder, which it drags to the rear on discharge, and which brings it back into the firing position by means of springs, after it has recoiled a distance of from 39 to 48 inches. Slots engaging the guide-rails on the cradle keep the gun in position. Along the gun on each side, and in rear, are fixed plates protecting the cradle. The breech mechanism is the Nordenfelt eccentric screw, and is so arranged that the layer, seated on the left of the breech, fires the gun. The thick shoulder of the breech block, due to the eccentric screw, is turned towards the top, which gives advantages in placing the gun on the cradle and increases the maximum angle of elevation. The French model is similar.

The carriage consists of a cradle and top-carriage, and a lower carriage with telescopic tubular trail and trail spade.

The cradle is trough-shaped, without weld or rivet, carries the gun and encloses the hydraulic brake and recuperating springs. The brake piston is fixed to the front end of the cradle, while the brake-cylinder is drawn to the rear by a lug on the breech. The recuperating springs are disposed round the cylinder; they are compressed on recoil against the rear end of the cradle, and bring the gun back into the firing position. The walls of the cradle, like the protecting plates, are sufficiently removed from the parts they cover to keep the bosses on their surfaces from interfering with the movements of recoil and return.

The cradle is supported in the middle by a top-carriage which is attached to the axle and forms a pivot; and in rear, by the laying mechanism. The motion of the cradle for laying in elevation is about the axle of the piece, and for lateral direction is about this pivot. The sights are on the cradle, and the foresight can be folded down.

Lower carriage. The trail consists of two steel tubes of circular cross-section, fitting telescopically one inside the other. Thus a comparatively short trail can be used on the march, or when shooting either on a slope trending downwards toward the objective or at long ranges. For small angles of elevation, or on ground sloping to the rear, an extension of 27.56 inches can be obtained.

The lengthening and shortening of the trail is quickly carried out. The former movement is made generally after the first round, which fixes the spade in the ground; it is not however indispensable to the steadiness of the gun on level ground. It is not extremely inconvenient to maneuver limbered up with the trail elongated.

At the end of the trail is a short fixed "spur", a folding trail-spade, and a traversing handspike, also folding. There are two seats on the carriage, one on the left for the layer, the other on the right for the number working the breech screw.

A travelling road brake with shoes can be applied if desired during firing.

The axle is hollow. The nave is of compressed steel. Two seats are provided on the axle for the detachment on the march. The carriage is fitted with detachable shields, which are as a rule carried on the caissons or limbers.

The caissons and limbers are very light, owing to the fact that steel tubing is largely employed in their construction. The stores are packed as low as possible. The fixed ammunition lies horizontally separated by cocoanut matting, in wicker baskets containing 4 rounds each. The limber carries 36, and each caisson 112. The caisson bodies are not armoured.

Ammunition. Shrapnel and explosive shell; the pattern of the latter has not yet been finally decided on. The former is grooved on the inside and has the bursting charge in the base, and a smoke-producing composition assists observation. With the fuze set at 0 the shrapnel serves as case shot.

The following are some extracts from a report of practice and marching tests carried out at Lexdalen, August 4th-10th, 1903. These experiments were made with a view to determine the ballistic qualities of the new material and for the purpose of drawing up as soon as possible the drill regulations and instructions for practice for the new gun.

The material was entirely satisfactory, except that a better sight was considered advisable.

The Rödfos powder produced a considerable amount of smoke.

The fuzes acted admirably at long ranges, but were somewhat erratic at short ones, varying as much as 169 yards in 8 or 9 rounds.

Two baskets containing 4 pounds were put under water, one for 15 and one for 30 minutes, without affecting the subsequent practice.

The shields, which are .138 inches thick, were scarcely dented by shrapnel bullets, but fuzes and large portions of projectiles easily penetrated them. The quality of the metal is excellent.

The Committee consider that accurate shooting is possible up to 4900 yards and that an enemy can be considerably harassed up to 6000 yards.

—*Revue de l'Armee Belge*, January-February, 1904.

Rearmament of the Field Artillery, Belgium.

Since September 15th, 1903, the Belgian government has been conducting tests of various types of field guns and carriages submitted in competition by various firms. These tests have been most carefully and thoroughly carried out. All taking part in them, including the representatives of the competing firms, acknowledge that they were conducted impartially, the main desire being to determine the system best suited to the needs of the government.

Various accidents have marked the course of the trials, which account in a measure for the length of time it has taken to complete the program. The great secrecy that has prevailed in regard to details of the experiments has rendered it difficult to obtain precise information on the subject during their their course. It is not without difficulty that we have been able to procure the following information.

The last part of the program had for its object the determination of the relative resistance of the several types to the fire of the enemy. The pieces were first subjected to infantry fire executed normal to the front and at close ranges from about 600 to 200 meters; then to shrapnel fire, the shrapnel containing steel bullets; and then, finally, to fire with explosive shell. The material did not suffer from the infantry fire. On the other hand, the cannoneers were hit at all ranges in spite of the shields. And what, indeed, appeared even more surprising was the fact that the cannoneers of the piece with a rigid carriage, which had no shield to protect them, received but few more hits than the others. The steel shrapnel bullets proved infinitely more destructive to the material. All the shields were penetrated as with a punch, their fastenings, hinges, rivets, bolts, bent or torn out. A single one, thicker than the others, resisted penetration but was completely dismantled.

It was shown, besides, although only 3 or 4 rounds of this nature were fired, that a steel bullet which happens to hit a slide or guide rail, or any other essential organ, would put the gun hors de combat. It was the fear of completly disabling the pieces, it seems, that prevented the commission from exposing them to a more prolonged fire. As to the fire with explosive shell, it would seem that it caused less injury than the preceding.

The rigid carriage, not having any delicate parts, came out of these trials free from damage. A useless result, however, for what is desired to-day are carriages that remain immovable when the gun is fired.

As a result of the tests two types have been chosen for final consideration. These two are those of St. Chamond and Krupp. They are based on different principles but both possess the qualities that the Belgian artillery demands of a new gun and especially of a new carriage. The other types have, without doubt, also shown certain qualities, but are far from equaling the two that the commission recommends to the government for purchase for the purpose of continuing practical trials with them in the field.

Before reaching a final decision, accordingly, the Minister of War, accepting the recommendations of the commission, has asked for an appropriation to purchase some guns and carriages of these two types, which will then be put in the hands of troops. Recently the Minister of War has renewed in the Senate his request in regard to the continuation of the trials from a practical point of view. So very soon there will be turned over to the troops one battery from Krupp and one battery from St. Chamond.

—*La Belgique Militaire.*

Italian Field Artillery, 1904-05.

In the budget for the coming fiscal year, an examination and report is made on the present situation and needs of the Italian field artillery. The report says: If we consider as distributed all the material which is to be issued during the year 1904, the present status of field artillery in Italy will be as follows:

Mountain batteries: All the material consists of the 70 mm. pieces, steel. Horse batteries: All the material consists of the 85 mm. pieces, steel. Field batteries: There are 99 batteries equipped with the 75 mm. pieces, steel, and 145 batteries with the 87 mm. guns of bronze, model 1880–1898.

In principle, the model of the carriage for the field gun has been adopted. At present a new type of long recoil field material is being constructed. The new model is the result of the tests that have been made. When this material is completed, it will be compared with the best model from the Krupp firm. Theoretical studies on a material for a long recoil mountain gun have led to the conclusion to construct a gun less powerful than that of the 70 mm. material, steel. Comparative tests will determine which is the best model to adopt.

On the whole, the work completed or shortly to be completed is as follows: 36 mountain batteries of 70 mm. guns, steel, representing an expense of 4,000,000; 120 field batteries of 75 mm. guns, steel, costing 24,000,000; or a total expenditure of 28,000,000.

Studies and experiments will be continued in order to determine in all their details the conditions to be fulfilled by a mountain gun and a field gun answering modern requirements and developments and possessing all the improvements resulting from scientific investigation. The report states that the questions to be solved relate to long recoil carriages, shields, armored caissons, reduction of the number of guns to four per battery, the increase of the number of batteries resulting from this modification, ammunition supply for the batteries, etc.

All these transformations depend on financial resources, and as Parliament appropriated 60 millions for this purpose, there yet remains available the sum of 32 millions since the contracts thus far made amount to 28,000,000.

—*La France Militaire*, July 5, 1904.

Swiss Field Artillery Organization.

The Swiss Federal Chambers have recently adopted the new reorganization scheme recommended by the Federal Council in consequence of the adoption of new R.F. material; 72 batteries of 4 guns each will be formed in place of the present 56 batteries of 6 guns each, or 16 batteries more, but 48 guns less; 2 to 3 batteries will form a brigade division; 2 to 3 brigade divisions will form a field artillery regiment. According to arrangements, brigade divisions of 3 batteries will be the rule; as regards the composition of the regiment, it will be adapted to the organization of the large units; the question with regard to the abolition of corps artillery remains an open one.

Effectives of batteries, brigade divisions, and regiments will be fixed provisionally by decrees of the Federal Council. The allowance of ammunition is fixed at 800 rounds per gun, instead of 500 as at present; the battery will thus be supplied with 3200, instead of with 3000 rounds. The total number of caissons remains as formerly; but the new battery consists of 4 guns, 10 caissons, 1 six-horse wagon with forge and kitchen, 1 six-horse van, and 2 two-horse provision wagons. Each battery will, in addition, have 8 caissons parked.

Coast Maneuvers at Lorient.

The combined maneuvers between the torpedo boats of the mobile defense, representing a hostile naval force, and the troops for the defense of the military port of Lorient, took place on the 22nd and 23rd of June, 1904.

Three tugs had transported to Groix Island the artillery and infantry troops for manning the batteries of that island, and for opposing an attempt at landing. Elsewhere, the rest of the troops proceeded by rail to the stations that would be manned by them in time of war. All these movements took place under the general orders for mobilization emanating from the headquarters of the maritime prefect. They were carried out skilfully and in perfect order. The personnel of the fixed defenses, including that of the searchlights and observing stations, likewise went to its posts on the 22nd.

Towards 2 o'clock in the afternoon the torpedo gun-boat Lance, carrying the flag of the commandant of the mobile defense, and the torpedo boats 197, 78, 82 and 86 left the harbor. They went first to Gâvres Bay to carry out some torpedo practice-firing, having no relation to the coast exercises, after which the Lance and the 197 returned to Lorient, while the other torpedo boats went to sea and disappeared from view. It was not until night fell that the first phase was begun. This consisted of a run-past, its object being to exercise the batteries in following the movements of torpedo boats illuminated by the searchlights and in firing upon them. Towards 11 o'clock the batteries ceased firing and the lights were extinguished.

The next day at about 5:30 in the morning, the Lance and the four torpedo boats put to sea again. This small squadron, which represented a fleet of the line, divided into two divisions. The first comprising the Lance and two torpedo boats went off to the south of Groix, while the second, composed of two torpedo boats proceeded to direct its attack from the direction of Pouldu Bay.

Groix Island, on account of its situation, would very likely tempt an enemy. Without being altogether protected from a sudden bold attack, it is to-day in condition to offer serious resistance to a fleet, thanks to the works that have been constructed in recent years; by its powerful batteries it ought also defend Lorient from bombardment and from a surprise by day, for by night there is little possibility of foreign vessels even of small tonnage entering there if care is taken to extinguish certain lights or to modify their character.

Towards 8 o'clock in the morning the fleet represented by the Lance and the torpedo boats came up from the south to bombard first Loc-Maria, a little port on the southern coast, where it was supposed a disembarkation would be made. But it was only a feint. Turning to the west, the fleet soon after came to anchor at the entrance of the harbor of Saint Nicholas, rapidly lowered its boats and sent a detachment ashore. A detachment of the 62nd of the line, hidden in the rocks, received it with a hot fire. No doubt the landing party could have secured a footing on the island, as the defenders were very few in number. It thought otherwise, however, and retired, while detachments of the reserve came running up from Loc-Maria and Pen-Men, firing from the top of the cliffs upon the fleet, which having shipped its boats withdrew at full speed towards the east, throwing a few shell over Loc-Maria as it passed.

In the case of a real attack the marines would, without doubt, have succeeded in disembarking in small numbers before the arrival of the supports; but it is probable that they would not have been able to maintain themselves any length of time on shore. However a strong landing party supported by rapid-fire artillery could perhaps be successful from this side, especially if the defenders of the island, as was observed, advanced in the open and in a compact body towards the sea, imprudently exposing themselves to the fire of the Hotchkiss guns of the fleet. But the days are very few on which the nature of the sea would permit an attempt at disembarkation on this steep and rocky coast almost always beaten by the waves of the open sea, a valuable auxiliary to the defense.

The attacking division then rounding the Pointe des Chats proceeded to bombard the coast works erected at the northeastern part of the island. These replied briskly, as well as Forts Gâvres and Loquettas, on the mainland, which immediately took part in the action.

The Lance and the torpedo boats then maneuvered in Gâvres Bay, continuing their bombardment to the east of Port-Louis. They finally rejoined the second division, Nos. 197 and 82, at the anchorage of Port-Tudy. The latter division had all morning attacked the works to the west of Lorient, and attempted a landing on the beach of Pouldu.

The exercises closed at this point. They were carried out with great spirit, and the resources of the defense of the port could not well have been better tested than by these maneuvers in which all the elements of the defense were put in operation.—*Le Yacht*, July 2, 1904.

Progress With Submarine Boats.

It is perfectly obvious, says "Engineering," that the practicability of the submarine boat is now established, and even from the limited information available it is clear that the ships built by the Vickers Company for our Navy are superior craft. The difficulty of maintaining a uniform depth has been quite overcome, and with the help of the periscope, or optical tube, it is clear that objects can be plainly seen, although in the several systems applied in various navies there is a wide difference in the arc of vision. This has been met in the British boats by an increase in the height of the conning tower, which has also been made ship-shape, so as to involve as little disturbance as possible in passage through the water, the success of submarine attack being necessarily dependent upon the invisibility of the ship, and the range of vision of the officer within the conning tower. France has now 26 submarine or submersible boats built, and 20 in course of construction; Britain has 9 built, and 21 building or projected; the United States has 8 built; Germany has constructed, or in progress, 5; Russia 7, and Italy 5. It is said that the French boats are only utilisable in local harbor defense, but some of the vessels to be built will have a much larger radius of action. The British boat is also said to be more efficient in buoyancy, and is more quickly submerged. As to the sea-keeping qualities of the vessels, a writer in the 1904 "Naval Annual" points out that the British vessels have behaved well in bad weather off the Lizard, while the French boats have been maneuvered off Cherbourg, Brest, and Lorient, in a considerable sea. He suggests, however, that bilge-keels might check rolling and improve the comfort of the crew. The vertical sides of the upper part of the hull adopted in the French Triton class steadies them. The author strongly advocates the importance of a torpedo of longer range than that of 2000 yards, and states that experiments are now being carried out with 18-inch torpedoes, which run 3300 yards; while the United States Navy Department have on order two 21-inch torpedoes to run at 26 knots for 4000 yards, and there are reports of 18-inch torpedoes to run 3000 yards. The use of the gyroscope very materially improves the efficiency of the submarine. The gyroscope, it is hardly necessary to mention, enables the torpedo to be fired at any angle to the fore-and-aft line of the submersible boat. The British vessels have two tubes in the bow, while some of the French vessels carry four tubes—two pointing ahead and two astern. With these improvements there can be no doubt of the effectiveness of the submarine boat. Up till now there has been no successful method evolved of combating the submarine attack. The idea of an outrigger carried by destroyers has not proved successful, and it is suggested that destroyers should have quick-firing torpedo tubes. The speed of the submersible boat when under water is not likely to be more than 7 or 8 knots, so that a comparatively cheap and light torpedo which would run at 16 knots for 300 yards would overhaul the boat.

Messrs. Vickers, Sons and Maxim are very busy completing submarines in order to have as many of these as possible ready for the naval maneuvers which are to take place off Holyhead. New experiments of an important character will be tried on at least one of the latest boats.

The Torpedo as a Defense of Harbors.

A useful field for the employment of the torpedo, which I have not as yet touched upon, is for the defense of harbors not suitable for mining, both from regular or improvised torpedo batteries on shore, or from submarine boats. It is well known that there are many harbors in which, owing to a great depth of water, rapid current, or other causes of a like nature, it is almost impossible to establish a thoroughly reliable system of mines. Here we have a field in which the automobile torpedo is without a rival. In the first place the ease with which it may be fired is not thoroughly appreciated by most people. The regular firing tube may be set up almost anywhere in a very short space of time, for the recoil of firing is not great. It is also a fact that absolutely no launching apparatus is necessary. Two men may stand in the water and point the torpedo while another pulls the starting lever, and good shooting is easily possible by this method. An old barrel with the heads out forms an easily operated means of pointing in this manner.

A method of submerged firing from a stationary battery on shore may be also easily knocked together. If an ordinary above-water tube is available, all that is needed is a coffer-dam to hold it, of such a character as may be easily extemporized from readily available material, by a carpenter's gang of ordinary intelligence. The only change that would have to be made in the tube itself would be to take off the spoon and secure the tube-mouth to a hole in the coffer-dam by some form of sluice valve, and I feel sure that a wooden hull connection and valve of this sort could be readily made that would answer all purposes. Such coffer-dams should be constructed and temporarily moored as desired, and an enemy would have very little chance of knocking one of them to pieces.

The advantages offered by this style of harbor defense in places where mines are not available, or even as an adjunct to mines, are so great that I am at a loss to understand why it has not yet been taken up. A more powerful torpedo could be used from permanent shore batteries than it is possible to carry aboard ship, where the confined space available for handling marks the present five-meter torpedo as about the limit in length. By increasing the dimensions of the torpedo to about double those of that now in use aboard ship, I see no reason why a range of 5000 yards with a speed for that distance of 30 knots should not be attained by a torpedo carrying 200 pounds of explosive, and such a weapon should give a speed of over 40 knots for 1000 yards. From a shore battery, where range and position of the enemy can be readily determined, such a weapon should be absolutely accurate and reliable.

A great difficulty that presents itself in the defense of all harbors is the question of fog. A place like the Race, for instance, where mines are not reliable, furnishes a splendid field for use of the torpedo. I think it will be admitted that an enemy who had a sufficient knowledge of our coast to enable him to dare the risks of ordinary navigation, would stand a very fair chance of success in an effort to take his fleet through the Race in thick weather, as far as the stationary mines and shore defenses are concerned, and when the immense advantages to be gained by such procedure are considered, I have no doubt that any wide-awake enemy would do just that thing. But would he dare to try if he knew that there were a half-dozen submarines, armed with modern torpedoes, cruising to and fro across the passage? And if he did try it under those conditions would he not be more than likely to pay an enormously high price for this effort?

Therefore, I believe that, in all harbor defense work, but especially in those special harbors where the use of stationary mines is beset with unusual difficulties, the use of the automobile torpedo is an absolute necessity,, and one that is very unwise to neglect in the way in which we are now doing. Regular shore submerged batteries, with powerful torpedoes; extemporized shore batteries, submerged or otherwise, with our service weapon; and the mobile torpedo batteries furnished by the submarine boats; taken in conjunction with such stationary mines as can be used, and an outer and constantly shifting line of regular torpedo boats, will beyond question form a defensive barrier that it would be madness for a hostile fleet to attempt, and the two mobile features of such a defense would also go far to keep such a fleet at a respectful distance from the harbor mouth. In a word, such a force, I believe, would render any such thing as forcing a harbor or maintaining a successful blockade impossible, except at such a cost that no nation would be able to stand it.

—Lieut. Lloyd H. Chandler, U. S. N., in Proceedings Naval Institute, No. 108.

The French First-Class Battleship Democratie.

The first-class battleship Démocratie was launched at Brest on Saturday, April 30, 1904. She is the third of the program of 1900, and was commenced April 5, 1902. The two preceding ships are the Republique and the Patrie, constructed, respectively, at Brest and La Seyne. Three more on yet on the stocks; the Liberte at Saint-Nazaire, the Vérité at Bordeaux, and the Justice at La Seyne.

The dimensions of the Démocratie are as follows: Length, 135 meters (443 feet); beam, 24.25 meters (79.5 feet); draught, 8.38 meters (27.25 feet) with a displacement of 14.927 tons. The details of the hull and of her protection are the same as for the Republique. The armored belt is 280 mm. (11 inches) thick at the water line, tapering to 7 inches forward and 5.5 inches aft, the belt being carried to a height of 2.30 meters (7.5 feet) above the water line. The armored deck has a thickness of 70 mm. (2.75 inches) on the inclined and 50 mm. (2 inches) on the horizontal surfaces, and the upper deck 60 mm. (2.36 inches) armored plates. The turrets for the heavy guns are protected by 12-inch armor; the small turrets and casemates for the secondary armament, with 6-inch, while the conning tower is also 12-inch. Above the belt forward to the bow to a height of 5.20 meters (17 feet) the side will be armored with 64 mm. (2.5-inch) plates.

The armament has been considerably altered with respect to the first two units of the class, while she was under construction. It comprises four 305 mm. (12-inch) 45-caliber guns, in two turrets, forward and aft; ten 194 mm. (7.6-inch) guns, six in turrets and four in armored casemates on the deck below; twenty-six 47 mm, (1.8-inch) and two 37 mm. (1.4 inch) guns. The 7.6-inch guns are disposed in the same manner as the 164 mm. (6.4-inch) guns of the Suffren and they are the same in number. These ten guns have been substituted for the eighteen 6.4-inch guns of the R publique. It may be asked if the increase in caliber compensates for the diminution in number; we do not think so, and the armament of the République seems to us preferable. To obtain this compensation it would be necessary either to add some 100 mm. (3.9-inch) guns, as in the Suffren, or to replace the 1.8-inch guns, recognized to day as insufficient, by at least 65 mm. (2.5-inch) guns and better by 75 mm. (2.95-inch) guns, a piece yet to be introduced in the Navy.

Though the number of guns has been diminished, on the other hand the same number of torpedo tubes has been retained as in the Republique: two submerged, two above water under light armor, and finally one at the extreme stern, situated in a place totally devoid of protection. All the weight due to this tube could very well have been economized, the tube itself being of doubtful utility.

Three engines are to develop 18,00-I. H. P., giving a speed of 18 knots with 110 revolutions. Originally the Democratie was to have Belleville boilers; we do not know whether they have been ordered.* Her radius of action with 1,850 tons of coal on board is 8,299 miles at 10 knots, and 1,880 at full speed.

Compared to similar ships of foreign navies, the Democratie holds a creditable place. The French battleship is clearly superior as regards armament and protection to the English Formidable class, of the same displacement, and to the Duncan class. To find a battleship of heavier armament we must pass to the King Edward VII., the displacement of which is in the neighborhood of 17,000 tons. But the Democratie maintains even over this latter the advantage of a better devised protection.

Germany, without attaining the large displacements of the Democratie and English battleships, has in the Braunschweig type of 13,000 tons one most nearly approaching the Democratie.

In the Regina-Elena type Italy will have a ship a little less protected than the Democratie but more powerfully armed and possessing the speed of a cruiser. All these qualities, obtained with 12,600 tons displacement, rather overshadow defects of another nature, notably a lack of free-board.

It is to the American ships that we must go to find a battleship clearly superior in power to our type Democratie or Republique. The Connecticut class of 16,000 tons and 18 knots, now on the stocks, possess with sufficient protection the heaviest kind of armament: four 12-inch, eight 8-inch, twelve 7-inch, and twenty 3-inch. Nevertheless, we prefer always the system of protection, especially that forward, of the French battleships.

—*Le Yacht*, May 7, 1904.

Underwater Armor.

The small depth below water to which armor plating is carried in all classes of warships is a feature which has been so long accepted, that its full bearing upon the question of armor protection is apt to be left unnoted. Taking the case of a typical first-class battleship of 75 feet beam, if the armor belt extends six feet below water an angle of inclination of less than 10° in still water would emerge the unarmored portion of the bottom. If the coals were consumed and other stores or ammunition expended, of course, a less angle of inclination would produce the same result in still water. When a vessel is

* The contract has now been awarded the Belleville firm for the boilers of the Democratie and the Verite in construction at Bordeaux. Each battleship will have 22 Belleville boilers, capable of developing 18,000 H. P. The choice of these boilers is a guaranty of the future efficiency of these two powerful fighting units.—*Yacht*, July 2.

moving at speed in still water, the the wave-profile along her sides, at certain portions of the length, considerably lowers the water level, and so diminishes the depth of the armor below the surface; even exposing the unarmored bottom at certain points. In a seaway a very moderate rise and fall of the wave-surface exposes many portions of the unarmored bottom; and rolling or pitching of moderate amount may produce greater exposure. Here again there is no difference of opinion as to the facts, but a very frequent forgetfulness of what the facts involve. It is generally assumed that projectiles which do not impinge upon the hull of the ship because their range is a little short can have little or no chance of penetrating below water and reaching unarmored portions of the hull. Long ago it was proposed to use "flat-headed" projectiles for this purpose, but the objections to that form of head were obvious, and no practical effect has been given to the proposal. As remarked above there is nothing more difficult than to obtain the exact range required in order that a vessel may be struck at, or very close to, the water-line, and this is especially true in the long distance firing which now finds favor; but it is interesting to note that in the action at Port Arthur the Japanese are said to have made most excellent practice against the Russian ships and to have seriously damaged some of them at or below the water-line. The increasing use of range-finders of a trustworthy character may have had something to do with this result; and it is known that the Japanese were well equipped in this respect; but other means may have been taken in this special case for accurately determining the range against ships which were at anchor and in fixed relation to well-known positions on shore. However this may be, enough has been said to show that it would be folly to regard the unarmored portions of the bottoms of ships as safe from all attack of gun-fire. At the same time that risk is hardly worth mentioning when compared with the dangers resulting from under-water attack by torpedoes, of which the speed, effective range and maintenance of course have been so remarkably developed in recent years.

There have been many proposals to extend the use of armor plating to the submerged portions of ships, more especially as a protection against torpedoes. Experiments have shown that, if fitted on the outer bottom, armor is ineffective against the explosion of large charges of explosives in contact with, or very near to, the ships. As a result it has been suggested to fit armored inner bottoms (or wing bulkheads) at a few feet inside the outer skins, which were to be formed as usual of thin steel plating. Sir Edward Reed has patented arrangements of this nature, and Russian designers are reported to have constructed armored "wing" bulkheads in their latest battleships. The Borodino class are said to have vertical and longitudinal armor bulkheads 4 inches thick in wake of engines and boilers, extending from the armored deck down to the turn of the bilge (about twenty-three feet below water) and placed about five to six feet from the outer skin, and 4-inch armor on the outer bottom. The latter item seems doubtful. In the Cesarevitch it is stated that there are armored wing bulkheads, but ordinary outer skins. This ship is one of those attacked by the Japanese torpedo flotilla at Port Arthur and very seriously damaged. As yet our information is incomplete, but so far as is known the armor protection to the under-water portions of the Cesarevitch have been altogether ineffective, and she has been put out of action as completely as her companion ship, the Retvizan, which was constructed in the ordinary manner. Personally, I have been always opposed to this application of under-water armor, chiefly because it appeared probable that, even with external armor fitted at some distance from the outer bottom, the effect of the explosion of a modern torpedo would produce such serious shocks and jars upon the armored inner bottom or bulkhead and its fastenings, that leakage into the interior would result even if the armor itself was not perforated or driven in. So far as can be judged from accounts hitherto available, this form of injury really proved fatal to the Cesarevitch, for it would seem that she was kept afloat for a considerable time by her pumps, and this suggests that the leakage which occurred was through openings having a small aggregate area such as would result from "jarring" of the rivets and fastenings, rather than from any large holes in the water-tight portions of the structure, through which water would pour in large quantities and overpower the pumps.

Another serious danger from the use of external armor, supposing that this material did its work and maintained its integrity, obviously arises from the "water-logging" of spaces outside the armor protection, but within the the ship; which water-logging would inevitably result in serious heeling or possibly in absolute instability. Calculations made for typical vessels protected in the manner suggested, have shown conclusively that this danger from water-logging is real and great. On the whole, therefore, my opinion remains unchanged, and, in my judgment, the use of under-water armor as a protection against torpedoes is not to be recommended. Torpedo attacks have no doubt been greatly developed in recent years, by improvements in the speed and increase in the charges of locomotive torpedoes, and it may be anticipated that the school of writers who take exception to the construction of large and costly battleships or armored cruisers will be disposed to point to recent events at Port Arthur as additional proofs of the soundness of their contention that it is unwise to "put too many eggs into one basket."

Before the incidents at Port Arthur, the same opinions were expressed, in consequence of the results of the experiments on the Belleisle, which was sunk by a torpedo explosion. To quote words used by me in my recent address at the Civil Engineers': "History is thus repeating itself, as it is apt to do. It appears to be forgotten that many years ago ships were similarly sunk by torpedoes and the same arguments used. Of course it is necessary, in view of improvements in torpedoes, carefully to consider how the defense may be strengthened, and this is doubtless being attended to. My own conviction is, however, that these improvements in torpedoes are matched by the advances made in rapidity, range and accuracy in gun-fire, and in projectiles and 'bursters.' So that relatively the gun and the torpedo stand much in the same relation as before. In these and in all questions of warship design it is necessary to take a broad and comprehensive view, not to narrow the discussion to a single feature of offense or defense."—*Sir William White in the Naval Annual, 1904.*

Steaming Powers of the Russian and Japanese Fleets.

Since the outbreak of the war the rival warships have gone through several months of active service, and some particulars as to how they have fared may be of interest. For obvious reasons very exact data are not procurable, and such as are available refer to some six weeks ago. Most interest centers in the Japanese ships, which have been submitted to a very severe test indeed. As might be expected, not a single ship is now able to steam at its original speed, but in the majority of cases this seems due to absence of docking rather than to machinery and boiler troubles.

Up to the time of her loss the most efficient steamer in the Japanese fleet was the Hatsuse. An officer of hers, writing only a few days before that event, mentioned that no defects of any kind had appeared in her boilers or machinery, and her speed loss from foul bottom was very little—about half a knot. The lame ducks were the Asama, Yoshino, Chitose, Niitaka, Fuji and Yashima. All these except the Niitaka had had boiler troubles, mostly of the "bird-nesting type." Of these all save the Niitaka have cylindrical boilers, in most cases nearing the end of their span of existence. The Niitaka has water-tube boilers of the Niclausse type, and these appear to have worked well. The ship had either been aground or badly hit, and it was not deemed well to press her upon that account. There is some mystery about her.

Loss of water was experienced in the Iwate after an extensive hit during the battle of February 9th. Her boilers are of the Belleville type. She would seem to have been hit in the region of the boiler-rooms, but her steaming capacity was not affected to any extent, and her own people tightened up the joints that had been sprung.* This ship is at present good for 21 knots. The speed of the Asama has sunk to 18 knots or thereabouts; the other cruisers mentioned are somewhere about the same. The two old battleships were down to something like 14 knots, it being considered unsafe to press their antique boilers. The Mikasa, Asahi, Yakumo, Azuma, Idzumo, were, the time of our advices, steaming fast and well; their Bellevilles had given no trouble at all, and machinery defects had been of a very mild nature. The Shikishima had had no boiler troubles, but some small injury had been suffered by the machinery—probably from Russian projectiles.

As was only to be expected, the destroyers had one and all fallen off in speed under the tremendous strain put upon them. Data of the speed losses are not procurable, nor is it possible to ascertain how far hostile projectiles are responsible. The general feeling on destroyer performances was not one of dissatisfaction, bearing the circumstances in mind. The best steamers of the lot are the Shiakumo and Asashio.

Only one Russian ship has done much hard steaming—the cruiser Bayan. It was the Bayan which, when she reached Port Arthur a little before the war, came up at full speed, exceeding her contract rate at the end of a long voyage. She was therefore in the pink of condition, and from all accounts has so remained right through the war—an all around credit to her designer, her builder, her machinery, her boilers, and her crew.

The Gromoboi and Rossia are both in good steaming condition, and so is the Askold. This ship has Thornycroft boilers; the others have Belleville.

The Novik has been several times injured, and, having been also hard pressed once or twice, her machinery has been shaken up a good deal. It is doubtful whether she can do 20 knots at present; possibly not more than 18. Her boilers are said to be in very passable condition.

The Retvizan had her engines thrown out of alignment when she was torpedoed, and her steaming powers are very poor, despite repairs. The shock developed leaky tubes, but the repairs were not very lengthy. One tube is said to have burst.

The Tsarevitch suffered no hurt at all to her machinery or boilers when torpedoed, and her propellers were untouched, though the torpedo hit her rudder. She is still able to steam at a good speed, the steering gear being the only part of her machinery injured.

* Another version is that the leaks were in the boiler-room, not in the tubes at all.

The Pallada was hit amidships by a torpedo that came through the side and exploded partly in a coal bunker and partly right inside one group of her Belleville generators. The tubes were torn out and bent S shape. They were taken out, straightened, and replaced, mostly by her own engineers.

A not very dissimilar hit was received by the Pobieda, which was hit by a mine in the port boiler-room. The boilers run the length of the ship instead of athwartships, and this probably did much to save the men in the room concerned. A great deal of water came in and the fires were quenched, but no one was injured, no tubes burst, and the ship returned to harbor without assistance under her own steam. In harbor the water was pumped out. No repairs were needed save a patch in the side where the hole was. The main engines were quite uninjured.

The three Poltavas had well-worn boilers when the war began, and none of them seem to have done more than about 12 knots speed. Lying mostly in harbor, the war has put no strain upon them.

In the early days of the war Russian destroyers were hopelessly outmatched in speed by the Japanese; but the harder service to which the latter have been put has done much to equalize this, and there is little to choose between them now. If anything, the Russians have got better speeds out of their destroyers recently than when the war began, which would seem to indicate that past slackness had much to do with their early failures to steam well with these craft. The fastest Russian destroyer is the Schichau-built Lieutenant Bourakoff.

Speaking generally, the engine-room lessons of the war have been as follows:

(1.) The impact of heavy projectiles has a strong tendency to affect the alignment of machinery by shock, but less effect than might have been expected upon boilers, whether water-tube or cylindrical. Only direct hits seem to have affected the generators.

(2.) All small ships, especially torpedo craft, wear out quickly, and lose heavily in speed as the result of hard work.

(3.) The deterioration of big ships is considerably less; and in the case of ships which, like the Idzumo and Bayan were well cared for in the days of peace, very little indeed.

(4.) Disablement of machinery by gun-fire is quite improbable; partial injury is all that is to be feared.

(5.) Cylindrical boilers have proved inferior to water-tubes, or, at any rate, to the Belleville variety, with which most of the water-tube combatants are fitted. The tubes have been easily swept at sea, whereas the cylindrical ships have had to go into harbor continually for cleaning.

(6.) It has not been possible to maintain full speed for any length of time in either fleet, though the Bayan is said to have once steamed nine hours at top speed. One cause of failure has been the physical difficulty of getting the coal from the bunkers quickly enough. It is deduced from this that coal economy is even more important tactically than strategically. A fractional difference in consumption per indicated horse-power means a good deal of difference in three hours' coal shovelling, where large horse-powers are involved. The Bayan in her nine hours' run would certainly have been captured or destroyed had she been unable to keep up the supply of steam. In the majority of the ships engaged, the tendency when full power was wanted was to shovel coal on recklessly. This meant that the boilers were given more coal than they needed, and accelerated physical exhaustion resulted. In the Bayan, firing was done by system and regularly, with the result that less coal was burned, more efficiency per pound secured from it, and the physical exhaustion problem of stoking not felt. The ship has always been remarkable for a low consumption, but the firing signalling system employed undoubtedly bore its share in the paradox that "she steamed away from the enemy by burning less coal than they did!" The most pregnant lesson of the war would seem to be that the all-important qualification for a naval boiler is the giving of the maximum result from every pound of coal. The endurance of the stoker is the rock that lies in the way of keeping up continuous full speed.

We are indebted for the above particulars to officers in the Far East who are in a position to glean the views of the combatants.

—*The Engineer*, July 15, 1904.

BOOK REVIEWS.

The Naval Annual, 1904. Edited by T. A. Brassey, A. I. N. A. 8+486 p. il. pl. O. Portsmouth: J. Griffin & Co. 2, The Hard. Blue Cloth, 15 shillings.

The "Annual" this year, the eighteenth year of publication, contains a number of excellent papers in addition to the usual main features giving full information on the details of ships, guns, armor, etc., and the progress made during the past twelve months.

The progress of navies is given in a carefully prepared chapter by the editor and Mr. John Leyland, and the editor also contributes an interesting chapter on the estimate of comparative strength. Naturally, the two Chilian battleships recently purchased by England, now named the Swiftsure and the Triumph, come in for remark and comparison with English and foreign vessels. It is stated that on the gun trials of the Triumph the 7.5-inch guns, using 200-lb. shot, attained a rapidity of fire of eight rounds per minute and no difficulty was experienced in maintaining this high rate of firing. "The Swiftsure and Triumph are valuable additions to the British navy where in speed and offensive power they have as yet no equals." Their offensive qualities are even more strikingly brought out, in a subsequent part of the book, by the writer on the progress of guns. He makes the effective comparison that owing to the superiority of the new armament, these two ships, which are to be added to the Home Fleet, "could fight the whole five ships of the Royal Sovereign class now in the Home Fleet, with a very fair chance of success."

French progress is ably discussed. Economy seems to be the feature of recent estimates. Efforts of France in the way of battleship strength have only resulted in increased efforts on the part of England, hence M. Messimy comes to the conclusion that French naval policy should be mainly directed to the construction of cruisers and submarines.

As regards Germany it is rumored that a fresh battleship program will be introduced this year. Under Russia only the opening naval actions of the war are referred to, sufficient authentic information not being at hand to deal with the subject effectively. There is a slight slip here, when it is stated the Retvizan had been built specially with a view to resist torpedo attack (p. 15).

"The United States will shortly become the second naval power of the world; there being at the present time no less than 24 first-class battleships completed, completing, and under construction, 13 being in the two latter categories." There follow facts and figures to give convincing color to the statement.

Chapter II. is devoted to prize-firing and naval efficiency. The author makes a five years' review of the progress in prize-firing in the British navy, with many statistics, and the records show a very steady, if not very great, improvement in the gunnery of the Fleet as a whole.

The British naval maneuvers in 1903 are comprehensively dealt with by Mr. Thursfield. While open to a number of criticisms, the maneuvers were of considerable importance, and several significant facts were brought out. "Coal strategy" is touched upon, and a lesson quite similar to the case of our Missouri in southern waters is made evident; that if vessels are to be successful in fleet evolutions, the crews manning them must have experience of their ships. Another point of interest is the use of the heliograph as an effective agency for distant signalling at sea. Heretofore the unsteady platform of a ship at sea has restricted its use afloat. But with apparatus devised by Admiral Wilson it seems to have been used with marked success. With a height of bridge of 40 feet, the signals can be instantly seen and clearly read at over 14½ nautical miles.

By far the most important article this year is Chapter V. on the principles and methods of armor protection in modern warships, by Sir William White, K.C.B., for a long time the Director of Naval Construction at the Admiralty. It is very interesting. The growth of armor application is traced and the changes in distribution necessitated by the introduction of high explosives and quick-firing guns of larger natures very thoroughly gone into. The author is against much economy in the weight of protection, barbettes, etc., is in favor of unarmored ends, and insists that "the *longitudinal extension* of the armor is a matter of much less importance than its *vertical extension*, when considered in regard to the capability of battleships to maintain buoyancy and stability when attacked by modern gun-fire." Casemates, central batteries, protection for secondary armaments, deck armor, its relative importance to side armor, depth of armor belt, armored cruisers,—are all dwelt upon with great lucidity and engaging interest. The entire article is important and forms a valuable contribution to naval literature.

Under the head of marine engineering in Chapter VI. the progress of the steam turbine, development of internal combustion engines,—incidentally submarine boats with respect to their engines and engine trials—and various aspects of the boiler question, are carefully reviewed.

An interesting chapter on commerce and war is given by Lieutenant Carolyn Bellairs, in which he shows that an attack on commerce is only efficacious when combined with the successful action of fleets, and in which he emphasizes the need for keeping the fleet thoroughly up to its work.

Chapters on the reorganization of the personnel and on the Japanese navy, the latter being mainly descriptive and historical, complete Part I. Here as elsewhere in the book no attempt has been made to deal with the Russian-Japanese war, due, as the editor states, to the lack of full or reliable information as to what has taken place.

Part II., as usual, contains the tables of ships and plates. These have been improved, though a few discrepancies and errors, not of great importance, are still to be noticed.

The first chapter in Part III., armor and ordnance, is an excellent one on submarines and torpedo warfare. This gives a good summary of what is known on the subject of submarines and deals with submarine attack and torpedo warfare generally. The author confines himself to facts, but writes in an interesting way of their merits and disadvantages, their use and effectiveness, methods of combat, and speaks with just moderation of the future of these craft.

Chapter II. enters very fully into the subject of the thickness and disposition of armor, by comparing latest designs of warships. There are some differences of views to be noticed here from those of Sir William White's previous paper, but in the main the conclusions are not very dissimilar. Taken together they constitute a well-handled and thorough exposition of the subject of armor in modern warships.

Then follows a chapter giving a large amount of information on progress in guns and gunnery, some extracts from which we have quoted on a previous page. Tables of naval ordnance, statistics, official papers, etc., complete the book.

This volume of the "Annual" is certainly of great excellence, and is above the standard attained last year. As a history of the development of naval ideas its articles in this as in preceding volumes have a lasting value, while it maintains its reputation for completeness and interest and its position as an invaluable authority on the details of ships and navies of the world.

The "People's War" in France, 1870-1871. By Colonel Lonsdale Hale. 12+284 p. Maps. O. London: Hugh Rees, Ltd., 124 Pall Mall, S. W. 1904. Red cloth, 6 shillings.

In many respects this is a remarkable book. We are accustomed to look upon the Franco-German war, as given in the Official Histories, as a single war marked by a series of continuous and uninterrupted successes all well planned and skilfully carried out. As a rule, there is little to lead the reader to imagine that either von Moltke himself or any of the other leaders and generals of the German army, ever made mistakes, or were other than marvelously perfect soldiers. True, in some of the operations, by reading between the lines, one can mark some mistakes made and the unnecessary waste of life caused by them in the period from the battle of Weissenburg to that of Sedan. But in this continuous series of victories and their ultimate decisive result, the shortcomings fall into the background and are overshadowed by the successes achieved.

But in this campaign there were, as the author shows, virtually two distinct wars, the second commencing immediately after the conclusion of the first. The first, carried on by the organized armies of the two countries during the first seven or eight weeks, came to a close on September 1st, 1870, with the battle of Sedan; the second, in which the German army found itself opposed by the French people as well as the French organized army, began on the 4th of the same month and was carried on for five months. It is this period that the author deals with, under the term "People's War," when the civil population rose and assisted the army in the defense of the country.

For some twenty-three years the details of this period were kept secret by the German General Staff, but in 1893-97 they were to a certain extent given to the world in Hoenig's "Volkskrieg an der Loire" in six volumes. Other papers have also come to light, such as journals of prominent leaders and staff officers, and these throw a new light on the subject, though, as the author says, the narrative is not yet altogether complete.

Colonel Hale bases his work mainly on Hoenig's and the latter's extracts from the official archives, on von der Goltz's and other accounts of the operations, but he himself is so eminently fitted for dealing with the subject and knows his ground so thoroughly, that his narrative is full of action and is so interestingly told that it can be read with pleasure as well as profit.

The reader learns of war not only in the widest sense of the word and in the widest aspects of the strategy employed, but also in its most minute details. We are presented with a striking picture of the German control and command during this period; many errors were made, members of the staff distrusted and abused each other, friction developed between the various headquarters, situations were completely misunderstood and wrong combinations contrived,—and all this mainly on account of the practically insurmountable obstacles presented by a hostile population to the collection of reliable information, on account of that Fog of War, both strategical and tactical, which baffled every effort of the assailant. Hence the leading became difficult and at times went altogether astray, and the admirable German Staff System and their devolution of responsibility, sometimes failed in these difficult circumstances, as every system worked by fallible human beings must fail.

But the power of the hardened soldiers of Germany to hold their own in the field against numerically superior forces, their superior *morale*, the failure of the leading of the French improvised army and the demoralization produced by the profitless endurance of suffering and misery, finally combined to take the heart out of the National Defense, so far as the participation of the People was concerned.

Though the study of this period of this war furnishes proofs that in every defensive land-war against invasion, the whole People should take their part, it is also made clear that organization, sound, fully completed and practically-tested is the indispensable necessary basis for their participation in every such National Defense, the foundation, the all important part of which is the highly-trained, thoroughly equipped, thoroughly disciplined and well-staffed Field Army.

The author says, "From the book soldiers will learn the "seamy side" of command and of staff work; the regular army will form a better appreciation of the capabilities of the rank and file of even the shortest service soldiers; the auxiliary forces will be impressed with the value of a highly trained army in the field whether for offense or defense; and rifle clubs will realize that while they can be of great value in home defense, there are distinct limitations to the sphere of their operations and of their usefulness."

Excellent maps accompany the text, one on a large scale, and the arrangement of references when names of places are mentioned, enables the reader to follow readily the situations and encounters so well described by the author. In all respects it is a readable, well-written and instructive book.

Notes on Strategy and Military History. For promotion examinations, militia entrance, volunteer "classes," etc., etc. Compiled by Captain H. T. Russell, Royal Artillery. 12+206 p. D. London: Gale and Polden, Ltd. 2, Amen Corner, E. C. 1904. Red Cloth, 4 shillings.

The author in his preface modestly states that he has made no attempt to enter into details in this book as the object of the "entrance" and "promotion" examinations is ordinarily to test the knowledge of general principles without a display of intimate acquaintance with details. "Consequently, it will appear to all save those whose military education is beginning that these 'notes' are merely a collection of baldest truisms." But a careful reading of the book is convincing proof that such a conclusion is hardly just. We rather think the conciseness and directness of statement throughout the book is an advantageous feature,—the principles, though perhaps well-known, stand out more clearly. The instructive and interesting manner in which the author restates these truths makes the book useful for the purpose intended and also for all interested in this fascinating, as well as vital, subject.

Captain Russell starts from the beginning, saying that strategy is not only the art of generals, but also of statesmen; "for the impulse to preparation for war must, during peace, be given by the statesman." The subject is then carried to all its branches: morale, marches, mobility, bases, lines of communication, flying columns, the offensive and defensive, etc., etc. The value of the initiative, objectives, their nature and choice, influence of policy, choice of theatre of war and operations, and the influence of natural features—all receive due attention, and the teachings of military history are concisely applied to fortify the opinions given.

These Notes are intended to be read in conjunction with military histories of campaigns illustrating the various "principles," and for the purpose of making notes of such instances a number of blank pages are given at the end of the book.

The author has well succeeded in giving the reader in a readable and instructive little book a large amount of excellent matter that will most certainly assist those "whose military education is beginning," and deserves study by others as well.

Stratagem. By Major Charles G. Morton, Sixth Infantry, U. S. A. 48 p. O. Kansas City, Mo. Hudson-Kimberly Publishing Co. 1904. Cloth, 75 cents.

Stratagem as the author defines the term "is the art of deceiving the enemy," and may come under military policy, strategy, or tactics. While the subject of strategy and tactics has been extensively treated by military writers, this particular branch does not seem to have been given the attention it is entitled to. But it is important both for armies and for small forces, hence a knowlege of the subject is equally valuable for officers of high rank and for the young officer with a small command. "The subject recommends itself to the consideration of the soldier on two grounds: First, that he may know how to make use of a stratagem when occasion offers; and, second, that he may be able to foil the devices of the enemy."

The author treats the subject in the form of a lecture, broadly yet interestingly, illustrating by many historical examples its various features and the means employed. He shows the value of secrecy, of reticence on the part of a commander, yet in some cases how even the truth itself may deceive. The value of knowledge of the character of the opposing commander, the various means of securing information, use and treatment of spies and guides, the dissemination of rumors, false orders for publicity, etc., are touched upon. It is shown how such information and means may be employed to advantage in carrying out military operations, and how such ruses as ambuscades, false retreats, surprises, etc., have been used in former and recent times. The whole subject is then well illustrated by some of the stratagems used by Napoleon—the great master of this art—in his first campaign.

The principles and examples set forth, while not new, have been grouped together in a concise and satisfactory manner, the whole forming a readable book.

Field Fortification. Notes on the Text-Books. Specially designed and arranged for the use of officers preparing for promotion examinations. By Major-General H. D. Hutchinson, C. S. I. Ed. 5. 12+245 p. il. D. London: Gale & Polden, Ltd. 2, Amen Corner, E. C. 1904. Red Cloth, 4 shillings.

The constant demand for this little book, now in its fifth edition, is sufficient proof of its value for the purpose for which it was originally written, as indicated by its sub-title, and of its excellence as a compact and useful work on the subject of field fortification.

The author's experience as an instructor has enabled him fully to appreciate what is most needed in a book of its kind, to be of assistance to the student, both in regard to the subject-matter and its arrangement; so that the result is a concise, well-digested and complete manual.

In this new edition the book has been entirely revised and brought up to date. Special attention has been paid to the *practical* side of the subject. The information is set forth in plain language, and numerous examples worked out in the book make clear the application of principles involved. In addition, 34 good plates, each containing several figures, fully illustrate the text. A series of questions on each chapter, at the back of the book, serve to review the subject and as a preparation for examination.

While designed to meet the requirements of the English promotion examinations, the book is, at the same time, an excellent practical manual on field fortification, and will be found a useful guide by anyone taking up the subject.

Manual for Non-commissioned Officers of a Troop of Cavalry in Security and Information, with a scheme for progressive instruction in that subject. By First Lieutenant Jno. J. Boniface, 4th Cavalry. 43 p. T. Kansas City, Mo. Hudson-Kimberly Publishing Co. 1904. Blue Cloth, 50 cents.

In this little manual, the author outlines a scheme of instruction which appears to be thoroughly practicable, and if carried out properly ought to produce a bright, able and skilful set of non-commissioned officers in a troop. It is evident troop non-commissioned officers should fully understand at least the elements of security and information, for in command of patrols, on outpost duty, and in other positions they will be called upon to fill, a large amount of responsibility will be placed upon them in this regard. And to be of any value this instruction in security and information must be constant and not intermittent. Hence this progressive scheme is offered, combining both theoretical work in garrison and practical work in the field, which only needs to be adapted to the most convenient hours, when it can be at once carried into execution.

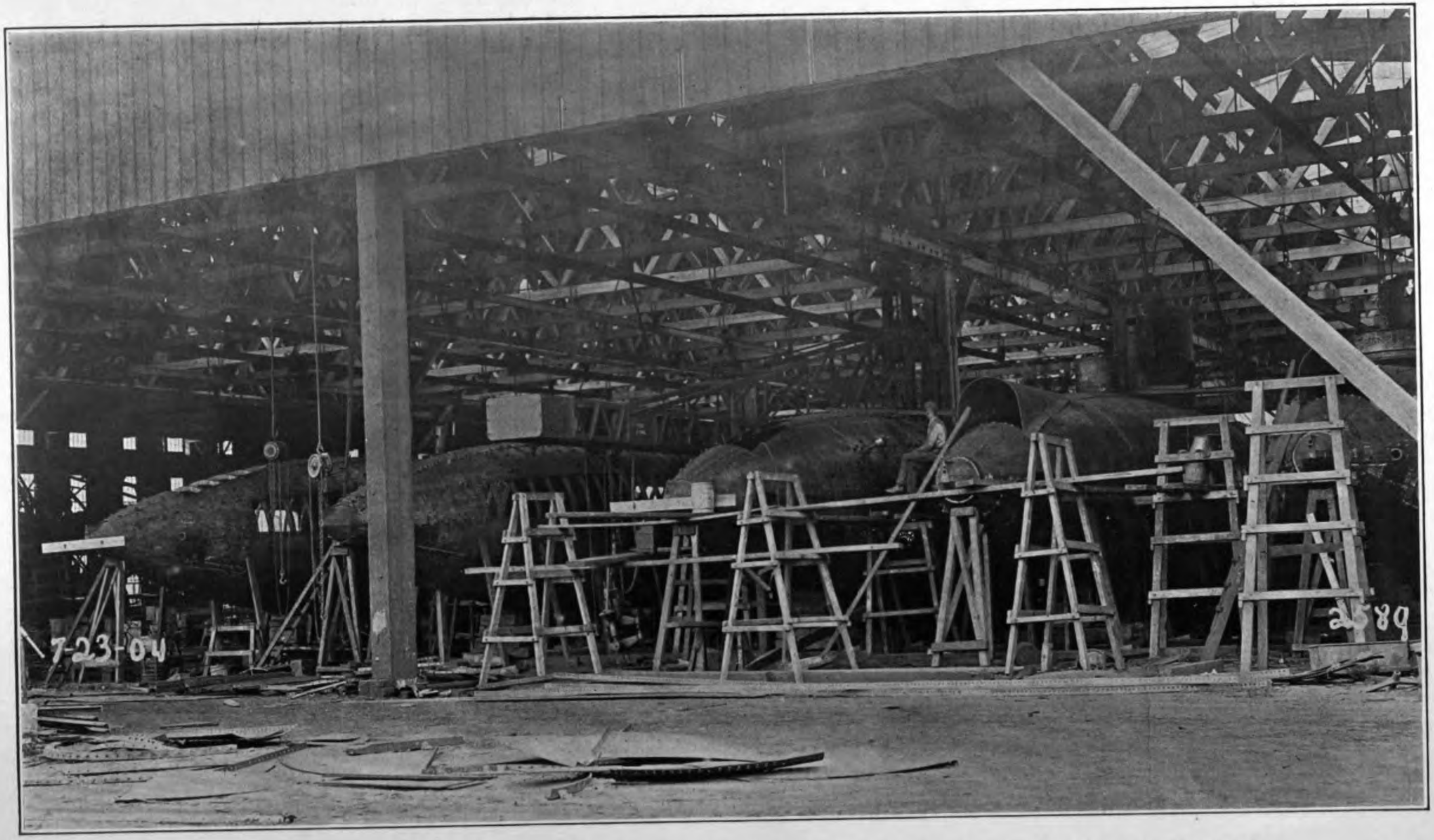
The author has had practical experience in applying his suggestions, with, as he says, excellent results. The only objection we would offer is in regard to the writing of a thesis by non-commissioned officers, however simple in character it may be. Omit all essay-writing. Let the work be as *practical* as possible, and let their ability and skill be judged by the practical application of information acquired. However, the little book offers many very good suggestions that are well worth consideration and trial for the purpose intended.

The Rifleman's Handbook for Military Riflemen. By J. G. Ewing 63p. il. D. New York: Laflin and Rand Powder Co. 1904.

This is a very practical and valuable little pamphlet on rifle shooting prepared by the Assistant Inspector of Small Arms Practice, Delaware National Guard. The author frankly says it is intended as a primer; if the reader wishes to study rifle shooting as a science the works of Freemantle, Tippins and Hudson should be consulted. The object of this work is to give the beginner a broad general outline of matters which are necessary for him to know and remember in order to become a good shot.

Hence the handbook deals in as simple and concise a manner as possible with the various details of military rifle shooting, the Krag being the arm considered. There are chapters on the loading mechanism, aiming and sighting drill, indoor gallery work, outdoor shooting, and general observations in regard to estimating distances and shooting on the range. An excellent feature of the book is a pithy summary at the end of each chapter, giving in condensed form the points and rules to be remembered.

The instructions are clear and concise, fully illustrated by a number of good plates, and the book contains a great amount of practical information for the rifleman. It is worthy of careful study by every one who is interested in rifle shooting and who desires to become a "good shot."



CAPTAIN LAKE'S SUBMARINES UNDER CONSTRUCTION IN THE UNITED STATES FOR FOREIGN GOVERNMENTS.
FIVE BOATS NOW BUILDING AT THE YARDS OF THE NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO., NEWPORT NEWS, VA.

JOURNAL
OF THE
UNITED STATES ARTILLERY.

*"La guerre est un métier pour les ignorans,
et une Science pour les habiles gens."*

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THE EVOLUTION OF THE SUBMARINE
AND
HOW FAR THE LAKE TYPE SOLVES THE PROBLEM.

BY ROBERT G. SKERRETT.

The scepticism with which the submarine boat was regarded but a few years back has substantially disappeared from the minds of naval men the world over. Some of this change is due to the more reasonable claims now advanced for this type of craft, while the practical accomplishments of this order of fighting machine and the recent effective work of the torpedo have conjointly removed many of the objections heretofore advanced.

The implements of offense with which modern mechanical cunning has equipped the battleship of to-day are sufficiently impressive to bear heavily upon the nerve of the fighting force against which they are pitted, and when to this stress is added the dread potentiality of the torpedo discharged from a hidden, mobile base, the submarine--as such—despite its unproved value in actual conflict, becomes an instrument of annihilation that must be reckoned with in the immediate future.

Much of the unsuccess of the submarine in the past has been due to the lack of systematic development and the fact that so many of the inventors in this direction have essayed their tasks without either research or any practical knowledge of the difficulties peculiar to subaqueous navigation. The French, who of all others have probably given greater official encouragement to the inventors of submarines, are to-day undecided upon a desirable type, and this fact is proved by the great diversity existing among the vessels already built and those now under construction at the naval arsenals of France. By far the larger number of her boats are too small for effective work; but in this hasty construction of small craft of a special class, France is but repeating that feverish desire with which, but a few years back, she built her large flotilla of uselessly miniature surface torpedo boats—supposed then to be an effective foil to Great Britain's magnificent programme of naval increase. To France, however, is due full credit for having demonstrated with convincing practicality the probable utility of the submarine in actual warfare, and to her "submersibles," as she is pleased to term her autonomous submarines, the palm must go for the accomplishment of so much that has removed the type beyond the slurring ban of "mere mechanical toys of an enlarged order."

TYPES OF SUBMARINES.

The technical readers of the JOURNAL are, of course, sufficiently versed in the nomenclature of the submarine cult to be familiar with the distinction made between the "submarine" and the "submersible"; and it is not necessary to go further into detail than to say that the "submarine," being entirely electrical in its propulsion, has an endurance limited to that of its storage batteries, which are charged from an extraneous source, while the "submersible" being propelled alternately by gasolene engines or electric motors, has, in consequence, a radius of action limited only by the joint capacity of its gasolene tanks and its storage batteries—the latter being drawn on principally for totally submerged work. By reversing the electric motors so that they become generators, the accumulators are recharged under the impulse of the boat's own gasolene engines. This dual propulsive agency has greatly widened the field of application of the submarine boat; but it must be plain to anyone familiar with the relative efficiency of the gasolene engine and the electric motor so installed—measured pound for pound—that the electrical outfit, while making the submarine practicable in the totally submerged condition, costs so much in weight that its use must be limited to the utmost extent. A writer upon submarine boats in this year's edition of Brassey's Naval Annual, declares that out of one ton of electrical installation but two or two and a half horse-power are to be got under the most efficient conditions. In the "Protector," however, the results were decidedly different ; but even there one pound of gasolene engine installation was found to equal eighty pounds of electrical equipment. Because of this great disparity, the "submersible" will be operated at least ninety per cent of the time under her gasolene engines ; and the problem of first importance is to give the craft the widest range of action in the various conditions of partial submergence by using the gasolene engines—reserving the storage batteries and motors for the short-lived, totally submerged runs. So much for the methods of propulsion.

METHODS OF SUBMERGENCE.

Apart from the distinction of "submarine" and "submersible," submarine boats are further classed by reason of the manner in which they disappear beneath the surface, into "diving" and "submerging" boats. The "diving" boat works upon the principle of a delicately poised balance and, for its quickness of disappearance, depends upon a substantial absence of longitudinal stability—the mere pressure of a few pounds exerted by her horizontal rudder at the stern being enough to cause the craft to plunge. It must be plain that this destruction of longitudinal stability brings in its train grave risks and imposes fatiguing immobility upon the vessel's complement. The "submerging" boat, on the other hand, sinks bodily beneath the surface on an even keel, when underway, by reason first, of her great longitudinal stability, and second, by the action of symmetrically disposed hydroplanes that forcibly thrust the vessel uniformly below the waves. As proved by Great Britain's costly experiments, the diving boat, to be efficient, is of necessity limited in dimensions by the very principle upon which she works, for the greater her length the more difficult is the task of diving, while the "submerging" boat may be of any length so long as the area of her hydroplanes increases proportionally, the facility of submerging remaing constant. Naturally, with greater size follow wider radius of action, better sea-keeping qualities, higher speed, greater offensive power, less strain upon the individual members of the crew, and more comfortable and commodious accomodations for her complement.

THE LAKE SUBMARINE "PROTECTOR."

With these distinctions in mind, a better idea can be had of what Captain Simon Lake has accomplished in his "Protector" which, while of necessity not everything he hopes to accomplish, is still so far in advance of all other submarines as rightly to merit the honor of having blazed the true way to radically material advance in the future, and this because of the essentially sound and widely adaptable principle upon which she is planned to work. To understand what the "Protector" represents to-day it is necessary to give a brief outline of what Captain Simon Lake had accomplished before the "Protector" was dreamed of and to cite the official inspiration that led him in the evolution of his peculiar type.

THE NAVY DEPARTMENT'S REQUIREMENTS.

Without dwelling too much upon the latter-day history of the submarine in this country, it is sufficient to know that in 1893 the Navy Department issued a circular invitation to naval architects, engineers, and others interested in the design and construction of submarine torpedo boats to submit plans for such a vessel for the United States Navy. The circular defined the eight prerequisites desired by the Department, and, naming them in order of their relative military importance, they were:

1st. Safety.
2nd. Facility and certainty of action when submerged.
3rd. Speed when running on the surface.
4th. Speed when submerged.
5th. Endurance, both submerged and on the surface.
6th. Offensive power.
7th. Stability.
8th. Visibility of object to be attacked.

The broad principles upon which that circular was drawn will make it applicable for many years to come, so intelligent was its grasp of the prime essentials of submarine warfare, and, save for the postponed importance given "visibility," the specifications would answer to-day as well as they did eleven years ago. The circular further stated:

"Any valuable qualities not enumerated by the Department (which limits itself to pointing out those that appear to be the most useful) will be fully considered and given due weight in deciding upon the design to be adopted.

As the Department does not define the means by which results are to be attained, *it will accept no responsibility as to the efficiency of the methods proposed to be used.*"

It is significant of the Department's attitude that, during the years that have followed, no other circular modifying these essentials has ever been issued, and to-day, by that fact, it forms the only true basis upon which a competitive analysis of rival types of submarines can justly be made.

This circular was Captain Lake's inspiration in the beginning and has been his guide up to the present.

THE EVOLUTION OF THE LAKE TYPE.

Agreeably to this invitation of 1893, Captain Lake, then a young man of only twenty-seven years, submitted a design and specifications for a submarine boat—being in principle substantially that of the present "Protector" so far as methods are concerned. Because of techni cal informality in his proposal and the fact that he would give no bond in guaranty of performance, his bid was rejected although his design won verbal praise from many of the Department's technical experts. The award, as the public knows, went to the Holland Company, and the original "Plunger" was begun at the Columbian Iron Works in Baltimore, Md., in 1895. The history of that boat is instructive only so far as her failure points a moral to the inventor without practical experience, and in no sense is a reflection upon the Navy Department which, by the terms of its invitation, disclaimed responsibility as to the efficiency of the methods proposed to be used by the designer.

THE "ARGONAUT, JR."

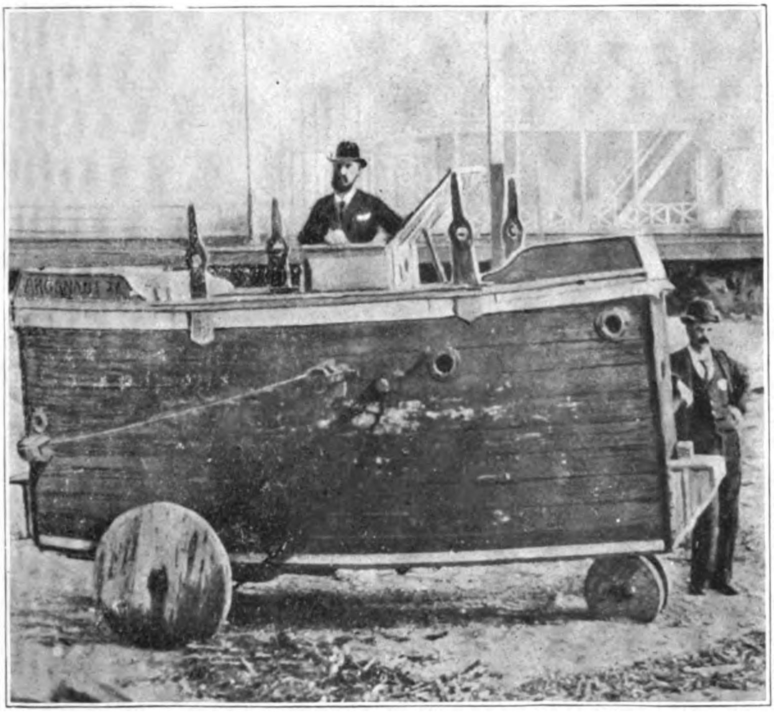
Young Lake, undeterred by his failure to secure governmental recognition, pursued his own way in proving the soundness of the principles upon which his design was based. In the fall of 1894, at Atlantic Highlands, N. J., he built a crude affair of modest dimensions embodying the more important features of his design, and in the spring following, gave public demonstration of the fundamental soundness of his scheme. That craft was hardly more than an exaggerated box on wheels. Its dimensions were : length fourteen feet, height five feet, and maximum beam four and a half feet. The body was made of two courses of yellow pine planking, lined with felt, and coated outside with coal-tar to make it water-tight. The vessel was designed to float upon the surface and to crawl upon the water-bed under the impulse of her two driving-wheels. These wheels were connected outside by chain-and-sprocket gearing with a crank-shaft revolved by hand inside the craft. The boat was ballasted with pig-iron, was submerged by filling a tank with water, and was provided with a forward water-tight compartment with a bottom outlet which, when subjected to air pressure from a soda-water tank, became a diving bell and permitted the opening of the bottom door and passage thence outside upon the water-bed.

The air compressor was a small plumber's hand-pump, and the diving dress was a very modest creation of his own. The crew generally consisted of two persons. With these imperfect facilities, young Lake was able to submerge his craft in sixteen feet of water, pass out through the bottom door, and pick up things thrown overboard for his recovery. The performances of the "Argonaut, Jr," for he so dignified her, were sufficiently convincing to secure the organization of a stock company and the subscribing of means enough to build a much more ambitious craft. This second vessel was called the "Argonaut," and, side by side with the original Holland "Plunger," was built at the Columbian Iron Works, and launched just a week after the Government boat was put overboard.

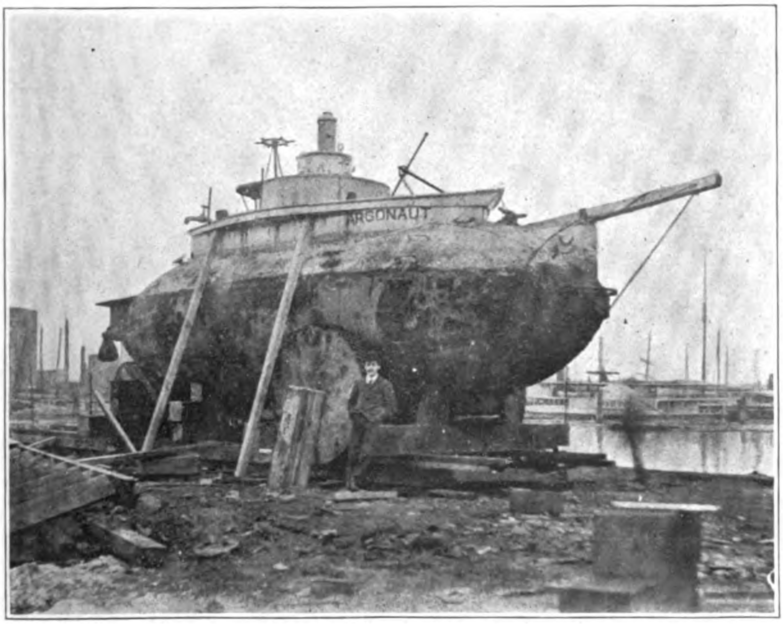
THE "ARGONAUT."

The "Argonaut" was built of steel, spindle-shaped hull with a circular cross-section, had a maximum beam of nine feet, and was thirty-six feet long. Her motive power was a 30-horse-power gas engine. When running on the surface the engine was coupled up to the propeller shaft, and when running on the bottom the same engine, geared to the two big driving-wheels, drove the craft over the water-bed. The "Argonaut" was lighted by electricity, carried a powerful searchlight forward of her diving compartment, and had a regular air compressor and commercial water-ballast pumps. There were accommodations in the living space for five persons; and an intramural telephone made it possible to communicate between the diving chamber and the rest of the boat when the former was under pressure. Air was drawn down into the body of the boat, when submerged, by a long pipe leading to the surface, and another pipe of equal length carried the engine exhaust above the water.

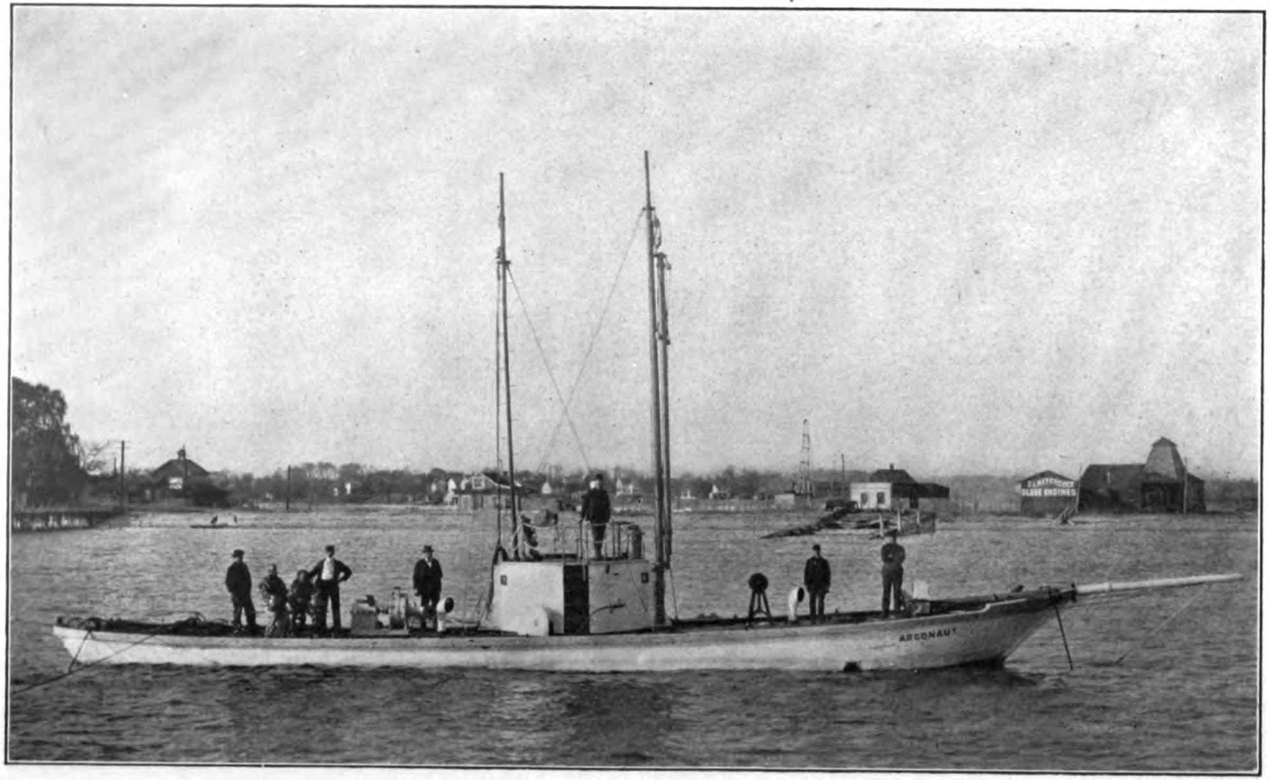
The "Argonaut" proved the entire practicability of bottom travel and the easy maintenance of a fixed course despite currents and other tidal considerations; she showed that it was possible and easy to pursue diving operations by way of her diving chamber under weather conditions that would have made like undertakings dangerous, if not impossible, working from the surface; she established the great desirability of longitudinal stiffness or stability; proved the habitability of her type; and *disproved* the long maintained theory that the spindle-shaped hull was the most desirable form for a submarine boat—experience showing that the boat tended too much to bury in a seaway, and was far too sluggish in her recovery for facility of navigation. During the year and more of her active existence, the "Argo-



"Argonaut, Junior."



"Argonaut the First."



"ARGONAUT THE SECOND."

naut" traveled unassisted more than two thousand miles on the bottom and the surface of the waters of the Chesapeake and along the Atlantic coast in all sorts of weather.

THE "ARGONAUT II."

Having proved the entire practicability of the boat, Captain Lake decided upon certain important modifications prior to her assignment for commercial submarine salvage work. To that end, during the latter part of '99 and the early months of 1900, the vessel was taken out of the water at New York, cut in two and lengthened twenty feet, and outside of the spindle-shaped hull, from the middle of her cross-sections upward was built a ship-shaped form of lighter material, and upon that superstructure amidships, but resting upon the main hull, was built a good-sized conning-tower from which the boat could be controlled and navigated. Inside of the superstructure were placed the air reservoirs and the gasolene tanks, thereby affording greater available space within the main hull, and, at the same time, removing the explosive fuel outside. The propelling power of the boat was doubled by the installation of a 60-horse-power White and Middletown gas engine, and other important improvements were made in keeping. The rolling wheels were arranged in tandem on the keel line and had no power of self propulsion. The craft had accommodations for eight persons. As a submarine salvage vessel the "Argonaut 2nd," as she was called, proved her usefulness, while as a surface craft her seaworthiness was established beyond cavil by exposure to a number of severe storms in Long Island Sound. Like the "Argonaut," air was drawn down into the hull, when submerged, through one long iron pipe, and the foul air and engine exhaust discharged through another.

With these pioneer boats Captain Lake established the usefulness of the diving chamber and the bottom outlet; the ability of the "Argonaut 2nd" to operate upon nearly all sorts of bottom and her power to rise easily over any obstruction above which her nose projected ; the necessity of the superstructure and the prime service of a large conning-tower as a means of centralized control and as a secure position for navigating when running on the surface in rough weather or when operating in varying degrees of submergence. He proved the peculiar and at times superior nature of the bottom as a guiding medium when running on the boat's wheels ; he showed how the vessel could be held at any desired depth in suspension, when still, by means of two anchoring weights controlled from within the conning-tower; and he demonstrated the practicability of running the craft safely with gasolene propulsion under varying conditions of submergence.

THE BUILDING OF THE "PROTECTOR."

In 1901, with this wealth of practical accomplishment, Captain Lake again turned his attention to the military adaptation of his type and sought the Navy Department with that in view. In his new design he embodied certain important features that had not been tried in his earlier boats. These were four in number:

The maintenance of the boat in suspension at any desired depth by means of hydroplanes while under way.

A storage battery installation.

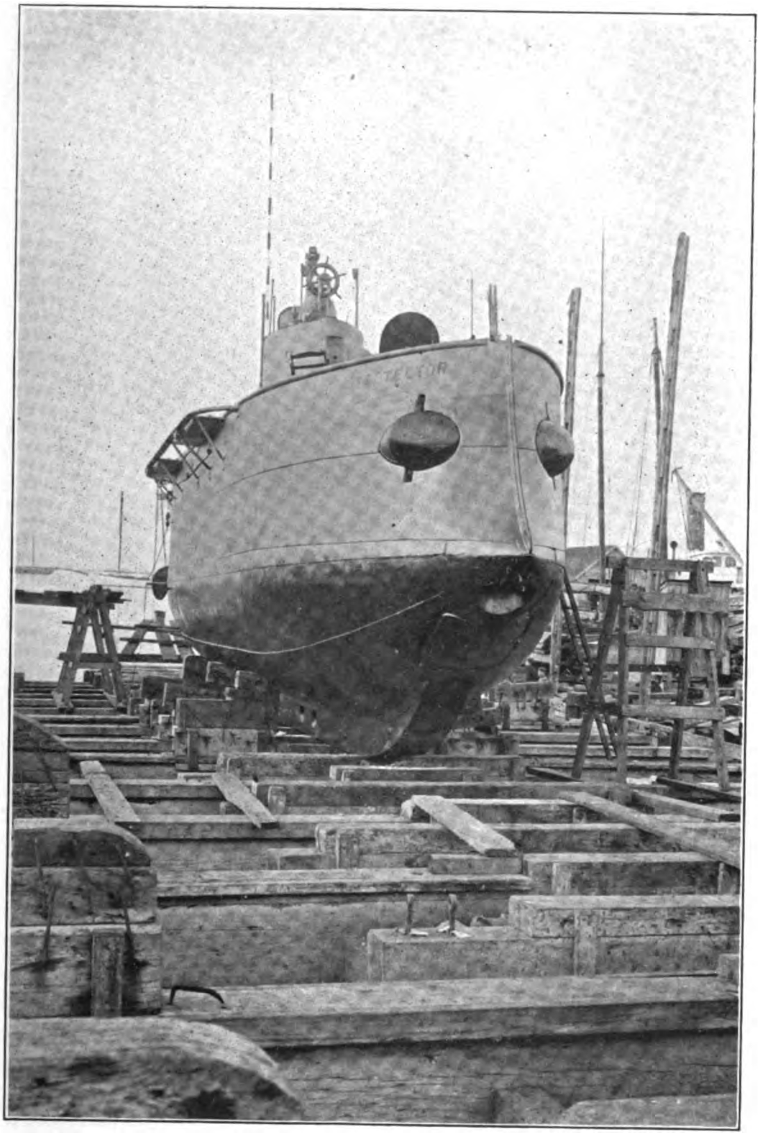
An observing instrument, which he called the "omniscope."

The handling and firing of torpedoes.

Of these the hydroplanes presented the greatest problem of uncertainty, for he had no reliable data upon which to base his calculations.

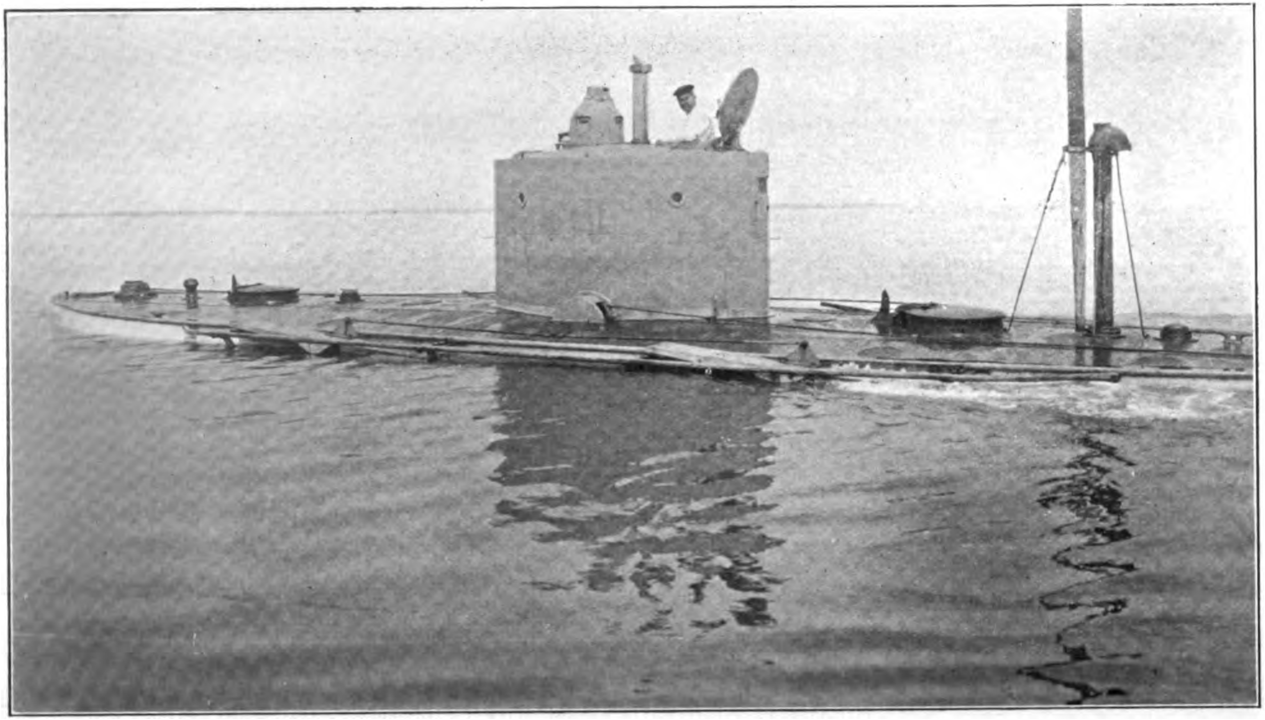
In 1901 the submarine had become, however, a political question backed by a well-intrenched corporate influence, and it was not in the gift of the Navy Department to give Captain Lake substantial encouragement. The Board on Construction, before whom he laid his plans, however, was so impressed with his designs and the record of performances on the part of the earlier "Argonauts," that it recommended that no more boats of the Holland type be authorized specifically, but that the whole question be left open to competition. In Congress he failed likewise of material encouragement, but his appearance halted further partisan legislation. With this scant measure of assurance, and by the advice of the chiefs of the technical bureaus of the Department, Lake began the construction of the "Protector," which, at the time of her departure from this country, probably represented an outlay of little short of four hundred thousand dollars on the part of a private enterprise; and meant, for this government, a saving of millions by halting further legislation for a type that has so far proved entirely unequal to the task for which it was designed, and which has met but modestly only a part of the requirements outlined in the circular of 1893—the extravagant promises to meet which first gained for the type governmental recognition.

The "Protector" was launched at Bridgeport, Conn., in November of 1902, and in January of 1903 she made her first surface runs. It was not until May, however, that the vessel was thoroughly prepared to operate as a submarine boat.



"Protector" on Dry Dock.

Plate II. to face page 116.



Showing Details of Conning-Tower, Deck Fittings and Hydroplanes.

At the suggestion of the Board on Construction, for the sake of a closer comparison with the rival Holland type then building for the navy, the "Protector" was built with a total length, over all, of only 67 feet 6 inches—17 feet 6 inches shorter than originally designed. This gave the boat bluffer lines and a more difficult body to drive through the water at top speed. The boat has a spindle-shaped main hull of sufficient strength to withstand safely hydrostatic pressure at a depth of 150 feet. Outside of this is built a lighter superstructure within which are stowed the gasolene tanks, the air flasks, and the lubricating oil tanks. The maximum beam of the main hull, which is generally circular in cross-section, is eleven feet two inches, and the maximum beam of the boat over the guards is three feet greater. In light cruising trim the vessel has a displacement of 136.3 tons, and totally submerged has a displacement of 174.35 tons. To fill the superstructure and to bring the deck level with the water increases the boat's displacement by 20.8 tons. This water can be let in either by flood valves or by direct pumping—the latter taking about twelve minutes to accomplish.

ESTABLISHED SEAWORTHINESS.

Under all ordinary cruising conditions the boat would travel in the light condition, and within the past year her seaworthiness has been amply tested. At no time, despite this heavy weather, has the boat received the slightest assistance, and, in the face of a 27-knot southeasterly wind and a nasty sea, she towed her supply sloop around Point Judith.

THE CONNING-TOWER.

Rising above the superstructure, amidships, and resting securely upon the main hull, is a bronze conning-tower, elliptical in plan section, having a major axis of ten feet one inch, and a minor axis of four feet seven inches, with a height of six feet five inches above the spindle hull. Above the conning-tower rise an armored sighting-hood of bronze and the tube of the omniscope. Apart from contributing to the stability of the boat, when submerged, by providing a buoyant moment well above the centre of gravity, the object of the conning-tower is threefold.

1st. To give a centralized position of control when submerged.

2nd. To provide a secure and sheltered station for navigating in rough weather.

3rd. To insure reliable action of the compass by placing that instrument in non-magnetic surroundings well beyond the magnetic influence of the steel hull.

The conning-tower is comfortably roomy with three persons present, though, in time of war, but two are needed there—these being the man at the wheel controlling the rudder for horizontal steering, and the commanding officer whose duty is the control of submergence and the conning of the craft either through the dead-lights of the sighting-hood or by means of the optical sighting instrument, the omniscope. The operative mechanisms in the conning-tower are those for handling the vertical rudder (for horizontal direction), for working the hydroplanes which cause the boat to rise or sink—the vessel being ballasted for submergence—and under way, for shifting the small horizontal rudder at the stern, by which a permament correction is made for the backward-tipping thrust of the column of water against the face of the conning-tower when running below the surface, the valves for manipulating the water ballast in the superstructure and the submergence tanks, and the switches for controlling the motors actuating the two drums bearing the wire cables for the bow and the stern anchoring weights. In addition to these are the observing end and the controlling gear of the omniscope, the mechanical telegraphs to the engine-room and the torpedo-firing stations, the clinometers, water columns, and other gauges essential to a thorough understanding of the boat's condition. The compass, which is of the transparent sort, with a double face, is mounted in the forward roof of the conning-tower, and can be read either from the navigational wheel within the tower or from the steering position on top, for which a portable wheel is supplied and fitted when the weather permits. Under ordinary cruising conditions the steersman, standing on top of the conning-tower, sheltered from flying spray by a canvas weather-cloth, is nearly eight feet above the water line; and, by actual experience in heavy weather, this position has been tenable at all times. To a seafaring man, this facility of all-around conning, together with the wider field of observation, is particularly significant; and, when compared with the low freeboard of the diving type of submarine, their sluggish action in a seaway, and the dangerously exposed position of the man at the wheel on deck, the difference is at once apparent. The remarkable steadiness of the "Protector" has a direct bearing upon the action of her compass—which has been proved reliable at all times, and, unlike those installed in the boats of the diving type, has *not* called for the frequent use of various deviation cards with all of the uncertainties associated therewith.

A large circular hatchway leads from the conning-tower below into the main hull immediately forward of the engine-room bulkhead. This affords an excellent means of vocal communication in case of breakdown in the mechanical telegraph, and gives visual supervision of practically the major part of the engine and motor control stations, and the more important manifolds affecting the ballast tanks. When running totally submerged, with only the low hum of the motors to disturb the quiet, it is possible to pass the word from the conning-tower to all parts of the vessel without raising the voice above ordinary conversational pitch.

THE SUPERSTRUCTURE.

The primary purpose of the superstructure is to assure seaworthiness when running in the light cruising trim by providing buoyancy additional to that of the spindle-shaped hull. The results have been in full accord with expectation, and the "Protector" has shown herself a very steady boat, and one so buoyant as to presage her safety under the most trying of weather conditions. Because of her great buoyancy, the "Protector" is very "quick" in her action in a seaway, but her angle of heel is remarkably slight, and this, in a measure, is aided by her box keel and by the guards and the hydroplanes, which act not unlike bilge keels the moment they touch the sea. For this reason, even had the "Protector" the faultily designed batteries of the diving type, she would not roll enough to spill the electrolyte. By official record, the boats in our navy have rolled as much as 28 degrees, have spilled the electrolyte, and have grounded their batteries most seriously.

The secondary objects of the superstructure are to provide a safe and convenient stowage of the gasolene and air tanks outside the main hull and to afford at the same time considerable deck room, thereby adding to the available space within the craft, her habitability, and the safe and efficient discharge of deck duties common to all vessels. To those that have followed the performances of the submarine boats now in the navy, and the evolution of the diving type generally in this country, the mishaps from gasolene explosions are readily recalled; and, during the official trials of one of the United States Government submarines, a leakage of several quarts of gasolene right in the body of the boat was happily discovered before accident occurred.* The peculiarly search-

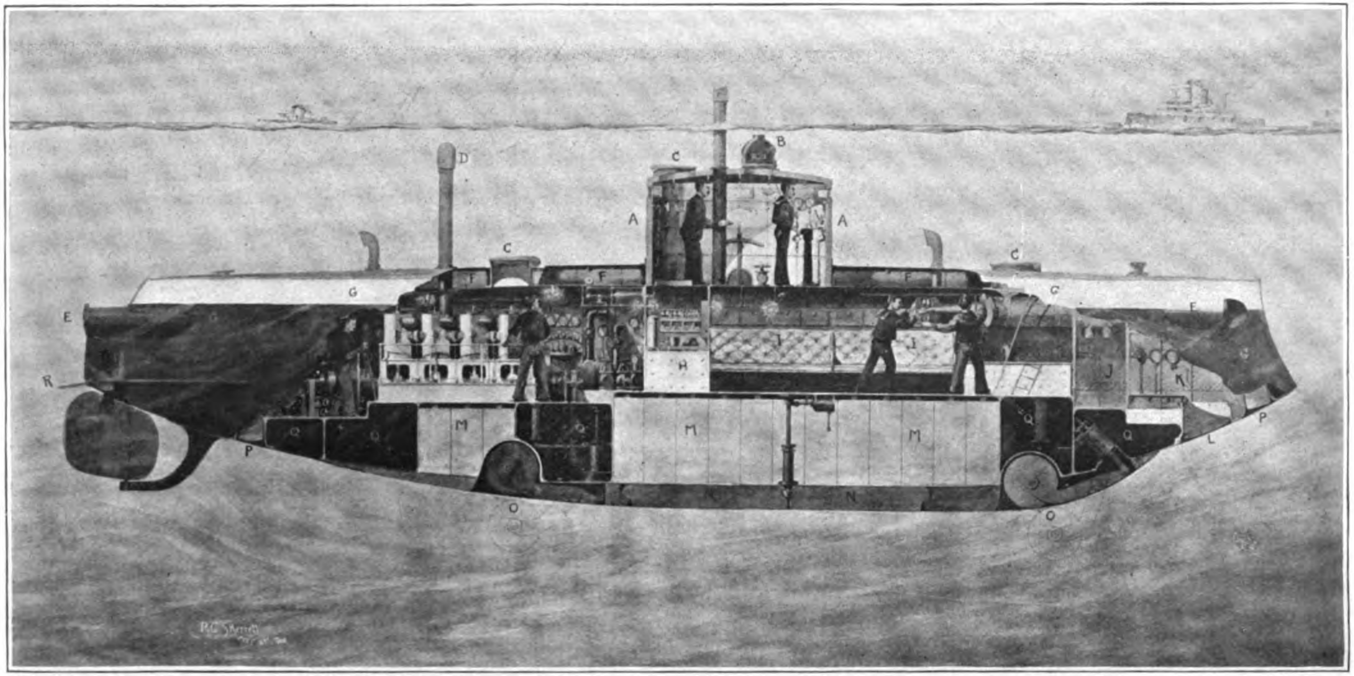
* For technical accounts of the acceptance trials of the U. S. Government Holland submarines. See Vol. XV., "Journal of the American Society of Naval Engineers."

ing nature of gasolene makes it especially hard to ensure thorough tightness in tanks and piping connections, while the explosive character of that fuel, when confined, as it must be in a submarine, makes its presence within the main hull a constant menace—for the mere sparking of the dynamos would be enough to ignite it. With the "Protector" the stowage of the fuel in the superstructure entirely removes this danger, and at no time is there but the smallest quantity of gasolene within the main hull. The connection with the tanks is closed even before the engines are stopped, and by the time the engines have come to rest they have consumed the last drop inside of the cut-off.

To have some idea of the space saved by the outside stowage, so to speak, of the gasolene, air flasks, and other tanks, it is necessary to know only that within the superstructure are eight gasolene tanks having a combined capacity of 1050 gallons, two lubricating oil tanks of a total capacity of 120 gallons, six high-pressure air flasks of 8-inch Mannessman tubes, having a combined capacity of 21 cubic feet, built to withstand a pressure of 4000 pounds, and four low-pressure air flasks with a united capacity of 12½ cubic feet. With her ordinary fuel supply, it is estimated that the "Protector" should have a radius of action at full speed of not less than 350 knots. By filling some of the ballast tanks, if necessary, this endurance could easily be tripled. The interior of the superstructure is accessible at all points.

INTERNAL DIVISIONING.

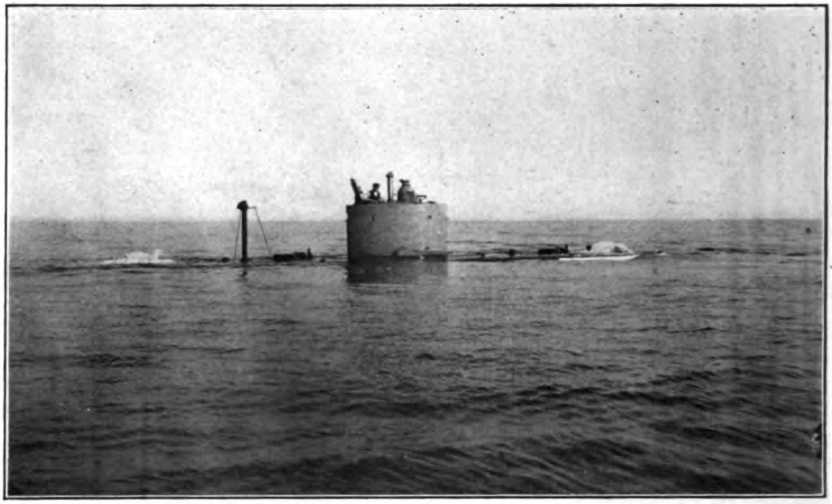
The longitudinal section (see plate III.) of the boat is the best explanation of the internal disposition of space. At Frame No. 6 there is an air-and-water-tight bulkhead by which the division forward is formed into the diving chamber. Through this bulkhead is a door of similar tightness, and in the floor of the compartment, opening outward and swinging aft, is also a water-tight door. This bottom hatchway is surrounded by a high steel coaming, to which is attached the gear for opening and closing the bottom door. At the forward end of the diving chamber are two gauges—one showing the amount of air in the supply reservoir, and the other, with a double index, giving readings of the water pressure without and the air pressure within the chamber. The chamber is fitted with all necessary reels, grappling irons, hose, life-lines, and other diving outfit to meet the operations either of dragging or the co-operation of a diver working therefrom. The chamber is large enough for the presence of three operators besides a diver, and capacious



INBOARD PROFILE.

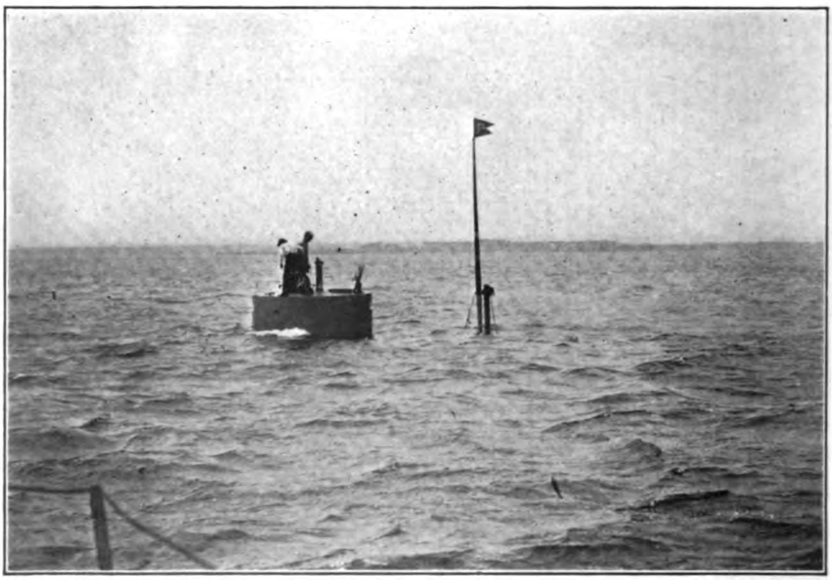
A, *A*, Bronze Conning Tower.
B, Sighting Hood.
C, *C*, Hatches.
D, Exhaust from Engines.
E, *E*, Torpedo tubes.
F, *F*, Gasoline Tanks.
G, *G*, Line of Spindle Hull.
H, Galley Compartment.
I, *I*, Crew Space.
J, Air Lock.
K, Diving Compartment.
L, Diving Door.
M, *M*, Storage Batteries.
N, *N*, Drop Keel.
O, *O*, Wheels.
P, *P*, Anchor Weights.
Q, *Q*, Ballast Tanks.
R, Horizontal Rudder.

Plate III. to face page 120.



Copyright 1903, by R. G. Skerrett.

"Protector" Filling Superstructure. Showing exhaust of overflow valves.



Copyright 1903, by R. G. Skerrett.

"Protector" Running with Half of Conning-Tower Above Water. Showing stability of boat with two men moving freely on top.

enough to hold the entire crew while the simple performance of opening the bottom door is being effected. To anyone at all familiar with the workings of the diving-bell or caisson, the operations of the diving chamber of the "Protector" are apparent. Telephone communications can be maintained either between the diving chamber and the rest of the boat, or between the diving chamber and a diver out upon the bottom. Practical demonstration of the workings of this compartment were given a board of army officers last January, detailed from the School of Submarine Defense; and, for particulars of that remarkable performance under conditions of weather and water-bed of a peculiarly trying sort, the reader is referred to the report of that board which has already been published.* So convincing were the evolutions of the boat on that occasion that those officers, with their intimate knowledge of the urgent needs of certain portions of our coast defense, did not hesitate to recommend the immediate purchase of five vessels of the Lake type, and the further report of the Second Division of the General Staff is especially significant of the military estimate of the advance made in the "Protector" type over that of the naval diving type, which the army had also examined carefully.

One peculiarly striking feature of the "Protector" is the perfect facility with which she can maneuver upon the bottom. It is possible to back her as easily as it is to drive her ahead, and the moment her motors stop the boat comes to a standstill. This admits of great nicety of operation and the most perfect and systematic examination of a given area of water-bed, while the positive holding the boat has upon the bottom makes it preeminently easy to keep to any desired course. Simply by watching the depth gauges for readings of sounding and checking distances by the odometer attached to one of the bearing wheels, the compass, which is especially reliable, can be used to follow, thus hidden securely from sight, a tortuous channel into an enemy's harbor.

Immediately abaft the diving chamber is an air-lock by which entrance into and exit from that compartment may be effected when the chamber is under pressure. It must be remembered that the body of the boat is not subjected to air pressure during any submerged work.

LIVING SPACE.

Abaft of the air-lock comes the living space of the boat, where four comfortable transom seats and their upholstered backs,

*See JOURNAL U. S. ARTILLERY, March-April, 1904.

when swung up into place, provide sleeping accommodations for eight persons. Back and above these seats are space and lockers enough for the convenient stowage of an unusual supply of clothing. As resting-places for the unengaged members of the crew, when it is inconvenient to be on deck, these transom seats have proved a welcome boon. A collapsible mess table is shipped at meal times. Plate-glass mirrors and electric lights add to the cheeriness of these quarters. Next abaft the living space, separated by a mahogany bulkhead, with a glass-paneled door, is the galley, where, besides the electrical cooking apparatus, is ample room for the stowage of pots and pans, table equipment, and a considerable supply of food. Abaft of this again, separated by a partial bulkhead are the switchboards for the electrical installation.

ENGINE ROOM.

The floor of the engine-room is lower than that in the living spaces so as to afford ample headroom, without bending, for a six-foot man. The engines are placed on each side of the boat, leaving a wide central passage between them by which splendid facilities of control and supervision of the machinery in all directions are afforded. The practical significance of this accessibility, as contrasted with the cramped arrangement on the Holland submarines was shown during the trial of the "Fulton," in June last, when it was necessary to suspend the tests of that boat for twenty-four hours merely to repair a leaky gasket on one of the cylinders of the gas engine. Immediately abaft the engines follow the motors.

The submergence tanks and the storage batteries lie beneath the living space and the engine-room; and the latter, which are placed mainly under the space forward of the engines, while readily accessible, are yet so securely sealed and ventilated that there is no chance for the escape of battery gas into the body of the boat. The prime effort of the sealing, however, is to thoroughly safeguard the batteries from the injurious admission of salt water, which, at times, is brought below in dripping clothes.

MOTIVE POWER.

The motive power consists of a double installation of gas engines and electric motors: One engine and one motor on each of the twin shafts.

The gasolene engines are of the four-cylinder, four-cycle type of the well-known White and Middleton make with certain modifications of Captain Lake's design, these modifications having to do with the peculiar requirements of submarine work. The cylinders are ten inches in diameter, the stroke is one foot, and the bases are water-jacketed. Each engine has a rated brake horse-power of 120. Ignition of the combustible is secured in no fewer than three ways—these being by dry-cell battery, by magnetos, or by a current from the storage batteries. No trouble has ever prevented the working of at least one of these alternatives. Much of the installation of the gasolene engines must, of necessity, remain secret ; but it can be said, without fear of substantial contradiction, that the engines of the "Protector" typify the only safe and reliable installation of that type of motive power in a submarine. Back explosions are effectually taken care of ; there are no leaky stuffing-boxes or valves ; and the air of the engine-room, after a long run with closed hatches, is invariably fresh and wholesome. Such cannot be claimed for any other submarine equipped with gasolene engines.

Owing to inefficient propellers and the position of their primary installation the full power of the "Protector" was, for some months, unsuccessfully applied ; but in February last larger screws and lengthened shafting produced the desired results. On her homeward run from Newport to Bridgeport, coming right off the dry-dock and without any preliminary adjustment of the new screws or tuning up of the engines, the boat made the distance of 98 knots—towing her large supply sloop 25 knots of the way—in something less than twelve hours. This under gasolene engines alone. With motors and engines combined, the "Protector" can do 10 knots.

The gasolene engines of the "Protector" are fitted so that they can be used to propel the boat when she is running with only the upper half of the sighting-hood above water ; and it is further possible—as has been proved by practice—because of the peculiarly designed induction valve fitted thereon, even to make short, quick submergences under gasolene propulsion, the valve automatically shutting out the surge of a passing sea or instantly closing when the boat goes under water. This is utterly beyond the power of any other submarine, but because it is protected by patents and is peculiar to the "Protector," the Navy Department denied this feature a place in the official schedule of tests. The direct advantage, from a military point of view, of this flexible adaptation of the gasolene engine—with its superior power and greater endurance—should be apparent to a tyro. As has been said, the electrical propulsion is an expensive one, and must be husbanded because of the very limited radius of action so afforded at the best. In boats of the diving type, like those now in the navy, the moment the craft passes from the light, cruising condition to one but slightly more submerged with her conning-tower clear, the gas engine—for safety's sake—must be shut down and the work of propulsion turned over to the motors. For a diving boat to pass from the cruising trim to readiness to submerge, i. e., with her conning-tower clear, takes nearly half an hour, and the ability of the type to so trim down in a seaway of any moment has never been proved. In consequence, in time of hostilities, the diving boat must leave the shelter of her base all ready for immediate submergence and under electrical propulsion, which driving power is not only disproportionately expensive, but, likewise, extremely limited in its endurance. In every direction where the gas engine can supplant the electrical motor there is a distinct gain in efficiency, in speed, and in radius of action. The "Protector" was designed, when leaving port in time of war to meet an enemy in the offing, to start out in what is termed the "war-time" cruising trim—that is, with her deck awash. The subsequent disposition of some twenty odd tons of water and the time taken to pump it in—12 minutes—is thus eliminated, and the boat, thus prepared for total submergence in only three minutes, goes forth speedily and securely under gasolene propulsion. On sighting the enemy, the "Protector" can be gradually submerged until all but the top of her sighting-hood is below water, and yet still be driven rapidly and safely under her gasolene engines until well within striking distance, when recourse at the last moment may then be had to the electric motors. Because of the reversible screws, which permit any desired variation of speed, the boat can literally creep upon the foe—under gasolene engines—without the slightest fear of betraying her presence by "broaching"—so beautifully does she lie in all conditions of partial submergence. It is not possible, on the other hand, to control a boat of the diving type with any such precision when lying so close to the surface, nor is it possible to make them dive at a speed of less than six knots an hour unless the reserve buoyancy be reduced to a hazardous minimum. In fact the diving boat betrays her presence by the wake she leaves unless she is well below the surface, and to guard against "broaching," the official reports show that the diving submarines now in our navy must be held at least fifteen feet below the surface—thereby necessitating the use of electrical propulsion and the long-sighting instrument; the first meaning reduced speed and restricted radius of action, and the second, while likewise cutting down the speed, incidentally giving still more imperfect vision because of the vibration of that length of substantially unsteadied tube.

For regular under-water propulsion the "Protector" has a six-pole, shunt-wound Diehl motor on each shaft, the motor being thrown in by a friction clutch. When only the engines are being used to drive the boat, the armature revolves freely, with lifted brushes, and incidentally serves the purpose of a fly-wheel. Each motor has a rated capacity of 37½ kilowatts at 125 volts, when driven at 300 revolutions a minute, a range of E. M. F. of from 80 to 160 volts, and a current capacity of 300 amperes at full load, with a momentary capacity of 450 amperes. There are sixty cells of the well-known Gould type, with spun plates of the Planté pattern. At full speed, it is estimated that the batteries will give a cruising radius of twenty knots, and, at an economical speed, about thirty knots. For an endurance test the batteries have never been run to exhaustion, and since the installation of the new screws and shafting no submerged runs have been made; but based upon the data from previous performances, the boat should do something over seven knots.

The motors and engines can be coupled together on the driving shafts, thus giving a combined propulsive power to the two screws of 350 horse-power. For the purpose of speedy dashes, either in attack or escape, this combination is valuable and unique among submarines, but its trial was refused by the naval board, despite its manifest advantages under certain conditions.

The propellers are reversible, making it possible to back the boat under gasolene engines; and varying pitches can be secured to meet changing needs. Because of this, it is not necessary to use gearing in connecting the motors to the driving shafts. By decreasing the pitch, the storage batteries may be charged while the boat is running at a reduced speed—the motors being reversed and run as generators; and by increasing the pitch the motors and engines may be used together for propulsion, giving 324 horse-power for higher speed. In the submarines now in the navy the engines and motors cannot be used together for propulsion, and to back the boats, the engine must be thrown out and the motor called into service.

AIR COMPRESSOR.

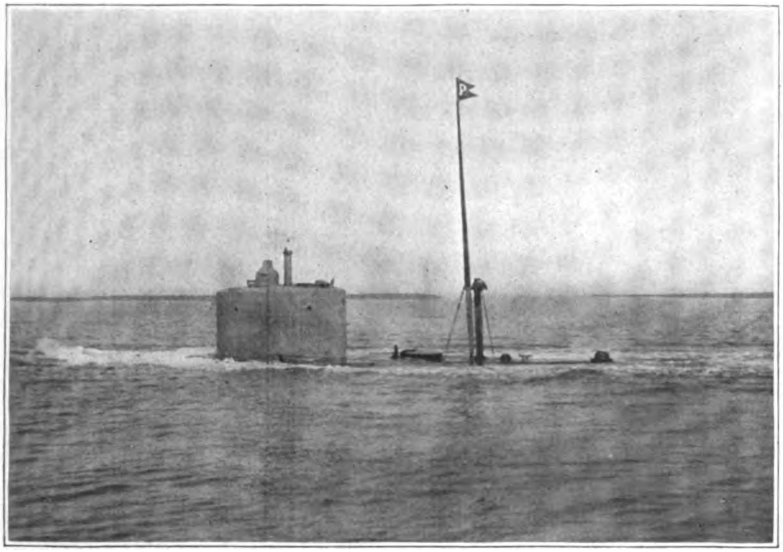
For charging the air flasks and providing compressed air for the various mechanisms controlled thereby, the "Protector" carries a compressor of peculiar compactness and modest weight of Captain Lake's own design. It was planned to compress sixty cubic feet of free air per minute to 2100 pounds, when running at 200 revolutions a minute. The ordinary working speed is 150 revolutions a minute; and the machine has always proved amply equal to its task.

Besides providing motive power for the torpedoes, compressed air is used for some of the motive mechanisms of the boat, and also to control the expulsion of water from the superstructure and the submergence tanks and to supply all of the demands of the diving chamber. The air flasks were planned to supply, besides these demands, fresh air for the body of the boat during long submergences; but, during under-water runs of four hours with no fewer than eleven persons aboard, not the slightest inconvenience was felt because of stuffiness—the free air, at time of sealing up, being enough to meet all demands with a generous margin.

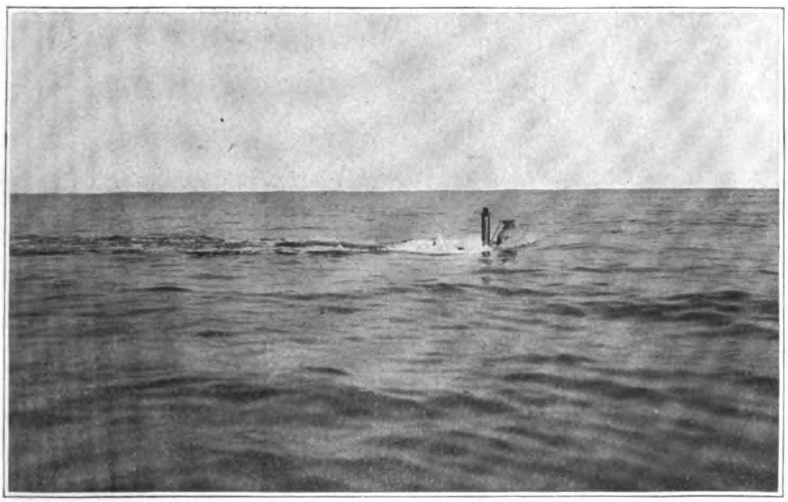
CONTROL OF SUBMERGENCE.

The precision with which the "Protector" can be submerged and her depth controlled is one of the truly remarkable features of this remarkable craft. To bring the deck level with the water, the superstructure is filled. This brings the boat to "war time," cruising trim. To bring the boat to submergence trim, that is, with the base of her sighting-hood awash, certain of the ballast tanks are filled. In this condition the boat has approximately 300 pounds of reserve buoyancy; and, with the vessel so submerged and making but a very modest target, direct vision can be had through the dead-lights of the sighting-hood. In this condition, while under way, by a slight depression of the four hydroplanes, it is possible to force the boat evenly below the surface, and to hold her there with only the top of the omniscope above water, or, by a slightly greater depression of the hydroplanes, to cause the craft totally to disappear beneath the waves.

The hydroplanes are really nothing more than four big, flat, rectangular paddles mounted in guards just outside the rail and even with the deck line. These paddles or planes are pivoted in the centre—the two on each side being bound together by tie-rods—and all four, by a system of levers and rods within the superstructure and an operating hand-gear in the conning-tower, are manipulated in absolute unison. Being symmetrically disposed, amidships, the result of their deflection when the boat is under way is naturally to force her up or down, as the case may

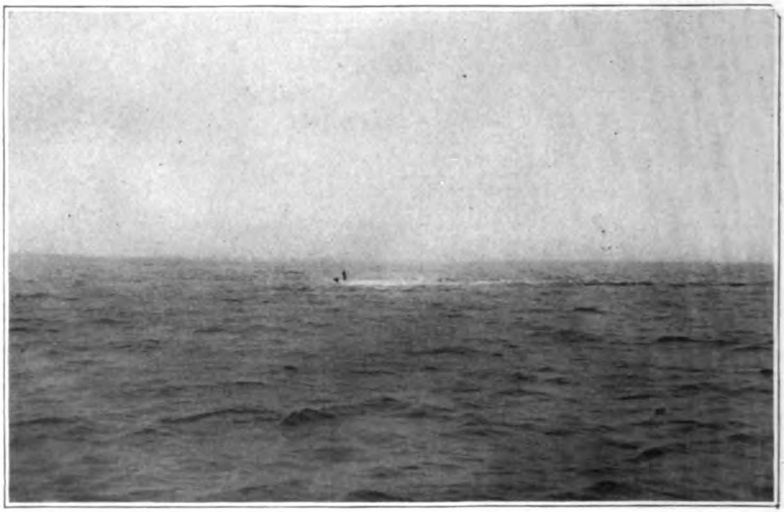


Degree of Submergence—Structure Awash.

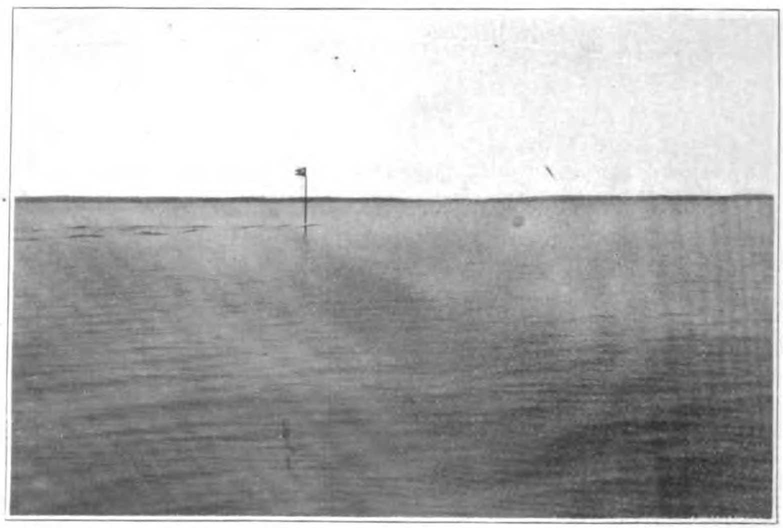


Degree of Submergence—Omniscope and Conning-Tower Hood Visible.

Plate IV. to face page 126.



DEGREE OF SUBMERGENCE—OMNISCOPE AWASH.



DEGREE OF SUBMERGENCE—SIGNAL MAST ALONE VISIBLE.

be, on an even keel, and to avoid that dangerous plunging method of submergence common to boats of the diving type. It is not at all difficult to maintain an even depth within a few inches for any length of time ; and no matter how near the surface the boat may operate in a seaway her action is so precise and her mass so little effected that there is no tendency whatever to broach. As a direct consequence of this peculiar steadiness, it is not necessary to use a long tube to the observing instrument, which, in boats of the diving type, seriously reduces speed, and also adds to the task of the man at the diving rudder by bringing into play a variable factor affecting the craft's longitudinal stability. In the "Protector," so simple is the control of submergence when under way, that novices, with only the depth gauge as a guide, have held the boat at a fixed submergence for considerable periods of time. The fact that this operation, so vital to the efficient working of a submarine, calls for so little skill aboard the "Protector" is especially significant of her possible utility in time of war when men may fail under stress or accident. Particularly instructive is this difference when comparison is made with the nerve-trying task set the man at the diving rudder of the diving type of boat, who must acquire his rare and equilibrist-like skill after months of training, and who, in case of physical breakdown, cannot be readily replaced.

For total submergence preparatory to running on the bottom, the reserve buoyancy of 300 pounds is destroyed by taking in sufficient water ballast, the boat being allowed to settle easily upon the water-bed even while under way. The body of the boat does not touch the bottom ; she rests thereon upon a couple of big rollers or wheels with broad bearing surfaces. These wheels, unlike those on the original "Argonaut," have no propulsive power, and are mounted in pivoted jaws and set tandem in the keel line. When running on the surface, the wheels are housed within pockets, but the moment the boat prepares for submerged work of any sort the wheels are lowered. This operation is under hydraulic control, and the arrangement is such as to give the wheels a cushioning effect when running upon the water-bed.

The object of thus lowering the wheels is to guard the bottom of the boat against mishap should an unexpected obstruction be met, the wheels first taking the blow. The screws provide propulsion, the wheels serving only as castors, so to speak. The negative buoyancy of the boat is regulated to suit the character of the bottom and the presence or absence of currents. While so running upon the bottom off Bridgeport, the writer, by merely operating the hydroplanes, has brought the boat to the surface despite her negative buoyancy. To draw the "Protector" to the bottom when not under way, without recourse to water ballast in excess of the vessel's buoyancy, the two anchoring weights are used. These weights, each of which weighs half a ton, are pocketed ordinarily within the hull, one at the bow and one at the stern, and are controlled by electric winches from the shelter of the conning-tower and do not call for deck service of any sort.

By simply reducing the boat's buoyancy to less than the total weight of the anchors after they are lowered, the craft can be bodily drawn to any depth below the surface, and held there, by simply winding in the connecting wire cables. To anchor the boat upon the surface under ordinary circumstances, it is not necessary at all to reduce her buoyancy. The ability thus to anchor the craft in a seaway without exposing the crew upon deck, and the power of holding the vessel immobile at any depth is sufficiently suggestive to need no elaboration. None of these operations can be accomplished with any of the diving type.

The great longitudinal stiffness of the "Protector" when submerged, by which it is possible for the crew to enjoy the utmost freedom of movement in the widest discharge of their duties and by which it is safe and practicable to move considerable weights in a fore-and-aft direction, is due to the very considerable buoyant moment of the conning-tower acting in opposition to the downward pull of the great mass of the boat's heavy weights, which are purposely kept low. This longitudinal stability has a direct bearing upon the control of the boat when running submerged in suspension ; is intimately connected with the endurance of the crew by imposing no taxing restraint ; and adds directly to the military efficiency of the craft by permitting the torpedoes to be withdrawn from or loaded into the tubes while running submerged— and this in the absence of a complex system of compensating tanks, etc., which might fail at a critical moment.

This same gift or feature of the "Protector" is likewise associated importantly with the safety of the craft, for, settling as she does on an even keel, it is not possible for her to plunge or to bury her nose in the bottom mud with the risk of being held there disastrously by hydrostatic pressure. This occured during the "Adder's" official trial, but, fortunately, without dire results—thanks to the character of the bottom and the moderate depth of water.*

* See Vol. XV, No. 1, "Journal of the American Society of Naval Engineers".

TORPEDO EQUIPMENT.

The primary military power of attack is centered in the three torpedo tubes carried by the boat, one on each bow and one in the centre line of the stern. The rear ends of the two bow tubes are in the forward part of the living space, into which the torpedoes can be conveniently withdrawn for inspection, charging, correction, or any of the adjustments preparatory to discharge. The after tube is abaft the engine space and directly in line with the wide central passageway, thus facilitating its easy handling. There is ample space under the transom seats in the living space for the stowage of two spare torpedoes. The weapons are commonly carried stowed in the tubes. These tubes were designed to carry Whitehead torpedoes of 3.55 M. Mark III., and are made of steel. The expulsion impulse is compressed air at a pressure of 60 pounds, supplied from the low pressure system. For convenience and speed of embarkment, the torpedoes are generally taken aboard by being floated into the tubes; and, at the loading trials at Newport, the possibility of exceptional celerity was convincingly shown.

Compared with the single tube boat of the diving type, with its complex system of ballast compensation during reloading—a period at best of not less than ten minutes—the power of the "Protector" to fire simultaneously two torpedoes at an active enemy and, by simply swinging, to fire a third from her stern tube in flight is pointed enough to tell its own story by comparison.

THE DIVING CHAMBER.

The secondary military power of attack is, of course, centered in the diving chamber with all of its possibilities for cable cutting, mine destroying, and the removal of subaqueous obstructions; while as a means of telephonic communication, from an outlying station, with a shore base the adaptation of the diving chamber is at once apparent. As an element of safety and as a means of escape for the crew in case of disablement upon the bottom and inability to rise, the diving chamber has been proved so by experimental drill.

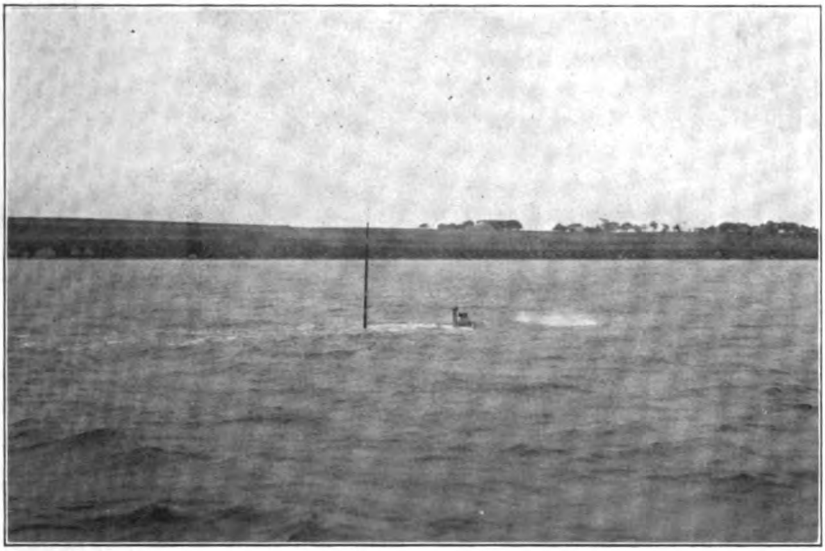
SAFETY OF THE TYPE.

To hark back to the Navy Department's circular of 1893, in which safety is given prime importance in the list of desirable qualities, let us see how far Captain Lake has met this demand.

To begin, the boat when running submerged in suspension, has a reserve buoyancy of quite 300 pounds. Should the motors stop, the craft would rise at once to the surface. Should a leak in any of the valves have permitted the entrance of enough water to destroy this reserve of buoyancy, and, should there be a failure of air pressure and the loss of that power of expulsion, electric pumps would supply the deficiency. Should these, however, fail, hand pumps could be used to drain the tanks fast enough to bring the boat to the surface where the gasolene engines could be started and the pumps so controlled, of great capacity, would soon drain the tanks. If these should fail, a five-ton emergency weight, set in the keel, could at once be detached, and should that fail, which is highly improbable, the two anchor weights, weighing together a ton, could be let drop on a run. Should, however, most of these fail, there is still the diving compartment as a means of escape, provided there were air enough in the low pressure system for the purpose. It is hard to imagine any combination of circumstances that could or would be likely to render escape impossible short of the total destruction of the boat ; and that is a risk that all war crafts have to face. The recent narrow escape from loss of the Holland type "Porpoise"—unsupplied with these safety features—points a moral to the wise provisions made against accident in the Lake boats. As will be remembered, the "Porpoise," in the hands of an especially expert crew, sank to the dangerous depth of 120 feet, despite all endeavor, and it was not until after twenty minutes of desperate, exhausting hand pumping that the crew succeeded in bringing the craft to the surface.

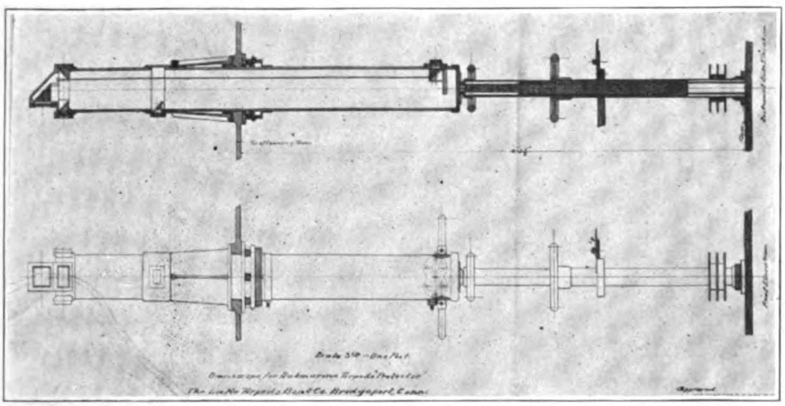
As a contributive to safety of no secondary importance, is the boat's twin screws and dual power of propulsion. The significance of this has already been demonstrated by breakdown or temporary disablement of the reversing gear of one of the propellers. That happened just after the boat rounded Point Judith last November in a storm, and yet, with only the port engine working, the "Protector" made Newport unassisted. A single screw boat under like circumstances would have been in a perilous position.

As a minor phase of safety comes the habitability of the "Protector." The crew of the vessel have been housed and subsisted aboard week in and week out, the vessel being under way night and day, yet at no time was their endurance taxed, while at all times they were ready and fit to perform any task agreeably to the nature of the service for which the boat was designed. In time of war it would not be necessary either to tow a boat of this type to the field of operations or to supply fresh crews at fre-

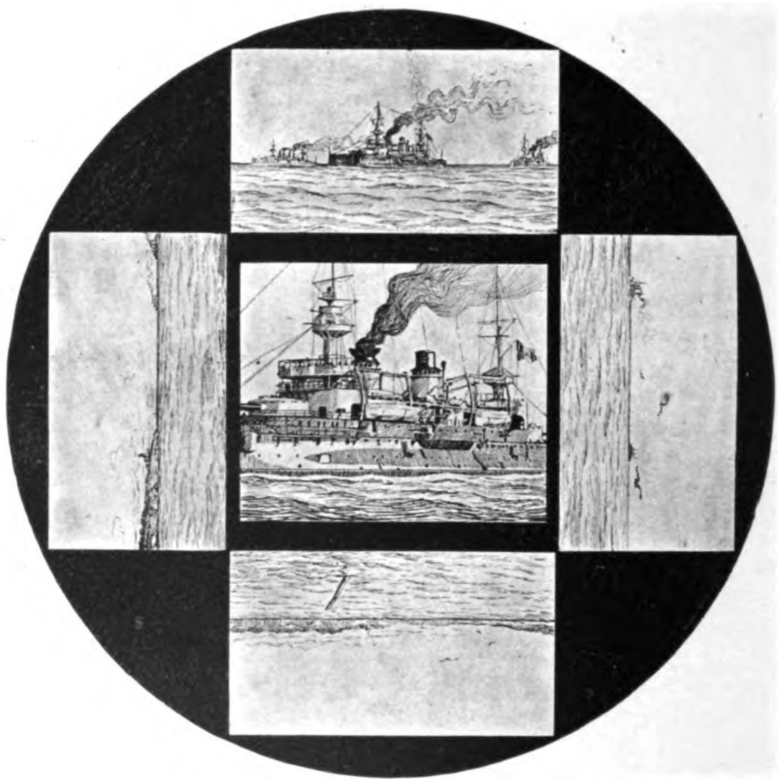


Copyright 1903, by R. G. Skerrett.

"Protector" Discharging a Torpedo. Omniscope and part of sighting hood above water.



Elevation of Omniscope.



THE FIELD OF THE OMNISCOPE.

With the central view upright, the top sketch shows the object reduced and viewed dead ahead. The lower represents the view astern, which is reversed, while the flanking finder views are those of the broadside vision. Corresponding magnification of any of the finder views would follow upon the central lense — normally dead ahead — being turned in that direction.

quent intervals from the much advertised "mother ships"—upon which the possible efficiency of the diving type will depend, if their advocates speak knowingly. The experiment with the "Adder" and "Moccasin," in their short trip from Newport to Norfolk proved the costly risk thus involved in towing these boats in a moderate gale and the total inability to board and enter them in a seaway.

THE OBSERVING INSTRUMENT.

Experience abroad and experience at home with the vessels now in our service has shown that an efficient sighting instrument has a bearing of utmost importance upon the safety and practical value of the submarine when denied the usual means of direct observation. Captain Lake anticipated this when he designed his omniscope. This instrument, as the accompanying cut shows, carries five lenses, and, with the omniscope pointed ahead, normal vision is given in the centre lens and reduced vision in the four smaller lenses or finders, which bear ahead and astern and on each beam. The field of the large lens is of 2 degrees and 40 minutes, while that of each of the smaller lenses is 21¼ degrees. The main lens can be rocked so as to follow the horizon during slight changes of trim. The omniscope tube has a diameter of 6 inches, is of rolled brass, and when housed lies eight inches above the top of the sighting hood. The tube can be rotated. In looking into the eye-piece, the observer sees a combination of five views similar in relative scope and size to those shown on the sketch. A quarter turn covers the entire horizon. In this an all around power of observation is secured, while, by bringing the main lens to bear upon anything picked up in one of the four finders, normal vision and a judgment of the true distance of the object may be had. The loss of the British "A1" was primarily due to her faulty sighting instrument and its inability to give a means of properly judging distance, and the same may be said of substantially all of the observing instruments heretofore fitted on other submarines, both here and abroad. By the official records, our own government submarines of the Holland type have had a number of narrow escapes, and they have never been able to judge correctly the distance of the target under the most favorable circumstances. In the omniscope a series of cross-lines on the field of the main lens gives the observer a means of accurately measuring distance. When the observer is following a moving target, the movement of the omniscope is automatically transmitted to the helmsman. This is done by means of a cross line attached to a movable collar on the under side of the compass, which, in turn, is actuated by a band passing around another collar on the omniscope. The effort of the helmsman, who cannot see without, is to keep the lubber-line and this cross-line coincident, and so long as he does so a small buzzer sounds confirmation. The omniscope is swung in azimuth by the observer. No difficulty has ever been found in following a moving target, and the instrument has proved uniformly efficient and free from fogging. Ice, when forming on the outside, is easily removed by an ingenious arrangement that has proved entirely efficient during the past severe winter in the waters of Newport. Recent important modifications have added greatly to this remarkable instrument.

To the student or even to the reader casually interested in the subject of the submarine, the present description of the "Protector" is sufficiently detailed to show wherein she has met successfully so many of the difficulties common to subaqueous navigation and also makes plain the generous manner in which she has fulfilled every one of the eight essentials outlined by the Navy Department in its circular of 1893. It is also plain to those that have followed the subject how far the boat has likewise blazed the way of original departure and widened the field of application of this type beyond the slightest possibility of intelligent contradiction.

To the military arm of the national defense credit is due for having first recognized officially the peculiarly significant worth of this particular type and having recommended its immediate adoption. With the confirmation that will surely come, after serious test, by a Power in the throes of conflict, a double moral is pointed that should strike home to the nation at large, which must be told some day why this uniquely American invention met with so little encouragement here when so generously approved by a government abroad bent earnestly upon its proper protection.

SUBMARINES.

Extracts from an article in the "Naval Annual,"* 1904.

It is usual to trace back the ancestry of the submarine to Bushnell's craft, invented towards the close of the 18th century; but Bushnell's vessel was a combination of the submarine and and the mine, and this arrangement has never been and can never be of any great fighting value. It is the combination of the submarine and the torpedo that is so valuable; but for the Whitehead the submarine would remain as an interesting toy, and but little more.

The first vessel in which the Whitehead was used from a submerged tube was the British Vesuvius, which dates back to 1874. Like the present day submersibles, she aimed at getting within torpedo range of a big ship without being noticed. For this purpose she was very low in the water, and presented a very small target. But small as the target was it was large enough to be clearly visible at quite a long range, and a very few hits on the above water portion would suffice to sink her. The advent of the quick-firing gun rendered the Vesuvius (with her slow speed of 10 knots) quite unserviceable, and her place was taken by high-speed, light-draft torpedo craft, with not only the torpedo tubes but also the engines and boilers well above water. These vessels used their high speed both for getting within range quickly and for escaping after firing. And when it was endeavored to build a type of vessel with high speed, but showing very little above the surface, and fitted with submerged torpedo tubes, the great cost of the first ship, the Polyphemus, prevented any similar craft being built. In order to get a number of invulnerable torpedo vessels for a moderate sum, it was considered desirable in the submarine or submersible to return to the small size and cost of the Vesuvius, with the same low speed, and to provide means for taking cover under water when attacked by the quick-firing gun. Thus it is the desire to evade the gun that has caused the evolution of the modern submersible, which escapes under water when hard pressed. It must be clearly understood that the submersible (a much more explicit designation

* The *Naval Annual*, 1904. Edited by T. A. Brassey. Portsmouth: J. Griffin & Co. New York: D. Nan Nostrand Co.

than submarine) is steered to the best position for attack in precisely the same manner as the low freeboard Vesuvius or Polyphemus. The officer who commands a submersible on seeing his opponent steers to intercept her, and he cannot choose the right course to do so unless he has a clear view. A vague impression still prevails in some quarters that some instrument may be invented, or has actually been devised, by which the captain of a submersible may be enabled to keep his craft entirely under water, and yet adjust his course so as to intercept a moving enemy. This is quite impossible, as even 100 feet of water is quite as efficient an obstacle to vision as a brick wall. The first necessity for a submersible is that the officer in command should have a clear view of the enemy up to the time when he fires his torpedo. The torpedo once fired he can dive to escape, but when fairly under water the submersible is practically harmless.

The problem of how to obtain a good view without being seen by the ship that it is desired to attack is the all-important one, and much of the success or otherwise of the submersible must depend on the arrangements made to enable her captain to see and not be seen. The simplest plan, and one that should be very efficacious when the weather is misty or there is a certain amount of sea on, is to have the top of the conning-tower above water whilst the hull is still immersed. This appears to be fully appreciated in France, and both the early submarines Gymnote and Zédé, together with the up-to-date submersible Triton have conning-towers rising some 5 feet above the hull of the boat. The Lake type of boat in the United States also has a high conning-tower, but the original Hollands have very low ones. This is, however, altered in the modified Holland boat A1, recently run down when exercising at Portsmouth, for the conning-tower is about the same height as the French craft. If the sea is very smooth a circular conning-tower makes a good deal of splash in going through the water, and it is therefore desirable to make it boat-shaped, as has been done in the Lake boat, and also in the French Triton and the latest Hollands. If the top of the conning-tower shows too much, then the boat must be sunk till only the top of the periscope or optical tube remains above water. With the help of this instrument, objects can still be clearly seen, but the arc of vision is necessarily limited, so that it is very difficult to judge the course of a ship which it is intended to attack, and it is almost impossible to guess her distance. As the submersible is very slow, it is above all things necessary that some idea of the range of the enemy shall be obtained, otherwise there is a great liability to get left astern—a hopeless position for attack. Whether the approach to the point of attack is made with the top of the conning-tower above the surface, or with the periscope only showing, it is evidently absolutely essential that the boat shall keep at an even depth. This is the more necessary because the more evenly the boat goes along, the less tendency there is to splash, and thus give away the boat's position. Moreover, if the conning-tower bobs in and out of the water the view is spoilt, and this equally applies to the periscope. In the earlier pattern of boat a good deal was said about the difficulty of maintaining a uniform depth, but both in England, France and America this difficulty has been quite overcome. For example, the Lake boat was kept within one foot of the depth ordered for a considerable time with a stranger at the helm who had never before steered a submersible. The Hollands have an equally good record, and, whatever the exact type of rudder or water-plane, it may be taken as certain that the problem of keeping a submarine at a uniform depth when running submerged has been practically solved.

The early French boats were submarines pure and simple, driven by electric motor only. They proved serviceable but very slow, their radius of action is limited to 50 miles or thereabouts, after which the accumulators needed recharging. After some years of experiments the French have now decided to fit special engines for surface-running to all their boats, and it is this class of boat that they designate a submersible. The first engines used by the French submersibles for surface-running were ordinary steam engines with boilers heated by liquid fuel, but there were grave difficulties in submerging quickly owing to the necessity of closing up the extensive ventilation arrangements. The heat was also very objectionable. They have now come into line with England and America in using gasolene motors for running on the surface and recharging the accumulators. All boats fitted for running under water, whether submerged or submersibles, use an electric motor actuated by accumulators when submerged. It is the invention of the accumulator that has rendered under-water navigation a practical matter. A motor actuated by an accumulator consumes no air, and there are no deleterious gases to be got rid of. The steam boilers and reservoirs used in the Nordenfelt boat and the early French submersibles made it so hot when under water as to be well-nigh unbearable. Compressed air is out of the question, as taking up too much space. All other motors consume large quantities of air, which cannot, of course, be procured when submerged. The great defect of the accumulator system is its enormous weight. Not more than 2 to 2½ I.H.P. can be obtained per ton of batteries and motor. A surface torpedo craft in which the total weight of engines, boilers, coal and water is the same as that of a submarine of 100 I.H.P. would develop some 3000 I.H.P., but such a craft burns a boatful of air in a few seconds, and this enormous supply of air is essential to all ordinary motors. Thus a very weighty installation is required to propel a boat 8 knots under water, and if an under-water speed of 10 knots was asked for, the displacement would have to be increased to 400 or 500 tons in order to admit of some 300 tons being devoted to the plant for electric propulsion.

When a boat is on the surface, a comparatively light air consuming motor will produce much more horse-power than the heavy electric plant. and can be used for recharging the accumulators. As to the type of motor for use on the surface, the French have tried both steam and petrol engines, the steam boiler being heated by liquid fuel. In England and America the petrol or gasolene engine is exclusively used, the power being generally about some three times that of the electric motor, and the resulting speed about 3 or 4 knots greater. Thus the smaller submersibles have speeds of about 6 knots submerged, 9 knots on surface, and the largest and latest about 8 and 12 knots respectively. Speeds of 15 knots on the surface are talked of, but the boat would have to be very large and very expensive, whilst, as pointed out above, 10 knots is a most unlikely speed under water. The cost of submersible boats running 12 knots on the surface and 8 knots submerged will probably be about £40,000. It is with a view to getting large numbers that the French are building a class of boat of only 70 tons displacement, costing £18,000. They are confessedly for harbor defense only, their speed and radius of action is very small, and they are generally stigmatized as being unsatisfactory.

Though France holds the lead with regard to numbers of under-water craft, she has after all only 5 efficient submersibles, namely, those of the Narval class, and they have steam propulsion, which is not altogether satisfactory, and may be changed for petrol motors. She has besides 7 submarines of the Morse class, but their radius is small, and 12 of the 77 foot Naiade class universally acknowledged to be unsatisfactory, owing to their small size and small radius. Three more vessels of 117 feet and over will be ready in 1904, but the other 8 to be finished are of the discredited Naiade class. Thus when at the end of the year, England has 12 of the generally satisfactory Hollands completed, and 7 others well advanced, it will only be in local harbor defense boats that the French will be superior. And if the 11 boats to be put in hand this year are quickly built, their completion in 1905-06 should see us well ahead of everyone. The United States have voted £100,000 for more experiments, but are holding their hands at present as to the building other boats. They have, however. 8 of the Holland type which have passed their trials well. Thus, whilst France leads at present, Great Britain is a good second, and is coming up fast, with the United States third.

Of the other Powers, Germany has a boat under trial which is supposed to be of the Holland type and is building two others. Italy has three experimental craft building ; they too are said to be gasolene and electric. They will not be ready till the end of the year. Russia had a complete failure in 1902 with small-sized craft something like the Gymnote, and is now experimenting with a Rubinoff boat supposed to be a modified Holland of 175 tons, some 80 feet long. Six new boats of the Djewestki type have just been ordered, but they are not likely to be finished till next year. It has been stated in the French Assembly that they are copied from French designs, but from which of the many boats tried in France is a moot question.

An important factor in the working of a submarine or submersible is the amount of buoyancy when running on the surface. The submarine proper has only 5 to 8 per cent. whilst some of the submersibles, notably the French Narval class, have as much as 25 per cent., and the American Lake rather more. When some 50 tons of water has to be admitted this cannot be done in a moment, and a quarter of an hour seems to be about the time necessary for bringing a buoyant submersible to the awash condition. Every endeavor is being made to shorten this time, and it may be that it will be considerably reduced, but if there is any sea on, the proper trimming of the boat is a delicate operation and very difficult to carry out quickly. How long the latest boats take is not known, but it is believed the Hollands are very efficient in this respect.

The first requisite for success in an attack by a submersible is either that the enemy should be stationary, or that his course should be such that it should take him past the boat within torpedo range. If the speed of the ship be taken at twice that of the submersible, the latter has no chance unless she is fortunate enough to plant herself within 2 points of right-ahead of the ship to be attacked, and even then she must see her a long way off to get into the awash condition before she herself is seen.

It is evident that speed is important for a ship passing through waters likely to be infested with submersibles, and that the power of turning rapidly is also most important. There is also a distinct and definite danger area extending about 3 points on either bow of a ship A couple of destroyers from 1½ to 2½ points on each bow, and say 6 cables off, might see the periscope and give warning in time to allow the ship to turn away. As to whether a destroyer could be fitted with any weapon competent for dealing with submarines, it does not seem that there is much or any hope of doing anything with an outrigger, the submarine would dive far too quickly to be thus caught. Of various proposals that have been made, one of the most promising* is to use torpedoes in a destroyer, not the cumbrous, slow-firing Whitehead which is used against ships, but something smaller, handier and lighter, of which several could be fired in a minute. The submersible presents an under-water target 120 feet long and 10 feet deep which ought not to be very difficult to hit at, say, 200 yards range, and only a small explosive charge is required if the torpedo is exploded on impact. The project of firing a big torpedo with a time fuze is most unpractical, not to say absurd. On the other hand, submarine warfare will naturally lead to a great development of submarine projectiles, and in all fighting in which projectiles are used the great point is to have the means of firing a great number in a very short time. The speed of the submersible when under water will not be more than 7 or 8 knots, so that a comparatively cheap and light torpedo which would run, say, 16 knots for 300 yards, ought to be competent to overhaul the submersible even if fired from astern. The Q.F. torpedo tube would be carried in a destroyer, torpedo boat, or even in a ship's picket boat. Immediately a periscope was sighted, the destroyer would make for it at her highest speed, discharging, say, 3 or 4 torpedoes when she reached 100 yards. If the submersible saw that she was discovered, she would of course dive and might thus escape, but, at any rate, her chance of torpedoing the ship would be gone. It does not seem impossible that by sending light scouts ahead in this way a ship might pass through dangerous waters in safety. Directly the submersible was sighted by the scout, the ship would turn away, and,

* See *Naval and Military Record*, February 25th. Letter from Mr. Carl Laughton.

having gone far enough to clear any torpedoes, say 1 mile, she would turn back, whilst the scouts and destroyers would resume their look-out station as before.

The submersibles themselves must evidently be fitted to fire the largest sized torpedoes, indeed all of them are doubtless so fitted now. It is not likely that they will get more than one opportunity of firing, and it is most important that a hit when made should be decisive. A ship with even a large hole can be repaired in a month or two if she can be got into dock, whereas make the hole somewhat more extensive, and she will go straight to the bottom as did the Almirante Cochrane. In the earlier Holland boats, and it is believed in the French ones also, spare torpedoes were carried other than the one in the tube. The tubes have now been increased in number, and there are no spare torpedoes. The tubes in a submersible must be fore and aft; the natural place for them is in the bows, so that the boat when attacking is steered so as to align the tubes in the right direction. Thus the handiness of the boats is important. Unfortunately it is not easy to attain handiness when submerged, and the turning circle of all vessels running under water is large, so it is therefore the more necessary to sight the ship attacked at a great distance off, and during the approach to keep the course accurate. The idea that the boat may altogether go out of sight under water, come to the surface, alter course as required and go down again in a few seconds is not a practical one, and assumes that the enemy steers a steady course, a very foolish thing to do when submarines are about. The speed and course of the enemy can only be determined by keeping her in sight for some time, a transitory glimpse for a few seconds is not sufficient. Moreover, the splash made on coming up may betray the boat, and allow the ship to turn away in time. If a boat has her stem in entirely the wrong direction, there is some advantage in being able to fire torpedoes aft as well as ahead. The French boats, or the larger ones at any rate, carry four tubes, two pointing ahead and two astern. A boat armed thus would certainly have an advantage over a double-tubed boat if she got close up to a fleet without being seen. If submarines take to carrying small torpedoes for defending themselves against destroyers, they would naturally point aft. Small torpedo tubes would not interfere with propelling and steering gear to the same extent as large ones. Although the tubes in a submersible must be fore and aft, the torpedoes can be directed by the gyroscope to any desired angle with the keel, as is done in the United States

Navy, where ordinary torpedo boats fire torpedoes from a tube abeam with a gyroscope adjusted to cause the torpedo to settle on a course parallel to that of the boat. The converse arrangement could be applied to a submersible's torpedo which could be adjusted so that after leaving the right ahead or right astern tube they would take up a course 4 points or more from the keel-line as desired. In this way a boat with 4 tubes, two ahead and two astern, could arrange to concentrate her fire, and could discharge 4 torpedoes almost simultaneously at the same target. This would be useful if it was impossible to get very near to the enemy without being seen. But the extra mechanism for making the torpedo alter course after it has left the tube is liable to cause a certain percentage of lost shots, and, in this country at any rate, the device is not looked upon with favor.

With regard to the sea-going qualities of submersibles, trips of 200 to 300 miles have been made by British, French and American boats in all kinds of weather.. The British boats were reported to have behaved well in bad weather off the Lizard, and the French boats have maneuvered off Cherbourg, Brest and Lorient in a considerable sea. The boats seem to behave best when running on the surface, that is with a buoyancy of some 30 tons or more. In most cases, unless the sea is very rough or the height of the conning tower insufficient, the latter is kept open. Otherwise the air supply depends on ventilators above the wash of the sea. There must always be a good deal of discomfort from rolling. The circular section of the boat offers little or no resistance to rolling motion. It is not known if bilge keels have been tried, but they ought to be as useful in checking the rolling as they have been with destroyers. The vertical sides of the upper part of the hull in the French Triton class must also tend to greater steadiness in a seaway. In this respect the development of the submersible is in the direection of a form of body very similar to the Polyphemus. Up to the present the accomodation for the crew in the submersible has been very limited. The Lake boat, however, provides fairly good sleeping quarters, as well as cooking and sanitary arrangements, for her crew of eight men, and there seems no reason that the men should not fare as well as they do in a surface torpedo craft. This, of course, applies to the light or surface running condition only. But it is on the surface that the boats will do all the running; their radius of action being at present governed by the amount of oil carried for the gasolene engines. It is quite likely that 600 miles may be attained. Moreover the boats can always be towed, the French have towed the submarine Gustave Zédé considerable distances, and the Gnome and Lutin were towed most of the way from Lorient to Bizerta. In the United States the boats have not only been used by day but at night; thus, in a torpedo attack on a defended harbor, a Holland boat running on the surface got in unseen, whereas the ordinary torpedo boats were discovered and ruled out of action.

Summing up, there is no doubt that the submersible has a useful future before it. The problem of maintaining a regular depth has been completely solved, and both the surface and submerged motors are serviceable and satisfactory, though doubtless improvements will be made. Their speed must continue very low, especially when submerged, and the radius of action must be somewhat limited; but, still, in the narrow waters of the Channel, North Sea and Mediterranean they will exert a considerable influence. And generally any waters in which a number of submersibles are stationed will be well-nigh untenable for hostile ships, though by taking special precautions they may pass through unharmed. As yet no satisfactory means of attacking these craft has been developed, but it does not appear likely that they will long retain their present immunity, and it is rather to the torpedo than to the gun that we must look as the weapon to be used. Harbors can be defended against submarine attack by the use of mines, but breakwaters and booms with heavy and strong under-water parts are very much to be preferred. It must be remembered that, even when running on the surface, the submersible has a very deep draught, say 10 to 14 feet, and when submerged she requires at least 30 feet depth of water. If a boom goes within, say 12 feet of the bottom, the submersible can only run under it by smashing up her conning tower and periscope, which, if it did not sink her altogether, would render her harmless. But ships will no longer be able to lie stationary during the day in positions known to the enemy, unless they have taken adequate precautions by the use of nets or a ring of scouts to shelter themselves against attack by submersibles. It remains to be seen whether this will have to be demonstrated in the next war, as a similar truth with reference to surface torpedo craft and anchoring at night in an exposed position, was forcibly demonstrated to the Russians outside Port Arthur. And it behooves those who would not wish to act as warning beacons to the world, not only to prepare in peace time the necessary defenses but also continually to exercise all concerned in their use.

REMARKS ON THE USE OF FIELD ARTILLERY IN GENERAL, AND THE NEED OF A REORGANIZATION OF OUR FIELD ARTILLERY.

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The scientific work of the field artillery first by the Japanese army at the battle of the Yalu, Nan-Shan Hill and Telissu, and later by both the Russian and Japanese armies, is what first attracts attention. This is especially striking when one considers it from a study of the use made of field artillery in connection with other arms of the service; its proper co-ordination with these carrying out thus in practice as well as in theory, in a masterful manner, the principles of grand tactics.

In order to bring out its work more completely it is necessary to take up its action in co-operation with the other branches of the service. From experiences in previous wars and from a theoretical study of the allowance for increased rapidity of fire, increasing thereby enormously the power of the defense, it has been generally accepted that to take an intrenched position by frontal attack requires ten times the number of the defenders. This rule seems to have been generally accepted as governing in maneuvers.

The Japanese had on their firing line at Nan-Shan Hill not to exceed 30,000 men, and of artillery not more than 5,000, making a total of 35,000. The Russians had a very strong natural position, carefully defended with intrenchments. Its center, resting on a hill 350 feet high was defended by siege guns behind semi-permanent fortifications, firing over infantry in hasty intrenchments. The entire front was defended by wire entanglements. The Japanese right flank was protected by gunboats. The Russian right flank was similarly protected.

The Russian line was defended by at least 10,000 men. The proportion of the attacking force to that defending the line was, therefore, as three and a half to one, and the line was forced by practically a frontal attack, both of its flanks resting on the water. At the battle of the Yalu almost the same proportion existed, although the works there are not so elaborate, but the natural position was very strong. At the Yalu the position was taken in one hour; at Nan-Shan it required sixteen hours. The conclusions that may naturally be drawn from a study of these battles are two-fold; first, the rule above referred to may not give the proper proportion; second, the Japanese, as offensive fighters, may be superior to the Russians on the defense, or perhaps, both of these may be taken together. But the excellent handling of the Japanese artillery in using it to protect and support the infantry advance to the very last stage of the battle is believed to have had more effect than has from a study of such conditions been allotted to it.

In making rules for maneuvers the increased efficiency of rapid-fire field artillery using shrapnel and high explosives hell-fire against infantry, has probably not been given full credit. In this war it seems to play a very conspicuous part. It is thought, also, that while the increase of the power of the defenders, due to improved armament, has probably not been over-estimated, the increased efficiency of the attacking force has been underestimated, especially that of the rapid-fire field artillery using shrapnel or high explosive shell.

At the battle of the Yalu the smallest groups of artillery, with one exception, were regiments of 36 guns each; the exception was the mountain artillery of the 12th division, where it seems to have been impracticable to take a full regiment over the difficult country through which this division marched, At Nan-Shan the artillery was placed in three groups, one regiment in each group. It is probable that the corps artillery of this army was in a separate group and under the direct orders of the chief of artillery on the staff of the army commander. This is not, however, definitely known at the present time.

A study of the campaigns now going on in Manchuria reveals the fact that both armies have a somewhat similar organization of field artillery. In both it is organized into regiments and brigades. The Japanese divisional artillery consists of 13 regiments, one for each division. A regiment, commanded by a colonel, consists of two battalions; a battalion, commanded by a major, consists of three batteries; a battery, commanded by a captain, with three lieutenants, has six guns. In addition to these there is what is called the divisional reserve artillery, consisting of one battery for each division. This is the artillery that belongs to the Japanese regular organization, or what may be called the Japanese army on a peace footing. It consists of 13 colonels, 26 majors, 91 captains, 273 lieutenants, and 536 guns. In addition to this there are two brigades of corps or army artillery which are under the direct control of the army commander, each brigade consisting of three regiments and each regiment of six battalions. These battalions are of the same strength as those in the divisional artillery. The officers of the army or corps artillery are 2 generals, 6 colonels, 36 majors, 108 captains, 324 lieutenants, and 648 guns. The organization of the field artillery of the Japanese army is thus seen to be entirely similar to the organization of the other branches of the service, i. e., there are trained officers of the higher grades who in time of war, acting upon the staffs of division and army commanders, have a proper organization for the efficient handling of the field artillery in conjunction with the infantry and cavalry of the army or division. So far as I have been able to learn by a considerable study into the details of the operations, especially of the field artillery, in the Manchurian campaign, both the Russian and the Japanese have made excellent use of this arm of the service. Everywhere the engagements indicate a scientific handling of the field artillery and a proper organization for such handling.

I attended the maneuvers at Manassas from September 1st to September 10th, and my particular duty there was to witness the action of the field artillery. It became at once apparent that the organization was not such as to develop the use of this arm to its full extent. There was a temporary organization of the divisional artillery under officers assigned for the occasion, and who, I believe, were designated chiefs of artillery. In the one case the senior captain of artillery, in command of one of the batteries, was so designated ; in the other a major, in command of one of the battalions. None of these officers had ever handled more than a battalion of artillery ; in fact, that is the largest unit at the present time in our organization. In may be necessary to point out here to the average reader, and even to many military students, that the occasion in the war now going on in Manchuria is a rare one when a smaller organization than a regiment of artillery is used in action, more especially in the attack. A regiment consists of from 36 to 90 guns. The artillery commander is placed in telephonic or other direct communication with the immediate commander, giving him thereby, in a measure, fire control ; not as complete, perhaps, but similar to the "fire control" exercised by a "fire commander" in coast fortifications.

In observing the use of field artillery in the recent maneuvers at Manassas it became at once evident that such control of the artillery was not possible, with the result that, except in a single instance, the artillery was hopelessly scattered and, with the exception noted, did not accomplish more than a fraction of what it might have done if properly organized and instructed. The exception referred to occurred on the second day of the maneuvers when the first division had 16 guns in one masked battery within easy range of the enemy's lines. The blank charges being necessarily smoke powder, at once revealed the position of this battery; but had shotted guns, with smokeless powder, been used enormous execution must have taken place in the heavy lines of the enemy. In the last day's maneuvers some attempt seems to have been made in the second division to concentrate the artillery in the attack, but it was not successful. The batteries were widely separated and some of them split into platoons and separately served. I saw some of them ordered about by aides apparently without authority from the division commander. Under such circumstances it was evident that the artillery commander could not keep them under proper control. There is no doubt that these orders were given with the best intentions, but with the proper organization of the artillery the divisional artillery would have been under such control as to make errors of this kind practically impossible. Let us assume that our artillery was organized in the same manner as the other branches of the service: There would then have been one regiment of artillery with each division. The training of the organization would have been such as to make it possible for them to act together. There would have been an experienced artillery officer of the grade of colonel on each division commander's staff as chief of artillery, who would have had direct control of all his divisional artillery. He would thus have been able to concentrate its fire upon that point on the line selected by the division commander to be most vigorously attacked. In our present organization we have no artillery officers of high grade who have been given the opportunity to command more than a battalion. It is thought that it is of the utmost importance toward maintaining the efficiency of our army on a par with that of other first-class powers, that our field artillery be reorganized, and that artillery officers of the higher grades be given opportunity of commanding, in time of peace, units of field artillery such as are shown to be most efficient in time of war. We should have organizations including at least regiments. This will give an opportunity for training in time of peace the officers and men of this organization to work together in time of war; to work up and apply proper systems of communication and to place the organizations in a proper state of efficiency, so that in time of war they may be controlled by the commanding general in a way that will insure both the proper co-operation with the other branches of the service, and will permit, during maneuvers, the more perfect development and application by the commanding general of grand tactics so necessary in a campaign of the magnitude that may be expected in a war with a first-class Power.

EMPLOYMENT OF ARTILLERY FIRE.*

Résumé of Articles Published in the "Revue d' Artillerie" from June, 1899, to March, 1900, by COLONEL PERCIN.

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II.

CHAPTER IV.

RECONNAISSANCE AND OCCUPATION OF POSITIONS.

"It is indispensable that the artillery execute as often as possible exercises on varied ground and especially exercises with all the officers and non-commissioned officers present, comprising a great number of reconnaissances of positions. Only by these means can the officers of this arm acquire the habit of putting in practice one of the most delicate operations which is incumbent upon them on the field of battle."

Thus is expressed the War Office Instructions of June 6, 1898, relating to the use of artillery in maneuvers.

Reconnaissance is really a delicate operation because it must be done *rapidly* and *correctly*. How is it possible to reconcile these two opposing conditions?

In his work on "Field Artillery in Co-operation with the Other Arms," General Langlois expresses himself on this subject as follows: "As soon as the advance guard meets with serious resistance and asks the artillery for assistance, this assistance must be given it. This will not always be possible if the reconnaissance does not begin until the necessity for artillery is making itself felt; it is important therefore that the reconnaissance of the artillery commander should be *prepared.*"

Preparation of the reconnaissance.—For this purpose, General Langlois recommends the employment of officers selected from the batteries, marching with the point of the advance guard, stopping upon those positions which are favorable for the action of artillery, making a study of the ground, rendering a report of this study to the artillery commander, and rejoining their bat-

* Emploi des feux de l'artillerie. Second edition. Berger-Levrault et Cie. Paris, 1901.

See JOURNAL U. S. ARTILLERY, July-August, 1904, page 55.

teries as soon as the latter arrive upon the ground. If the position which has been reconnoitered is not occupied, the officers pursue their march and their studies.

The first official text in which the temporary selection of officers of the batteries to aid the artillery commander in his reconnaissance, is anticipated, is paragraph 120 of the Instructions of December 24, 1896, for the service of artillery in the field. However, in those instructions it is a question only of *accompanying* the artillery commander,. and not of *preceding* him. The Regulations of July 18, 1898, supply this omission by prescribing that the artillery commander shall place the scouts under the command of an officer to whom he gives instructions as to the manner in which he must operate.

The new German Field Artillery Drill Regulations, of the 10th of August 1899, show that the Germans are pursuing the same course.

The first duty of the officer designated will be to *orient* the artillery commander, when the latter joins him on the reconnoitered position.

Indeed, it is well known how much trouble an officer experiences when, after a rapid journey across an unknown country, he reaches a position where he must place his artillery. He does not know where he is, nor where the enemy is, nor what there is in his front. He is completely at a loss as to his bearings; and there is not an officer who has not had this experience, even at the maneuvers, if he has arrived at the position with the desire to do things seriously, *rapidly*, and *correctly*.

If now the artillery commander finds at the position an officer who has leisurely made a study of the ground, who orients his map for him; who tells him where he is, whence he comes, where he is going, where the enemy is, what are the localities in his front, etc., his task is singularly facilitated; the reconnaissance is advanced several minutes.

The officer who preceded the artillery commander has thus played the role of "*orientor*." This is the name which we will have to give him, this mission being of all those which he will have to fill, the first and most important. Morever he will orient the artillery commander not only from the geographical, but also from the tactical point of view, and especially the technical point of view, his essential role being *to prepare the reconnaissance*.

Rôle of the orientation officer.—The orientation officer, to whom the commander of the artillery should have given some instructions regarding the object of the operation, marches with the point of the advance guard. By means of his scouts he keeps himself in touch with commander of the cavalry and the commander of the most advanced fraction of the infantry, so as to be as fully informed as possible in regard to the situation.

When he reaches a position favorable for the action of artillery, whether or not the infantry has met with resistance, he stops and studies the position with an eye to the eventual use of artillery. If, during this study, the infantry continuing its progress, he becomes convinced that the position will not be occupied, he will resume his march to the front ; but he will preserve the information which he has gathered and which might be utilized later.

When the artillery commander rejoins him upon the position, he makes a report of the operations which he has had time to effect ; he completes them if necessary.

The following paragraphs indicate, in the order of urgency, the points which the orientation officer should particularly observe. This order is by no means an absolute one ; it depends upon circumstances. If, for example, in the course of the study of the ground, the objective appears, the observation of the field of battle becomes of secondary importance ; it is then upon the objective itself that the orientation officer concentrates all his attention.

The first duty of the orientation officer being to orient the artillery commander, his first care will be to orient himself, to ask himself where he is, whence he comes, where he is going, where the enemy is, what places are in front of him, etc.

He then examines the position from the point of view of its possible occupation by the artillery, of the manner of approaching it, of the number of batteries which might be placed in position there, etc.; but he does not waste his time in studying means of occupying the position, in searching for defiladed roadways, positions for forming up, positions for the various echelons. His attention is fixed upon the ground in front, with an eye to the appearance of objectives, and to the measures to be taken to oppose them without delay.

For this purpose he seeks first a *point of departure* convenient for the designation of other points referred to it ; then an aiming point. This last point should be chosen, if possible, so that its distance is about the same as that to the target and in a direction nearly normal to the front ; but the conditions of visibility and facility of designation must take precedence over every other consideration.

The aiming point having been chosen, the orientation officer determines its distance, from the map, by the eye merely, or by calculation by the method of parallaxes.* From this determination he deduces the value of the deflection difference for converging fire corresponding to the mean fighting ranges of artillery; this is the value which he will adopt until he has better information as to the distance to the target.

If an objective appears upon any point whatever he determines the elements of fire for the batteries to be put into the firing line; he corrects them later, if circumstances permit.

He determines in like manner the deflection difference for the fan in the case of the batteries to be placed in a position of observation.

The operations relating to the aiming point having been completed, the orientation officer makes a study of the ground, first in the direction of its depth. He seeks to reconnoiter the crests, beginning with the nearest, to discover the valleys which they shelter, or where the enemy might make his way under cover. From the observations of lines of trees, piles of stones, hay mows, houses, and isolated trees, he endeavors to fix the trace of the highways and roads which might be followed by the enemy. He observes the points of support which the enemy would be tempted to lay hold of: edges of woods and villages, ditches, bridges, sunken roads, slopes of embankments of roads, etc. In short, he seeks to recognize "the important points of the terrain in the vicinity of which there is a probability of the appearance of objectives more or less important."

He considers the expressions he will employ in pointing out to the artillery commander these important points, for the choice of expressions has a great influence upon the clearness and rapidity with which the objects may be pointed out.

He then studies the ground in a lateral direction. He determines the angular distances of the important points with respect to one of them; he notes these upon his *Firing Memoranda* or upon a perspective sketch. He does not forget also to note the point from which these observations have been made, for they will not be applicable to any other point of observation without modification.

If he makes a perspective sketch, he notes upon it only that information which will be of interest to the artillery commander

* As explained under the caption "Determination of the Ranges of Importtan Points."—Translator.

with a view to the employment of fire : crests, important points, etc. The perspective sketch is not a photograph faithfully reproducing all the lines of nature, it is an interpretation of the terrain, based upon observation and reason. Its merit is precisely that it is more readable than the terrain itself.

The orientation officer determines finally the distances to the important points ; he deduces from them, by interpolation, the distances to the crests ; he notes both upon his sketch or his *Firing Memoranda*. He calculates then the exact value of the deflection difference for converging fire ; he corrects therefrom, if necessary, the elements of fire ; he prepares the solution of all of the problems relating to the employment of fire.

After having made a report to the artillery commander, of the operations that he has had time to complete,—after having completed them, if necessary,—he draws up the orders to be sent to the batteries at the rendezvous position, orders whose execution he will look after presently.

When the batteries arrive at the position he holds himself ready to make any modifications in the elements of fire rendered necessary by any irregularities in maneuvering. In short, his rôle is to relieve the artillery commander of all preoccupation of mind relating to observation of details or calculation of the elements of fire.

Reconnaissance of the artillery commander.—When the artillery commander arrives at the position, it may be that the orientation officer has finished not only the special reconnaissance of the objective but also that which relates to the observation of the battle-field. The artillery commander is then in possession of all the data that he needs to give his orders to the batteries : the number of batteries to bring immediately into action, the number to put into a position of observation, the elements of fire for both. He is ready to solve every problem relating to the employment of fire.

In the contrary case, he takes the data so far as they have been completed ; he completes them himself, or has them completed by the orientation officer.

If the objective has not yet appeared, the report is reduced to a simple description of the terrain.

Designation of the important points.—Whatever be this report, it must be made, like the reconnaissance, *rapidly* and *correctly*. This supposes between the orientation officer and the artillery commander, an understanding which evidently can not exist from the start, but which will result from numerous exercises carried out on the terrain. This understanding will result also from the adoption of a language which has been agreed upon, and particularly from a method of designation of the important points with which both have become perfectly familiar.

Former instructions upon the training of pointers, which have not been abrogated, say that to designate a target, the most practicable method consists in pointing out first a point of the terrain which is very clearly outlined, very prominent, situated *in the vicinity of the target*, and in arriving progressively, by the aid of *intermediate points*, at the target in question. The principal defect of this method of designation, sometimes still used in the artillery, is to cause exchanges of explanations which are sources of delays, misunderstandings, and errors. It may be indeed that in the immediate vicinity of the objective there is no point whose designation is readily made, or is understood at the outset without hesitation. In order to find a point which will satisfy this condition, it may be necessary to look in very divergent directions.

When such a point has been found, even if it is squarely on the flank, it should be adopted as a *point of departure* without hesitation. Moreover, in place of arriving at the target by a series of *intermediate points*, as is prescribed in these instructions, it will be defined by its angular distance from the point of departure.

If the object is plainly seen or is a very prominent object of the terrain, an aiming point, for example, the angular distance will be roughly estimated by the number of *hand-breadths*.

On the other hand, if it is a question of defining the extremity of an object very slightly visible, the number of *millièmes* which separates it from the aiming point will be indicated.

The objective might then be designated as follows:

Point of departure, the left corner of the farm house on our right. Aiming point to the left 4 hand-breadths, a poplar tree higher than the rest. Objective: line of artillery, its right end 30 *millièmes* to the right of the aiming point, front 80 *millièmes*.

This method of designation, which, without being laid down in the regulations, is already in use in a certain number of regiments of artillery, has over that of former instructions, the advantage, first, of being more intelligible; then, it comprises numerical indications from which the elements of fire relating to direction can be deduced. However, these indications can be utilized immediately only by a person alongside the one who makes the designation. While returning to his post, he must keep his eyes on the point of departure and the aiming point, as well as the wings of the objective, and on arriving, take into account the modifications which are produced in the relative positions of these various points.

Now, although it may be easy to keep in sight the point of departure and the aiming point, which are plainly visible, it is not so with the flanks of the objective which by hypothesis are not clearly defined ; otherwise one of them would have been taken for an aiming point. The objective may even become absolutely invisible, if it is a line of artillery which has ceased firing. The present method of designating objectives is therefore incapable of being used, from the fact that the firing has been stopped.

But, if to the usual indications :—

Right extremity, 30 *millièmes* to the right.

Front, 80 *millièmes.*

There is added :—

Deflection difference for converging fire, 9 *millièmes*, all the elements necessary for the calculation of the deflection allowances are given. It is no longer necessary to keep the right end of the objective in sight and to measure anew its angular distance from the aiming point.

The theory of the deflection difference for converging fire has simplified the matter for us. If the target is seen with difficulty, the orientation officer may dispense with pointing it out to the artillery commander in the customary way ; it will be sufficient for him to give the calculated elements of fire which fix the direction ; he designates then only the point of departure and the aiming point. It was for this reason that the present paragraph was entitled *designation of important points* and not *designation of objectives.*

Transmission of the elements of fire to the rendezvous position.— The transmission of the elements of fire to the rendezvous position permits a reduction to the minimum in the time from the arrival of the pieces to the first shot ; but one danger presents itself to which attention should be directed. If the coming into battery is accomplished by the movement, "Face to the right or face to the left in battery," it is necessary that the pieces come in from the left with the right in front, or from the right with the left in front. Otherwise, the deflection allowances are in inverted order.

Now, it may happen that the deflection allowances having been sent to the rendezvous position and given to the pieces in the order in which they are found, the terrain compels an inverted order to be taken by the battery, and the officer in charge forgets to notify the captain of the fact, the captain having intended that the battery should enter from the left ; or, again, the captain having intended to have it enter from the right does not remember to inform the battery that the deflection allowances must be reversed ; or, again, the orders having been correctly given, the head of the column is directed upon the right flank marker instead of the left flank marker.

Two ways of avoiding those errors present themselves. We may give up the plan of sending the deflection allowances to the rendezvous position and have them given at the position of the battery by the orientation officer. The opening of the firing is thus delayed, but not very much ; for that which takes most time is not the setting of the sights, but the calculation of the elements of fire.

The second solution consists in sending the deflection allowances to the rendezvous position and in rectifying them at the position of the battery in case of observed error. If the orientation officer ascertains that the pieces are in inverse order, he informs the captain who orders the necessary changes of deflection allowances.

It may happen that in consequence of errors or difficulties in maneuvering, the right piece is not placed exactly at the point assigned to it. In that case the orientation officer who supervises the placing of the battery in position as the representative of the artillery commander, immediately calculates how much he must modify the deflection allowance of that piece, and reports it to the commanding officer of the battery.

It may happen also that, in consequence of error or necessity, the pieces are placed at different intervals than the regulation interval. The deflection difference for converving fire must be modified correspondingly ; consequently, the orientation officer calculates the modifications to be applied to the deflection allowances and notifies the captain.

These calculations could not be required of the artillery commander, nor of the battery commander, upon whom so many obligations are incumbent upon the battle-field, but they may be required of the orientation officer, who has not so many things to do, and one of whose functions it is to determine the elements of fire.

Use of pointers to mark the position.—The use of pointers to mark the position of the pieces has the inconvenience of delaying the battery in coming into position, an operation which is already too long. The increase in number of the personnel thus brought upon the position endangers revealing the presence of the artillery. Moreover, the utility of this measure is very questionable. In collective fire, there is no reason for pointing out the objective to the pointers. In individual fire, the occupation of the position is not generally preceded by a minute reconnaissance. If the formation in battery is made by the movement: "Face to the right or face to the left in battery," it is sufficient that the carriages in column preserve their maneuvering distance in order that the pieces may be placed at the regulation intervals; it is not even necessary to mark both flanks. It will be sufficient if that one from which the pieces enter is marked; the direction which the pieces are to follow is indicated, and the command "halt" is given when the last piece arrives opposite the single marker.

Opening fire.—Will fire be opened as soon as the battery is in position? Not necessarily.

The orientation officer has seen the target which is to be fired on. It is a body of artillery about to fire; but its fire is of short duration; it would be puerile to hope that the batteries will arrive in time to intercept it. Before they can be there, more time will pass than is necessary to suspend and reopen fire several times.

From information furnished by the orientation officer, it appears merely that the enemy was there just now; that certain elements of fire must be adopted in order to reach him. Has he gone perhaps? Or, has he simply sheltered the personnel behind the shields? Fire will be opened when he comes back into view. The artillery will remain on the *lookout.*

This situation of artillery ready to fire but not firing is one upon which it is important to reflect, because it will frequently occur in future. Until the moment for intervening has come, a battery on the lookout must remain silent, must resist the temptation to fire, even if it should be fired upon by other artillery. It is not that it would be in less danger if it should fire; on the contrary, it would show itself more. When necessary it will shelter its personnel behind the caissons and the shields. The duty of defending it against the operations of the other artillery belongs to the batteries in observation. Sometimes it is said that the period from the arrival of the pieces to the first shot is a *critical* period which it is important to reduce by all possible means. It would seem that from the time fire is opened there is more security; but the contrary is true. In fact, the critical period is composed of two parts: The first begins with the arrival of the pieces and ends with the opening of fire; it is really critical only if the coming into battery has been badly concealed.

The second begins with the opening of fire and ends at the moment when the fire has produced a decisive result,—the moment beginning with which the personnel may be sheltered behind the shields. This second part of the period is always critical, because the flashes are seen, because the cannoneers are imperfectly covered, and the non-commissioned officers not at all.

That which must be done is to shorten the total of the two parts, principally the second; every practice which tends to shorten the first at the price of an increase in the length of the second would be very objectionable.

CHAPTER V.

INDIRECT FIRE.

General solution of indirect fire.—All indirect fire pre-supposes a post of observation from which both the target and the batteries can be seen. An aiming point will always be found which may be seen from the batteries and from the position of the observer, provided this point be chosen on the flank or in rear.

By direct measurement, the observer can determine the deflection allowance which must be given to a supposititious piece placed near him so that it may be directed upon the desired point of the target to be fired on. There will then remain only the calculation of the deflection allowance to be given to the actual piece, so that it may be directed upon the point in question. It is a calculation of parallaxes which will be more or less easy, according to the situation of the aiming point and that of the target; more or less exact, according to the knowledge which is possessed as to the distance to these two points; but the problem will always be possible and capable of solution without recourse to other theory than the usual one of the deflection difference for converging fire.

Advantages and disadvantages of indirect fire.—Formerly, to give the first direction to the piece, it was necessary to mount a horse, or a battery observation ladder, or a caisson, and to move along in this manner behind the pieces while they were pointed individually. It was distribution by sight, based upon the division of the targets into parts. The method of using pointing stakes and that of aiming upon the points of bursts were no better.

Moreover, only a provisional distribution was obtained in this manner, to be corrected later from the results observed. There was therefore a regulation in direction and this regulation had to be made shot by shot, since there was not that close connection among the shots of the different pieces which is given to-day by the use of goniometric apparatus of great amplitude. The direction was regulated by means of information furnished by two lateral observers whose indications had to be combined. The slowness and misunderstandings which generally resulted from this combination are well known.

To-day, thanks to the use of perfected pointing apparatus, to the introduction of the *millième* into angular measurements, to the theory of parallax and that of the deflection allowance for converging fire, a definitive distribution of the fire may be obtained ; and moreover it is sufficient now to have a single observer on the flank to regulate the fire in range. If this observer is on the right and the greater part of the fire appears to him to the left, the range is short.

One of the most serious disadvantages of indirect fire is the impossibility of sweeping the slopes in front of the covering crest. This circumstance should never be lost sight of ; whenever indirect fire is used, it will be necessary to provide for the means of having the slopes in question swept by other troops.

On the other hand, indirect fire enables the flashes of the guns to be concealed. The enemy is thus deceived as to the true position of the batteries, he is led to regulate his fire upon the crest without producing results, or to execute over great depth a progressive fire, which makes him use up much ammunition. But considerable difficulties are encountered in regard to the choice of posts of observation, as well as the organization of the service of transmission of orders and information.

Without going so far, it may be proposed simply to conceal from the enemy the *personnel* and *matériel* while coming into battery and during the fire, to conceal from him the abandonment of the position and the new direction that the batteries take. For this purpose, it is sufficient to occupy the line of defilade of a mounted man. The battery commander, by elevating himself a few meters or by going forward, can thus see the objective, distribute and observe the fire, while remaining near enough to the battery to have it within the reach of his voice.

A method of fire has been greatly advocated in which the pieces are disposed so that the pointers can see the objective, the lines of sight just grazing the crest. In order to realize this condition the position of each piece must be determined with excessive care. A few meters more in one direction, the piece is no longer defiladed; a few meters in the other direction, the pointers can no longer see the objective. Now, what reason is there that they should see it. The practice of dividing the target into sections, and distribution by sight, no longer obtain.

Moreover, the method of occupation referred to defilades the personnel very imperfectly. To do this well, the line of defilade of a man standing must be occupied. When we move back so far that we cannot see, it is just as well to move back to the line of defilade of a man on horseback. The ability of coming into battery without any precautions is thereby gained, as is done on the practice ground. The duration of the reconnaissance is thus shortened.

Paragraph 452 of the Regulations of July 18, 1798, reads:

"So far as possible, the opening of fire should surprise the enemy. This result is obtained by a minute preparation for firing without attracting the attention of the enemy." This condition may be satisfied better in indirect fire than in any other way.

Of course, this kind of fire could not be used in the "decisive moments of the struggle," moments for which, continues the paragraph above cited, "on the contrary, rapidity of movement and of coming into action," is necessary.

It is a question here only of getting in touch, of the first engagements of the artillery struggle, of that period of the combat the preparations for which may be made "minutely without attracting the attention of the adversary."

Artillery which, thanks to the prudence and cleverness of its personnel, shall succeed in obtaining the upper hand in this part of the combat, will be able to act with the greatest audacity in the subsequent periods.

CHAPTER VI.

TRAINING OF THE PERSONNEL.

Exercises on the map.—Exercises on the map should be taken up during the winter. Properly drawn up, these exercises lend themselves not only to perfecting the tactical instruction of the officers, but also to completing their technical instruction in whatever relates to the use of artillery fire. Better indeed than the autumn maneuvers, often better than target practice, do they bring out the influence which the choice of positions and the manner of occupying them can exert upon the useful effect of the fire. Indeed, in the autumn maneuvers, the rapidity with which the phases are developed generally prevent artillery officers from completing the operations which should precede the arrival of the batteries upon their positions. The intervention of the artillery is marked only by the arrival of the pieces in line and by the noise of the first cannon shot. Nothing indicates the point of the hostile line (troops or obstacles) upon which it is directed.

As for target practice, it is well known how artificial are its situations, what trouble is caused by the configuration of the target ground, and by the firing instructions to which it is necessary to conform; and then there is lacking the presence of the other arms. Also, it is often seen that target practice is confined to the placing of targets upon which fire is directed, without other purpose than the application of the rules of the Manual.

From this it results that the maneuvers and the firing, those two factors which are so closely connected upon the battle-field, are almost always studied separately. Problems on the map permit this omission to be supplied very readily.

For this purpose, the director of the exercise, having the faculty of being able to develop the action at a fixed point, has made beforehand a certain number of sketches of the terrain as seen from the positions in question. If necessary, these sketches are made forthwith. It matters little whether the formations of the terrain are exactly reproduced; they represent a conventional terrain.

The sketches are fastened to the wall. The scale is one millimeter for one one-thousandth of the distance, that is to say they constitute perspectives whose point of view is at a distance of one meter from the wall; so, by placing one's self one meter from the wall, a good impression of the actual ground is obtained: by means of the rule or the fingers of the hand, the front and the angular distances may be measured; the objectives may be designated, the elements of fire calculated, and the orders announced, just as would be done on the ground; the number of batteries to be engaged, distribution of rôles among the other batteries, supervision of the battle-field, utilization of the information from the orientation officer, in short, all tactical questions relating to artillery fire may be undertaken, and the influence which the manner of solving them exercises upon the general course of the combat may be taken into account.

Outdoor Exercises.—Gunnery questions indoors result in training the officers in handling deflection allowances. Outdoor exercises secure by their study a further benefit: they show whether or not the aiming point has been well chosen, its designation clearly made and thoroughly understood, the pointing apparatus correctly set on the indicated divisions.

For this purpose, the fire having been distributed over the object designated, the director of the exercise passes in rear of the pieces, has the deflection allowances announced, observes whether or not they form an arithmetical progression, then assures himself by an examination of the natural lines of sight that each piece is properly directed upon the portion of the target assigned to it.

In order that this verification may be easily made it is necessary to begin with clearly visible targets: the walls surrounding a park, the edge of a wood or of a village, the interval between two important points, etc. In short, objectives are chosen against which *individual fire* would be clearly indicated. The next case to be taken up is that of objectives not clearly seen, such as a troop or company moving so as to avoid being seen, a body of artillery in battery, or the interval between two points not plainly visible. The personnel is thus trained in the distribution of fire against masked artillery whose presence is only revealed by its flashes.

Observation of the flashes of artillery in action.—But one impression which no objective encountered in the field or on the target practice ground can give is that of intermittent fire. This intermission will be the source of difficulties not suspected by many officers.

Hence it is indispensable to use in special exercises the blank cartridges allowed annually to a regiment of twelve batteries. This allowance is only sufficient for one exercise per year; consequently the entire regiment must be assembled for it.

The personnel is assembled upon a position in front of a crest situated at ordinary fighting range. Behind this crest a line of artillery executes a ranging fire of four or five salvos, followed by progressive fire.

The officers are invited to measure the front of the objective, as well as the angular distance of its right extremity from an aiming point, and to deduce from these measurements the elements of fire relating to direction. They thus learn to take into consideration—

the difficulty that would occur in pointing out such an objective to the subalterns, in dividing it into as many sections as there are pieces, in causing each pointer to recognize the sec-

tion assigned to him, in requiring each one of the latter to find again his own section after each shot ;
the impossibility of keeping in sight one of the ends of the objective while moving to the left to determine the deflection difference for converging fire ; the consequent usefulness of the theory of parallax;
the impossibility of opening fire before the enemy has ceased firing, if we await the appearance of the flashes in order to choose an aiming point, to point it out to the personnel, to estimate its distance, to calculate its parallax and determine the deflection difference for converging fire ;
the consequent necessity of having these operations done in advance by the orientation officer.

Finally, this exercise affords the officers an opportunity to reflect upon the difficulties which will probably be encountered in ranging upon the flashes ; it calls their attention to the necessity of starting with an elevation as exact as possible, of beginning, when necessary, progressive fire without ranging. This result can be obtained only by a previous study of the terrain, which leads back again to the functions of the orientation officer.

Use of explosive bombs.—The insufficiency of the number of blank cartridges allowed is very fortunately compensated for by the abundance of bombs allowed.

The best plan is to use them in representing not the points of fall of our own artillery, but the shots of the hostile artillery. Undoubtedly, a cloud of smoke makes a more visible target than the flash of a piece firing, but its appearance is fleeting ; it affords therefore an opportunity for the personnel to measure fronts under conditions approximating the reality. It is not as good as the flashes ; but it is better than the targets found at the target practice grounds, or the stationary targets found in the country.

The line of the hostile artillery may be represented by a series of bombs placed at 16 meters interval, or simply by bombs at the extremities. The unexpected appearance of bombs in various directions affords the batteries practice in changing the direction of the fire from one point to another and of exercising themselves in this manner in supervision of the battle-field.

Studies of the terrain and exercises for the orientation officer.—One of the most important consequences of the adoption of a rapid-fire field gun is indeed the occurrence of frequent lulls in the firing, of which the officers must take advantage to watch closely the field of battle and to prepare for firing at new objectives.

Knowledge of the terrain, under these conditions, becomes of capital importance. It is therefore indispensable to formulate exercises in which the officers, placed upon any kind of terrain, will be invited to point out everything of interest from the point of view of the artillerist; to recognize the crests behind which objectives might appear, as well as the depressions that they conceal and where the enemy might approach under cover; to conjecture the trace of roads which the enemy might follow; to to observe the points of support which he would be tempted to seize; to designate the important points clearly and rapidly, to determine their ranges and their angular distances from each other; to deduce from these measurements the elements of fire in range and direction; in short, to prepare the solution of every problem relating to the use of artillery fire.

The programme of these exercises is contained in the paragraph relating to the rôle of the orientation officer. For their execution there is no fixed time; any occasion is suitable, and it is not generally necessary to go far away from the garrison. Moreover, in order to give one's self over to this kind of sport, it is not necessary to wait for it in the daily orders. During his horseback rides, an officer should put to himself, upon whatever terrain he may be, every question that he would have to solve if he were in command of a battery in a position of observation, or if he were fulfilling the functions of orientation officer. The route to the target practice grounds will furnish the opportunity to see new terrains.

It will be very useful to complete these exercises by the making of very simple perspective sketches in which the officer will endeavor, not to produce details of the terrain interesting only to the artist, but to bring out those things which especially concern the artillery.

But it is not enough that an officer should be able to analyze a portion of the terrain; he must be trained to see quickly, to make a report rapidly and clearly, to appreciate the relative value of the data to be furnished. The special exercises of the orientation officer consist in such work as this.

The critique of the exercise will touch not only upon the manner in which the reconnaissance has been made, but also upon the manner of making report of it, and also the manner in which the artillery commander asks the necessary explanations of his orientation officer, if any be necessary; because one of the most important results of this kind of exercise will be to create among the officers an absolutely indispensable common language and understanding.

Exercises in observation of the battle-field.—In the autumn of each year, the artillery regiments take out on the road the war material assigned to the various units of the active and of the territorial armies. It is possible to utilize these fatigue parties in instruction, with the greatest profit. For this purpose the commanding officer of the organization has an understanding with the director of the instruction so that he himself may regulate the itineraries of the road columns, while conforming, of course, to the usual prescriptions relative to gaits and duration of the trip. He causes these columns to move about in the field of fire of artillery in position of observation, for which they serve as fixed or movable targets.

The itinerary of the columns, the indication of the gaits and the stopping points are laid down in instructions which are handed to the commandants of the columns at the moment of starting. The batteries in observation are ignorant of these dispositions. Merely following these columns by eye, pointing them out, and conjecturing the roads that they may take, constitutes in itself quite a difficult exercise and a very interesting one. But it becomes particularly difficult and interesting to take the dispositions necessary to oppose counter batteries to these targets in the very short time during which they remain in sight. The thing is materially impossible if the ground has not previously been studied, if the ranges of important points have not been determined in advance, their angular distances from each other measured, and the deflection difference for converging fire determined. The officers of batteries in position of observation must then carry out what is prescribed in the regulations of 1898, as well as what is laid down above under the heading "Rôle of the Orientation Officer." There is distributed to them a blank form for "*Firing Data*" upon which they note the results of their observations. The commanding officer assigns their duties to the various batteries and, if necessary, the zones of observation. The service of scouts is used in order to signal, if possible, the approach of the columns.

When the objectives present themselves, the batteries designated bring their fire to bear upon them; they determine the elements of fire by utilizing the data contained in the "*Firing Data.*" Note is taken of the time at which the objectives appear and the times at which the batteries are ready to open fire. By examining the natural lines of sight, it will be seen whether or not the distribution has been well made, and whether or not the orders have been correctly given, thoroughly understood, and properly carried out.

Time for and order of progress of outdoor exercises.—These exercises should last all year and should alternate with the barrack-yard and drill-ground maneuvers. The men of the battery take part in them so far as the available resources permit ; but it is not for them, but for the officers and non-commissioned officers that these maneuvers are held.

It will be objected that the proper grounds are not available during the greater part of the year ; but there is no need to go off the roads to carry out maneuvers which are very interesting not only from the point of view of the use of artillery fire, but also from that of the conduct of the columns, the organization of the connecting links, the transmission of orders and information, the discovery of objectives, the reconnaissance of positions, the placing of teams and trains under shelter from the view of the enemy, etc. The coming into battery is alone incorrect, but this fault is corrected in one hour of drill-ground work. To wait until the crops are gathered for maneuvering abroad is to limit to a very restricted period of the year the exercises which constitute the true preparation for war.

It is moreover indispensable that the outdoor exercises should be very much advanced by the beginning of the target practice season. The configuration of the practice ground does not resemble in any manner that of the battle-field. Never, even upon the most satisfactory target practice ground, like that of the Camp at Châlons, does one see presented the concrete situations which are met with in war and the firing problems which they afford. These situations must be created ; those which are presented in the maneuvers must be reproduced. The garrison maneuvers thus appear as the indispensable prelude to target practice.

In the exercises carried out in the vicinity of the garrison, more readily than upon the target ground where the data are artificial, more readily than in the autumn maneuvers where time is not sufficient for analyzing situations, can officers take into consideration the degree of visibility of true war objectives, the time necessary to point them out, the difficulty experienced in referring their extremities to reference points and in determining the elements of fire. There they will observe the scarcity of aiming points satisfying the conditions usually required to be fulfilled. They will realize from this the necessity for utilizing those available. They will understand the usefulness of a single aiming point for a mass of artillery ; they will feel the need of thoroughly drilling themselves in the applications of the corresponding regulations ; in consequence, they will come upon the target ground completely prepared.

Target practice.—To make this instruction interesting, from the point of view of the employment of artillery fire, it is necessary to discontinue those practices, so long ago condemned by war office instructions, of causing the batteries separately to fire upon a designated objective, and instead to apply a definite method, each battery coming upon the scene only when the preceding one has gone off. A body of artillery of some importance must be constituted, in which the different batteries each play their rôle, some in actual firing, some in simulated firing. For example, one or more batteries will be charged with opposing the principal objective, the one which the mass of artillery will be regarded as having been called to destroy ; the others will be put into positions of observation, ready to direct their fire upon objectives whose ulterior appearance will be arranged for ; some will receive orders to substitute themselves for the first named when those have been obliged to cease firing. In succeeding phases of the combat, the rôles may be distributed in another manner.

In general, each battery will pass from actual to simulated fire after the fork has been obtained ; progressive fire will be executed only when an order for it is given. The simulated fire may even be taken up after the first salvo, the four shots thus fired having no other object than to allow the distribution to be regulated.

The adoption of a rapid-fire gun has indeed given capital importance to the question of distribution of fire. If the fire is correctly distributed and the elevation properly chosen, the fire becomes effective very quickly. The correction of the range is made in a trice. It is not so as regards the direction. To correct a distribution badly made, the deflection allowance of the right piece and the deflection difference must be corrected. This requires two commands whose execution necessitates different modifications in the deflection allowances of the different pieces. Besides being subject to error, the calculations required and the manipulation of the sighting apparatus require a certain amount of time. During this time, the regulation of fire as regards range is suspended and the advantage of the use of a rapid-fire gun is lost. So it may be said that distribution of fire constitutes to-day, not the sole but the principal problem in target practice. It would be much better, for example, to have a battery execute 15 distributions of fire using 4 shots each, than a complete course of firing comprising ranging and progressive fire which would itself use up 60 shots.

The target practice programmes will therefore be so made up as to afford officers an opportunity of solving a great many problems in distribution of fire, switching the fire from one target to another, and supervision of the field of battle. In the happy issue of these operations will henceforth reside the success of the artillery.

MINIMUM DISTANCE BETWEEN A BATTERY AND ITS MASK.*

By J. CHALLEAT, Captain of Artillery.

Translated by Captain J. C. JOHNSON, Artillery Corps, for the Second Division, General Staff, U. S. A.

The necessity of firing over parapets or other natural masks in front of a field battery often materially influences the choice of the place to be occupied. Nothing is found on this subject in the regulations at present in force. According to the old regulations for the 80 and 90 mm. cannon, the piece must be placed in position to see whether the projectiles will pass over the mask or not. This solution no longer appears admissible for the rapid-fire material of recent construction. Now, here are some of the examples of the numerous problems coming under this head.

I. It is desired to place a battery behind a mass of full-grown trees (fig. 1) to fire at a target situated on the same level as itself at the range **D**. Can the battery be placed at the distance **d** from the mask considered and fire over it?

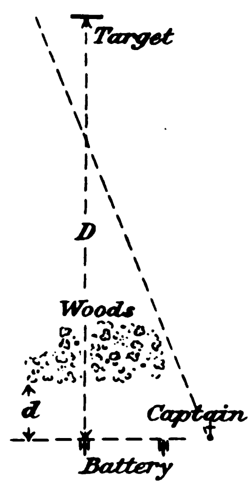

Fig. 1.

II. What position can it occupy if, under the same conditions, the angle of site of the target instead of being nil is plus or minus **n** millièmes?

III. It is desired to place a battery behind a parapet on the line of defilade for a man on horseback, and fire at the range **D** at a target whose angle of site is plus or minus **n** millièmes. Can it fire from this position without striking the parapet? Should it not on the contrary occupy the line of defilade of a man on foot, or even simply that of the material (carriages, ammunition, etc.)?

Doubtless these problems present no difficulty to the trained artillerist. He can solve them without the aid of any particular instrument, and without having to make the least calculation on the ground. But to acquire this degree of efficiency it seems necessary to proceed with numerous and varied exercises, estab-

* Revue d'Artillerie, June, 1903. Paris: Berger-Levrault & Cie.

lished especially on certain bases from a point of view which constitutes the object of these remarks. These certain bases can be obtained in many ways. The following appears very simple:

It consists of the employment of a ruler which gives for any abscissa whatever, the ordinates in millièmes of the various trajectories of the cannon considered.

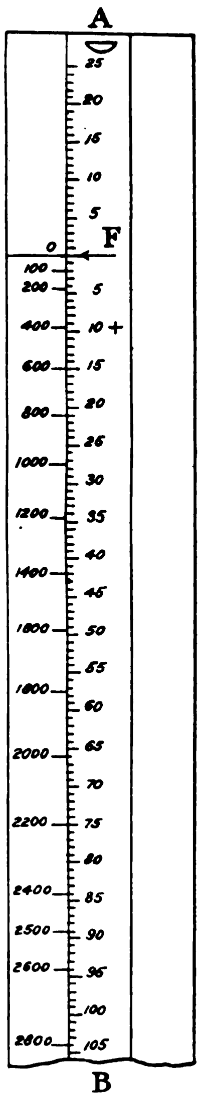

Fig. 2.

For this purpose, a sliding ruler **AB** (fig. 2) is graduated, beginning at the arrow **F**, in ordinates of the trajectory* expressed in millièmes. In addition the left-hand side of the ruler is graduated in ranges.

To find the ordinate of any trajectory, say of 2500 meters, corresponding to an abscissa of 800 meters for example, it suffices to bring the arrow down opposite the division 800 on the ruler, and read on the left edge of the slide the required ordinate, 68 millièmes, opposite the division 2500 on the ruler.

The practical solution of the preceding problems then is very simple.

Solution of the 1st Problem. Suppose, to fix the idea, **D** equals 2500, **d** equals 200. The angle of site of the tops of the trees has been measured and is 50 millièmes. The ordinate of the trajectory of 2500 meters, for an abscissa of 200 meters, is read on the ruler, and is 84.5 millièmes. The battery can then fire.

Solution of the 2d Problem. Suppose **D** equals 2500, **d** equals 100, and the angle of site of the target is plus 20 millièmes. In this case, to read the ordinate of the trajectory on the ruler, it is convenient to put, not the arrow but the + 20 division on the slide opposite the 100. The ordinate thus read is 107 millièmes. The angle of site of the tops of the trees is 100 millièmes. Therefore the battery can fire.

Solution of the 3d Problem. The battery commander having placed himself on the

* The graduation in fig. 2 corresponds to our cannon of 80 mm. model 1877. It would be calculated in the same way as will be seen below, for any other piece whose range table we have.

line of the defilade of a man on horseback, dismounts and considers the parapet as any mask. He sees immediately, as in the preceding cases, whether firing is possible from the place chosen. He can likewise occupy the line of defilade of a man on foot, also that of the material.

Graduation of the ruler. The ruler can be very easily graduated as follows:

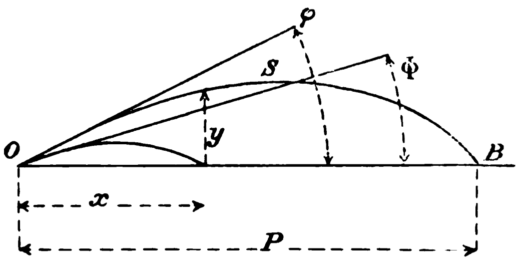

Fig. 3.

The expression for the ordinate **y** (fig. 3) of the trajectory **OSB** relative to a range **P**, is for an abscissa, **x**,

$$y = x \frac{\sin 2\varphi - \sin 2\Phi}{2 \cos^2\varphi}$$

φ being the angle of projection of the trajectory, **OSB**,
Φ that of the trajectory whose range is **x**.
This formula can be written,

$$y = x \tan \varphi - x \tan \Phi \frac{\cos^2 \Phi}{\cos^2 \varphi}$$

In field firing the angles, φ and Φ being small, it can be assumed that

$$\frac{\cos^2 \Phi}{\cos^2 \varphi} = 1$$

and hence we can write simply

$$y = x (\tan \varphi - \tan \Phi).$$

In this form it is seen that the ordinate **y**, expressed in millièmes, is equal to the number of millièmes expressed by $\tan \varphi - \tan \Phi$.

This difference can be read directly by means of a sliding ruler graduated in millièmes moving along the scale of tangents of the angle φ.

This scale is graduated however, not by writing the number of millièmes of $\tan \varphi$, but the corresponding range in meters.*

* The calculations can be effected by means of this ruler only because the ordinates of the trajectory are expressed in millièmes of the abscissa and not in meters.

In the case of an angle of site, it suffices, in order to take it into account, to increase or diminish all the ordinates measured, by the number of millièmes of the angle of site. This results from the principle of the rigidity of the trajectory, which principle is admissible here. The increase or decrease is made by systematically displacing the slide by this number of millièmes.

This ruler gives also without additional graduations, the horizontal distance from the point of burst to the target, for heights of 1, 2, 3, and 4 millièmes; that is to say, it permits the solution of the inverse problems from the preceding. To do this, the division 1, 2, 3, or 4 on the slide is brought opposite the range and the desired abscissa of the point of burst is read on the ruler opposite the arrow **F**.

The right edge of the ruler and the slide have no graduations. They could be used for any other element of fire if practice shows the necessity for it.

Conclusively, the ruler thus constructed gives by points without the least calculation all the trajectories of the cannon considered. However, it is well to notice that, its principal use being to train the eye of officers, it appears susceptible of being replaced in practice by certain mnemonic rules which are not very complicated. Rules of this kind are always more or less approximate and likewise more or less simple.

The following gives values for tan φ with a maximum error of about 6 millièmes.

These rules are as follows:

The values of tan φ are obtained by multiplying:

By 3 the ranges expressed in hectometers from 100 to 1800 m.
By 3.5 the ranges expressed in hectometers from 1900 to 2800 m.
By 4 the ranges expressed in hectometers from 2900 to 3600 m.
For example, the second problem above would be solved as follows:

$$\mathbf{D} = 2500 \qquad \tan\varphi = 25 \times 3.5 = 75 + 12.5 = 87.5$$
$$\mathbf{d} = 100 \qquad \tan\psi = 1 \times 3 = 3 = 3.$$
$$\text{Difference} \quad 84.5$$

The angle of site, + 20 should be added to this difference giving a total of 104.5. The battery can then fire, since the angle of site of the tops of the trees is 100 millièmes. In order to be more certain it would be best, if possible, to place it a little more than 100 meters from the mask.

The table given below gives, moreover, the approximation realized by the application of these mnemonic rules:

Ranges.	Values of tan φ read on the ruler.	Values of tan φ from mnemonic rules.	Difference in absolute values.
Meters.	Millièmes.	Millièmes.	Millièmes.
100	2.0	3	1.
200	4.5	6	1.5
400	9.5	12	2.5
600	15.	18	3.
800	21.	24	3.
1000	27.5	30	3.5
1200	34.5	36	2.5
1400	42.	42	0.
1600	49.5	48	1.5
1800	57.5	54	3.5
2000	66.	70	4.
2200	75.	77	2.
2400	84.	84	0.
2600	94.	91	3.
2800	104.	98	6.
3000	114.5	120	5.5
3200	125.5	128	2.5
3400	137.	136	1.
3600	149.	144	1.5

This table shows, that for ranges varying from 100 to 1400 meters, the mnemonic rule gives for tan φ values slightly too large, and that the contrary takes place beyond 1400, with some few exceptions. Now, we can allow in a general way that φ corresponds to ranges of over 1400 and Φ to less than 1400 meters. Therefore the difference tan φ — tan Φ, thus calculated, will be, for two reasons, less than its exact value and the number found will constitute an inferior limit for the ordinate.

The exceptions are from 1900 to 2300 and from 2900 to 3300 meters. In these cases, the value of tan φ are too great by 6 millièmes at the most, but as the value of tan Φ is, on the other hand, too great by at least 1 millième, the value found for the ordinate may be too great by 5 millièmes at the most. This approximation will suffice.

Mnemonic rules absolutely analogous to the preceding ones may be easily established for the cannon of 75 mm. The multipliers would be slightly different but very simple also.

To sum up, the question raised by firing field artillery from behind a mask can be solved either *exactly* and without *calculation*, by means of a ruler easily graduated, or *approximately* by the application of very simple mnemonic rules.

The employment of the last solution requires, however, the working out on the ground of various additions and subtractions, which are very simple it is true, but which cannot be avoided.

A PROPOSED METHOD OF COMPUTING THE DANGER SPACE.

By Captain ALSTON HAMILTON, Artillery Corps.

The present method of computing the danger space is by the "Rule of Double Position." It is neither more nor less than the process followed when confronting an equation of the fifth degree. You locate your unknown between known limits, and then narrow the limits as best you can; finally, if the operation be extended enough, obtaining a value which approximates closely to the true value of the variable, or rather to one of its values.

The application of the Rule of Double Position differs somewhat, however, from the "solution" of an equation of higher degree than the fourth, in that it involves two unknowns in one equation, a second condition giving the relation, at intervals, of one of the two unknowns to the other. We have, given, the equation

$$z(A - a) = \frac{Ay}{C \tan \varphi},$$

and we have, further, a table giving the value of **a** for **z** at **z**-intervals of 100. This does not define **a** as well as an equation would, for in the latter case we would have exact values of **a** for non-tabular values of **z**. As it is, we must interpolate; and the present method of interpolation is not all that is needed where great accuracy is essential,—as is the case in danger space problems.

Graphically we have a broken line representing the table, the ordinates being **a** and the abscissa, **z** or **V**, depending on which is the variable between whose tabular values we are working.

The true graph is a curve of which the different lines composing the broken line are chords. Simple interpolation gives us the ordinate of the chord instead of that of the curve. This error is greatest about midway between the ordinates representing the tabular values.

Suppose, now, that it is necessary to find **a** for non-tabular values of **z** and **V**. The double interpolation, whether all in one process, or repeated single interpolations, gives rise to error. The error in interpolation with regard to **V** tends to compensate for the error due to **z**-interpolation; it may over- or under-compensate; the result is more or less fortuitous due to the use of the *tabular* increments in the second part of the process.

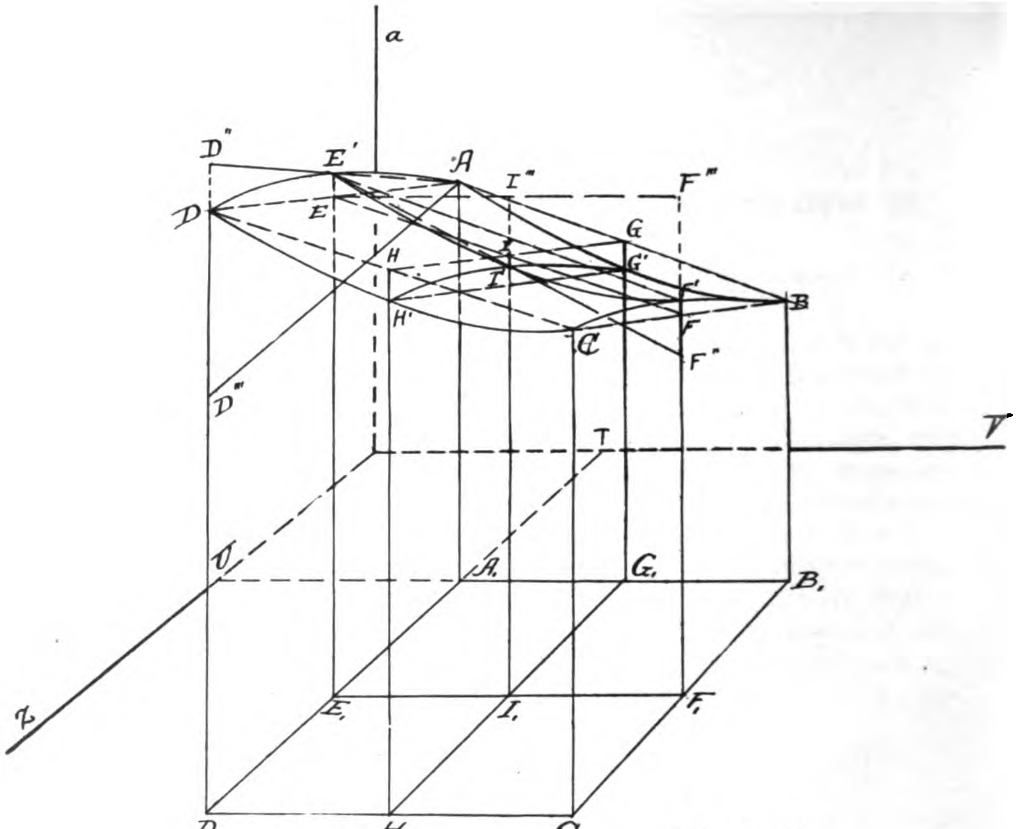

Figure 1.

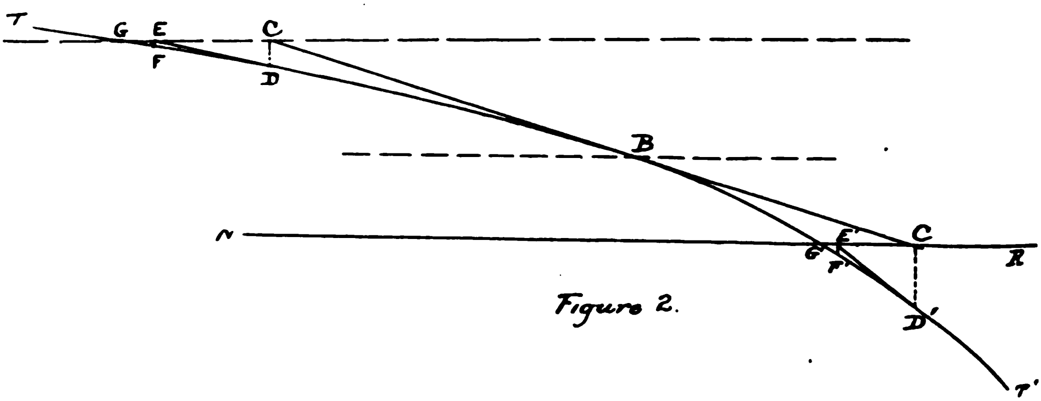

Figure 2.

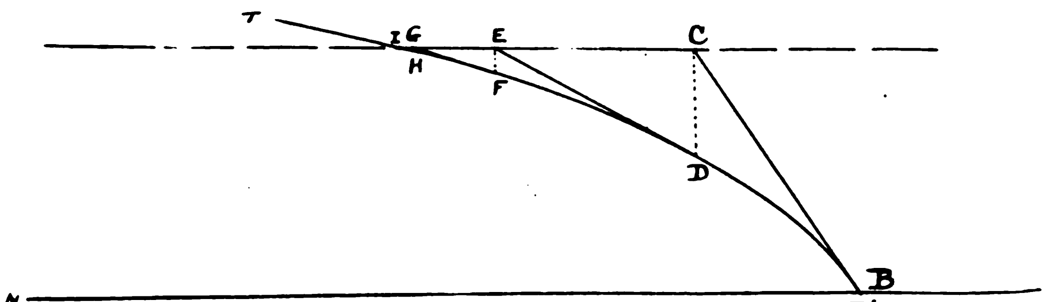

Figure 3.

It is obvious that the accuracy necessary in danger space problems calls, first, for a more accurate method of interpolation as a *sine qua non;* and, secondly, for a more definite method of solving the question; which method should, if possible, give us a *maximum limit* of the error of our final result.

In order to represent more clearly the error in interpolation incident to, and inseparable from, the present method, a graphic representation of **a** as a function of *z* and **V** may be of service.

Figure 1 shows the graphic surface of **a** as a function of **z** and **V**. Fidelity to the facts, as they are found in the table, has been attempted. It will be noticed that **a** is represented as decreasing with **V** and increasing with **z.**

Let **ABCDI′** be a portion of the graphic surface of **a** as a function of **V** and **z**. If TA_1 and TD_1 represent the tabular values of **z**, and UA_1 and UB_1 the tabular values of **V**, between which interpolation is to be made for **a**; and TE_1 and UG_1 the the actual values of **z** and **V**, respectively; then I_1I' is the corresponding true value of **a.** But an inspection of the figure shows that I_1I is the value obtained by interpolation, using present methods; and it is further evident that I_1I is the ordinate of either of two hyperbolic paraboloids depending on whether we interpolate first with reference to **V** or to **z**.

If the increments used are the proper ones; that is, if they are accurately determined *at* the values of the *non-tabular* **V** or **z**, then the two paraboloids coincide: for the elements of one are the directrices of the other. The point **I**, therefore, lies in either of them and the same result would be gotten by interpolating *first* with reference to *either*. If, however, the usual method of interpolation is used, the increments employed are those pertaining to the next lower tabular values of **V** or **z**; the two surfaces do not coincide, and have not, in general, a common point. This may be seen by interpolating first with reference to **z** and then to **V**, and then *vice versa*, and comparing the results. They may not widely diverge, but *neither* is correct.

The remedy proposed is that the *differential obtaining at the value* of the first variable be determined and also that obtaining at the *nearest* tabular value of the first variable (which is usually **z**, it being more convenient on account of the arrangement of the tables); and that the mean of these be taken as the increment of **a** (for $\Delta_z = 100$) to be used instead of the tabular increment; and then that *for the particular value* of **z** the same method be pursued in interpolating with reference to **V**. The result will be as accurate as is possible with the tables, and as accurate as is necessary.

That the mean of the differentials is equal to the increment, so far as these tables are concerned, may be seen to be a proper assumption. For, if the first order of differences of **a** be taken, we get the corresponding J_z- or J_v-column in the tables, as the case may be. If the differences between successive valves of these increments be taken, we get the second order of differences. This latter as shown by the table, is sensibly constant. Taking it as constant, we find that the first derivative of **a** with respect to **z** or **V** is a linear function of its variable. Therefore, it may be gotten without sensible error by simple interpolation. That is, the mean of two slopes is the ratio of the interjacent increment to the increment of the variable with respect to which the slopes are taken. Therefore, the slope at a point midway between the two points considered is the mean of the slopes at the points and is the slope of the chord joining the two points. Therefore, the differential at the point midway between two points corresponding to values of **a**, is the increment of **a** (J_z = 100 or J_v = 100, as the case may be) between the values of **a** at the two points. This establishes the assumption above made as just.

Reverting to the figure: if E_1 be halfway between A_1 and D_1, the differential of **a** with respect to **z** is the same as the increment of **a** between A_1 and D_1. If, then, we find the differentials at the tabular values by taking the mean of the increments of each tabular value and that of the one next preceding it; and then take the mean of this and the increment of the tabular value considered (which equals the differential of the next higher halfway value), we obviously get the increment obtaining for the value of **a** between the tabular value and the next higher halfway value (this increment corresponding to J_z = 100). Half this increment corresponds to J_z = 50 and gives the correct value of **a** for the halfway value of **z**, when added to the next lower tabulated **a**.

Solve this for both tabular **V**'s involved and interpolate to get the correct J_v between the lower tabular **V** and the halfway value of **V**. Halve this and add to the last value found of **a**.

An inspection of the figure shows that we have virtually drawn the line **AE'D''**, and that **E'''E'** (= ½ **D'''D'**) is the correct increment for interpolating to get **E'**.

Similarly, **I'''I'** (= ½ **F'''F''**) is the increment for **a** corresponding to the halfway value of **V**.

This method may be extended to values between the half-way values and adjacent tabular values; or such values may be found by obtaining, by interpolation, the differential obtaining at the given value and the differential at the nearest tabular value, and taking their mean.

In finding the danger space, a slight difference in **a** is greatly exaggerated in the final result.

Let it be required to find **a** corresponding to values of **z** $= 9150$ and **V** $= 2250$, first by simple interpolation and then using differentials:

DATA FROM TABLE II.

	$V = 2100$			$V = 2200$			$V = 2300$		
z	A	Δ_z	Δ_v	A	Δ_z	Δ_v	A	Δ_z	Δ_v
9000	.15408	296	1164	.14244	281	1071	.13173	266	985
9100	.15704	299	1179	.14525	283	1086	.13439	268	1000
9200	.16003	302	1194	.14808	286	1101	.13707	271	1014

Following the present method we find

$V = 2200$

$$a = .14525 + \frac{.00283}{2} = .146665.$$

$V = 2300$

$$a = .13439 + \frac{.00268}{2} = .13573.$$

$$\text{Mean} = .14120$$

Following the differential method we find

$V = 2100$

$$a = .15704 + \frac{296 + 3(299)}{8} = .15853$$

$V = 2200$

$$a = .14525 + \frac{281 + 3(283)}{8} = .14666$$

$V = 2300$

$$a = .13439 + \frac{266 + 3(268)}{8} = .13573$$

$\Delta_v = 1187.$ $\Delta_v = 1093,$

$$a = .14666 - \frac{1187 + 3(01093)}{8} = .14108.$$

The difference of the two values thus determined is .00012.

$\frac{12}{275} \times 100 =$ error in **z** at this range, corresponding to .00012 in **a**.

$\frac{12}{275} \times 100 = 4.37$; but if **C** $= 5$, say, this means 21.9 feet: a considerable error in **x**.

Similarly, **a′** is affected by the method of interpolation. It is a pity that the table does not give it to five places.

As **A, a′, a**, occur in the various problems in ballistics, any error in any or all of them leaves the accuracy of the result in question. This is notably so in danger space problems.

The foregoing method of interpolation practically amounts to the use of the method of differences for interpolating between tabular values. In my opinion, however, the matter is more clearly presented by the method used; the graphic presentation of the matter being simpler.

Having discussed the matter of interpolation, in its bearing on this subject, I will now give the method of finding the danger space, which I propose in lieu of the present one.

In figures 2 and 3, let **TT′** be the arc of the trajectory considered. **B** is the point aimed at, **NR** is the lower danger level, and **GC** the upper.

Draw a tangent at B: it intersects the upper and lower danger levels at **C** and **C′**, respectively, and the abscissas of these points are thus determined. The ordinates of the trajectory corresponding to these abscissas, will, with the abscissas just determined, give the points **D** and **D′**, respectively. Draw the tangents to the trajectory at **D** and **D′**, respectively, and find **F F′**. If a repetition is necesssary, make it; but it will not be necessary, as a rule. In case a closer approximation than **F** is desired, without finding any further points, a geometric progression may be assumed to obtain and the third correction gotten from the first two. This is not absolutely true, but gives a closer approximation than **F** would.

It is obvious that the rate of approximation with this method is very rapid.

In writing an analytical solution of the problem the following notation will be used:

Co-ordinates of C, E, G, and I, respectively: x'', y_2; x''', y_2; x^{iv}, y_2.

Co-ordinates of B, D, F, H: x', y'; x'', y''; x''', y'''; x^{iv}, y^{iv}.

Co-ordinates of C', E', and D', F', G', similar, except that y_1 takes the place of y_2 for points on *lower* danger level.

θ', θ'', θ''', θ^{iv}, etc., correspond to B, D, F, H, etc.

a_1 a_2 a_3 a_4 : a_1' a_2' a_3' a_4', correspond to θ', θ'', θ''', θ^{iv}, respectively.

The equation of the tangent at B is

$$\frac{y-y'}{x-x'} = \tan \theta'$$

This intersects upper danger level $(y = y_2)$ at the point whose abscissa is

$$x'' = (y_2 - y') \cot \theta' + x'$$

Then

$$\tan \theta'' = \frac{\tan \varphi}{A} \left\{ A - a'_2 \right\} = \tan \theta' \left\{ \frac{A - a'_2}{A - a'_1} \right\}.$$

$$y'' = \frac{x'' \tan \varphi}{A} (A - a_2)$$

$$x''' = (y_2 - y'') \cot \theta'' + x''$$

$$\tan \theta''' = \frac{\tan \varphi}{A}(A - a'_3) = \frac{A - a'_3}{A - a'_1} . \tan \theta'$$

$$y''' = \frac{x''' \tan \varphi}{A} (A - a_3)$$

$$x^{iv} = \frac{(y_2 - y''') (A - a_1') \cot \theta'}{A - a_3'} + x'''.$$

etc.; etc.

Danger space $= x^{iv} - x'$; etc.

This refers to front or rear of target; subtract one danger space from the other algebraically, i.e., add numerically. This gives total danger space.

It is obvious that, where aim is taken at the water-line, only one danger space need be found; similarly where aim is taken at the top of the target. In the latter case, the danger space is beyond the target; in the former, on the hither side of it. Where deck hits are considered, the beam must be added.

EXAMPLE.

The 8-inch B.L.R., 130 feet above the water fires at a point 5 feet above the water-line of an armored cruiser, distant 5300 yards. $V = 2200$; $\log C = .6875568$. Freeboard, 15 feet; beam, 72 feet. Find danger space, the vessel travelling across the range.

$$\log C = 0.6875568$$
$$\log x' = 4.2013971$$

$$\log z' = 3.5138403 \qquad = \log 3264.677$$

$$\log y' = 2.0969100_n$$
$$a.c. \log x' = 5.7986029$$

$$\log \tan \varepsilon = 7.8955129_n \qquad = \log \tan - 27' 01''.65$$

$$\log \cot \varepsilon = 2.1044871_n$$
$$\log a_1 = 8.4658512 \qquad = \log .0292315$$
$$\log C = 0.6875568$$

$$\log (a C \cot \varepsilon) = 1.2578951_n \qquad = \log - 18.1090$$

$\log(1 + aC\cot\varepsilon) = 1.2332246_n$	$= \log - 17.1090$
$\log\sin\varepsilon = 7.8955010_n$	
$\log\sin(2\varphi - \varepsilon) = 9.1287256$	$= \log\sin 7^\circ\ 43'\ 47.''6$
	$\varepsilon = -\ 27'\ 01.''65$
$\log\sin 2\varphi = 9.1028066$	$= \log\sin 7^\circ\ 16'\ 45.''95$
$\log C = 0.6875568$	
$\log A = 8.4152498$	$= \log .02601565$
	$a'_1 = .06800000$
$\log(A - a'_1) = 8.6230874_n$	$= \log - .04198435$
$\log\tan\varphi = 8.8035303$	
$a.c.\ \log A = 1.5847502$	
$\log\tan\theta' = 9.0113679_n$	
$\log\cot\theta' = 0.9886321_n$	
$\log(y_2 - y') = 1.0000000$	$= \log 10$
$\log(x'' - x') = 1.9886321_n$	$= \log - 97.41656$
$\log x'' = 4.1987280$	$= \log 15802.58$
$a.c.\ \log C = 9.3124432$	
$\log z'' = 3.5111712$	$= \log 3244.66$
	$a_2 = .0289938$
$\log(A - a_2) = 7.4739393_n$	$= \log .0029781$
$a.c.\ \log A = 1.5847502$	
$\log\tan\varphi = 8.8042015$	
$\log x'' = 4.1987280$	
$\log y'' = 2.0616190$	$= \log - 115.2445$
$\log(y_2 - y'') = 9.3882789$	$= \log .2445$
$\log\tan\varphi = 8.8042015$	
$a.c.\ \log A = 1.5847502$	
$\log(A - a'_2) = 8.6168179$	$= \log(.026017 - .067352)$
$\log\tan\theta'' = 9.0052696_n$	
$\log\cot\theta'' = 0.9947304_n$	
$\log(y^2 - y'') = 9.3882789$	
$\log(x''' - x'') = 0.3830093_n$	$= \log - 2.4155$

$a.c. \log (x'' - x') = 8.0113779_n$
$2 \log (x''' - x'') = 0.7660186$

$8.7773865_n \qquad \log -.0599 = \log (x^{iv} - x''')$ [approx.

$-\ 2.4155 = x''' - x''$
$-\ 97.4166 = x'' - x'$

$\therefore$ Hither danger space $= -99.8920$ feet

Referring to the further danger space :

$\log \cot \theta' = 0.9886321_n$
$\log (y_1 - y') = .6989700_n \qquad = \log -5$

$\log (x'' - x') = 1.6876021 \qquad = \log \quad 48.708$
$15900.000 = x'$

$\log x'' = 4.2027255 \qquad = \log \quad 15948.708$
$a.c. \log C = 9.3124432$

$\log z'' = 3.5151687 \qquad = \log 3274.68$
$a_2 = .0293500$
$\log (A - a_2) = 7.5229656_n \qquad = \log -.003334$
$a.c. \log A = 1.5847502$
$\log \tan \varphi = 8.8042015$
$\log x'' = 4.2027255$

$\log y'' = 2.1146428_n \qquad = \log -130.2096$

$\log (y_1 - y'') = 9.3213913 \qquad \log .2096$

$\log \tan \varphi = 8.8042015$
$a.c. \log A = 1.5847502 ; \qquad a'_2 = .06831$
$\log (A - a'_2) = 8.6262377_n \qquad = \log -.04229$

$\log \tan \theta'' = 9.0151894_n$

$\log \cot \theta'' = 0.9848106_n$
$\log (y_1 - y'') = 9.3213913$

$\log x''' - x'' = 0.3062019_n \qquad = \log -2.02395$

$2 \log (x''' - x'') = 0.6124038$
$a.c. (\log x' - x'') = 8.3123979$

$= 8.9248017 \qquad = \log -.0841 = \log x^{iv} - x'''$ [approx.

		$-\ .0841$	$= x^{iv} - x'''$
		$-\ 2.0240$	$= x''' - x''$
		$+\ 48.7080$	$= x'' - x'$
Further danger space	=	$+\ 46.600$	$= x^{iv} - x$
Hither danger space	=	$-\ 99.892$	
Total danger space	=	146.492	
Beam	=	72.000	
Danger space including deck hits	=	218.492	

(Vessel travelling broadside on.)

In all similar problems the *form* of computation used in this example is applicable and is believed to be as clear and as concise as any. The length of the numerical work in this particular case is due to the double character of the question.

The second and third corrections are comparatively small in this problem, but where the danger space ordinate, y_2, bears a larger ratio to the maximum ordinate, or where the trajectory is flat, these corrections cannot be ignored even practically, as their sum, in some cases, amounts to as much as one-third of the total danger space.

LOOSE LEAF BOOKS AS ARMY RECORDS.

BY SECOND LIEUTENANT PAUL D. BUNKER, ARTILLERY CORPS.

It is difficult to write on a subject like this. We all know the utility of "Loose Leaf" book-keeping, we all appreciate its manifold advantages over the system now in use, and for that very reason, because the facts of the case are perfectly patent to everybody, one feels as though he were arguing against himself. Every one knows what our arguments are, and not only appreciates their strength but also is perhaps of the same opinion himself. You know, probably better than I, how much cheaper, neater and more satisfactory a record is, when kept on the loose leaf system than when written by hand into a ponderous tome full of erasures, interlineations and additions. Some of us have tried to get these books for the use of our companies and remember how stolidly we were turned down by the Quartermaster's Department with the information that "they are not furnished." But why are they *not* furnished? That is the question for which we are trying in vain to find a rational answer.

Is it on the ground of cost, that elusive bug-bear of our supply departments? That can hardly be, for we know the new system to be by far the cheaper. Who can doubt it after looking at the big books in our offices, each page containing perhaps only a few lines of written matter, yet filed away as "used up." Blank books and binding cost money, so why not let the different people who use the books do their own binding? This is exactly what they do, with the new system. Send a company one cover and 500 sheets with appropriately printed headings, and this company will be able to keep, say its Clothing Record, in superb shape for the next ten years, at a cost to the government of about one-fourth the usual amount.

Or perhaps we are refused because the new books and records are not neat? Let us consider it. We have all seen some wonderful specimens of handwriting in our company records. And when different clerks, from time to time, make additions and alterations to a record, it is usually far from pleasing to the eye. And if these different clerks are not good penmen, the result is simply so much worse. On the other hand, what could look neater than a clean typewritten sheet? And when we say "typewritten" we have said enough as regards the clearness and neatness of the record so written. The personal equation does not enter. You will read the figures as the operator wrote them, and will not be at the mercies of his peculiarities of penmanship. When he makes a 7, you will read it a 7, and not a 4 or a 1. Suppose we have made a mistake: we can erase a few words, in one case, about as easily as in the other. But if the error extend through several pages it would be very easy, in one case, to rectify it, but in the other case the operation would be rather troublesome. This is one of the greatest of the many advantages of the loose leaf system. The books themselves present an appearance just as neat as the old style, and the neatness, clearness and conciseness of their contents far surpass the same qualities of the latter.

As to durability there is no comparison between the two. Our record books, as a rule, are heavy, and no matter how well bound, are sure to suffer from the stresses put upon their bindings. The loose leaf books, on the contrary, need contain no superfluous leaves, and hence are comparatively light and easily handled. As soon as any part of the record may become obsolete it can be put in the corresponding file book, and kept there for reference without encumbering the book that may be in daily use.

Now we come to another head. Which is the harder, to work a typewriter all day or to write the same amount in long-hand, or even to write for the same length of time? Why do all our business firms habitually use the typewriter? Why are they taking so readily to this very system of book-keeping of which we are talking? The various reasons they may have are comprised in the one reply—"Because it is better in every way."

The general worth and utility of these books can best be shown by an illustration. Take for instance our Company Clothing Books. Here we often have two or more books in use at the same time, and every "witnessing officer" and company clerk knows what trouble it is to look through several books, searching for places wherein to write a few figures or to sign his name. How much better it would be to have one compact, neatly typewritten book, with no unnecessary leaves! When a man is discharged or transferred, simply take out the corresponding sheet and put it away in the Clothing File Book.

This illustration, of course, brings to mind many other cases where this system can be used to advantage. It is the only logical way to keep Fort Record Books, Descriptive Books, Letters Sent and Received, and Order Books. It lends itself especially to prison records of all kinds. In fact there is scarcely a record imaginable wherein this system would not be the better of the two.

As another example, let us take an Emplacement Book. The company commander could use an arbitrary form something like that shown in plates I and II. The first sheet for his battery would look something like plate I. The second sheet he would reserve for "Alterations and Repairs." Then the third sheet (see plate II.) would relate to the 1st emplacement of the same battery, the fourth to the "Alterations and Repairs" for that emplacement. The fifth and sixth sheets would be the corresponding sheets for the 2nd emplacement, and so on for all the guns of the battery. These models give all the information called for in the "Record of Artillery" and some extra items* besides, that have, in different ways, proven useful to the company commander. But these so-called "models" have nothing to do with the matter in hand. They are merely forms that have been found useful and convenient. Of course the company commander is the judge, to a certain extent, of what shall be put into this book.

Another thing, we all know how hard it is to make out, on the first attempt, an Emplacement Book, in which we can turn immediately to any desired information. The difficulty is nullified by the loose leaf system which, if necessary, will allow of infinite re-arrangement.

With all these advantages to recommend it, is it not curious that we should hold aloof? To be sure "they are not furnished", but after all, we can imagine the reason therefor. It is because we do not ask for them, or do not ask often or strongly enough. The Quartermaster's Department will furnish us things if we only tell them what we want (and tell them often enough). But it is unreasonable to expect them to guess what we want and then to supply it to us. As soon as the demand for these

* The "Field of Fire", for instance, if entered at all, is noted as "270", "180" or the like. This, of course, conveys practically no information whatever. What we want to know is the *azimuth* through which the gun can fire. Hence in this form (shown in plate II.) there are places for the limiting azimuths of the field of fire, of which the left hand one should always be given first. Another addition is the "Height of trunnions above Mean Low water." This is necessary whenever certain calculations are performed. The "Time to send up and load first round" though unimportant, is useful to company commanders at target practice in allowing for the time to be lost before the first round can be fired. However, due to its changeability under different circumstances with the same gun, it is, in the opinion of the writer, not worth the trouble to write it down.

books grows at all, the supply department will cease regarding it as the vagary of a few deluded minds, and will realize that it is the will of the majority. We are all more or less conservative, and unless there is pressure we dislike to change our ways. But when something turns up that has conclusively proven its worth, let us of the Army not be the last to appreciate its merits or to make use of it.

GUN-

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CLASSIFICATION OF MILITARY BOOKS.

Wars of France, 1789-1815 and 1870-1871.

By EDWARD S. HOLDEN, Librarian, U. S. M. A.

The Library of the U. S. Military Academy has adopted the following scheme for cataloguing books on the Wars of France, 1789-1815 and 1870-1871. It is an extension of the Decimal Classification of Dewey, and may be useful in military libraries.

Works dealing with 944.04 and 944.05 together, should be catalogued under 944.05.

FRANCE.

944.04 Revolution.

1 Assembly, 1789-92.

2 First Republic, 1792-99.

3 Convention, 1792-95.

1 War of 1st coalition up to establishment of Directory, 1795. Valmy, Toulon, Fleurus.

7 Wars in the Vendée.

4 Reign of Terror, 1793-94. Destruction of Lyons.

5 Directory, 1795-99.

1 Napoleon in Italy, 1796-97.

2 Campaign against Austro-Piedmontese—Millesimo, Mondovi.

3 Campaign against Austrians—Lodi, Arcola, Rivoli.

4 Mantau (July, '96-Feb. '97).

5 Passage of the Alps.

6 Jourdon and Moreau in Germany, 1796—Würzburg, Etlingen.

7 Napoleon, (Kléber and Menou) in Egypt, 1798-1801.

8 Nile, 1798.

9 Kléber and Menou, 1800-1801.

6 Consulate, 1799-1804.

1 War of 2nd coalition, 1799-1801.

2 Campaigns of 1799.

3 On the Rhine and Danube—Stockach.

4 In Switzerland—Zurich.

5 In Italy—Novi.

6 In Holland—Bergen.

7 Campaigns of 1800.

8 In Italy—Campaign of Massena, Marengo (Napoleon).

9 In Germany—Hohenlinden.

944.05 First Empire.

1 War of 3rd coalition, 1805.
- 1 Campaign against the Austrians—Ulm.
- 2 Trafalgar.
- 3 Campaign against Russians—Diernstein.
- 4 Campaign against Austro-Russians—Austerlitz.

2 War of 4th coalition, 1806-07.
- 1 Campaign of 1806 against Prussians—Jena and Auerstädt.
- 2 Campaign of 1807 against Russians and Prussians—Dantzig.
- 3 Winter campaign—Eylau.
- 4 Spring campaign—Friedland.

3 Peninsular War, 1808-1814.
Corunna (Sir John Moore), Salamanca, Talavera, Albuera, Vittoria, Toulouse.

4 War with Austria, 1809.
Eckmühl, Raab, Aspen and Essling, Wagram.

5 War with Russia, 1812.
- 1 Invasion—Moskowa (Borodino and Moshaisk), Burning of Moscow.
- 2 Retreat—Passage of Berezina.

6 War of ("Liberation") 5th coalition, 1813-14.
- 1 Campaign of 1813.
- 2 Pt. 1, to armistice of Poischwitz (June-August), Lützen, Bautzen.
- 3 Pt. 2, to end of 1813—Dresden, Leipzig.
- 4 Campaign of 1814 (Invasion of France)—La Rothière, Laon, Montereau, Fère-Campenoise.
- 5 Entrance into Paris.
- 6 Army of Lyons.
- 7 Army of Italy.

7 Restoration of Louis XVIII., 1814-15.

8 Hundred Days, March-June, 1815.
Ligny, Quatre-Bras.

9 Waterloo (June 18, 1815). For special studies of battle of this date.

994.081 Franco-Prussian War, 1870-71.
- 1 Operations in Alsace—Wœrth.
- 2 Operations in Lorraine—Saarbrucken, Spicheren.
- 3 Operations about Metz—Rezonville, Gravelotte, Saint-Privat.
- 4 Operations of Army of Chalons—Sedan.
- 5 Operations on the Loire, Beaune-la-Rolande, Loigny-poupry, Orléans.
- 6 Operations of 2d army of the Loire—Le Mans.
- 7 Operations in the East—Héricourt.
- 8 Operations in Normandy and the North—Amiens, Saint-Quentin.
- 9 Operations about Paris—Champigny, Buzenval.

PROFESSIONAL NOTES.

◆

Defense of Harbors against Torpedo Boat Attack.

Now-a-days torpedo boats have increased very rapidly and destroyers have multiplied exceedingly, and it may be taken for granted that if any attack is made, it will be pushed home as long as a single boat is left. Therefore the problem with regard to defense is to account for every single boat that attacks. Say, for instance, that twelve boats attack, it will not be much good accounting for eleven if one gets through.

The first question in relation to defense it seems is to find out what has got to be defended, whether the boats are coming with a view to securing any odd ship, damaged or otherwise, that may be in a harbor or whether their intention is to try to block up the docks and dock entrances by getting inside and torpedoing these. The latter is perhaps what we might be most in fear of and must expect to see attempted.

If we take the various defense systems, every system seems to have its advantages and disadvantages. If we take the favorite system, No. 1 gun firing at No. 1 boat, No. 2 gun firing at No. 2 boat and so on, that in theory may be a very excellent system, but the defect of it is that in practice, No. 1 boat becomes No. 3 perhaps at one moment and No. 2 at another, and there is always the danger that No. 1 gun may be firing at No. 2 boat, and No. 2 gun at it also, leaving one boat neglected, and a practice of rushing based on the chances given by this system exists, and, if one of a dozen gets through, untold mischief may be done. There is also of course the question of what is to happen if more boats than guns should be used

Then take the zone system. There success depends upon doing a great deal with comparatively small armaments. If the boats, knowing that the zone system is going to be employed, come in in bunches, then again there seems to be a very good chance of one boat managing to crawl through. If the boats wonld each enter each zone singly, their fates would be certain ; but we cannot depend on that happening. Obviously the gun that has only one boat to fire at and the gun that has a dozen in its zone are very differently situated. Still, I incline to fancy that the zone system is better than any other. But whatever system of defense is adopted, there is always grave danger in a lack of definite co-operation between the Army and the Navy, and I think there can be no doubt that if the two forces fail to act in concert, it would tend to help and assist any attacking boats more than anything else.

Next to gun fire, perhaps, search lights form the most important part in all defense operations. The value of search lights is I think a very debatable point. From my own experience on torpedo boats and destroyers rushing harbors, I think there is a great deal to be said both for and against the search light. Of course for rushing in in peace time you are not firing any shotted guns, and therefore you cannot have any data to go on, as to how easy or difficult it may be for a destroyer coming in to fire at a search light and perhaps pick it out, and then in the sudden gloom get in easily.

Some experiments in Germany seem to have shown that it is not a difficult thing to hit the search light. My own impression of search lights is that when you are three or four miles out, they do not show you up, but they do show the way in, and show it tremendously clearly. This is perhaps more true of fixed beams than of searching ones; the difficulty to the attack comes in where the searching beam gets full on the boat, inasmuch as then the boat can see next to nothing, and when the light goes away or is evaded there is a sort of complete blindness; I think that the value of the search light for defense is perhaps to flash it on the eyes of the boat's crew and then off again. Its use thus should lead very often to the boat going ashore or running into other boats from the temporary blindness that the flash has caused.

The search lights no doubt light the way in to some extent, so much so perhaps, that the the real value of them to defense is only the confusing effect they have on the attack. If the boat does evade the search ray it seems to me that it is not very likely to be picked up again, whereas if a deliberate flash system be adopted, there will be no need to bother about picking up. I am not sure that a good deal could not be done by a mechanically operated light.

In harbor attack I notice a boat has great difficulty in evading the search beams at all, but at sea I have certainly noticed that the boats manage to evade the beams very well, and I think that in war time a boat coming into harbor and trying to maneuver in order to evade the light would be maneuvering differently to what it is in peace time; when the officers in command of the attacking boats do not care to run any unnecessary risk which is not warranted. But in war time where the question of retreat and attack comes in, I think a boat dodging about might possibly get out of the range of the searching beams and not be picked up again. In that case the searching beams would be to your disadvantage; but the great point altogether about the search lights is that it seems very little thought has been devoted to the question of fighting search lights with return lights. It was tried the other day at Portland when destroyers slipped in, and as soon as they were sighted switched their lights on to the forts and opened a heavy rifle fire on the guns, and it is an interesting question as to what would happen in war time. This more or less unexpected rifle fire, coupled with the glare of the attack's search lights, must have a very disorganizing effect on the defense for several minutes, say, for long enough to allow a certain proportion of the boats to slip through unhurt or nearly so.

The question that requires an answer is, how that sort of thing is to be met? Everything depends as I said before upon the point—which is of more importance than anything else—that nothing must be allowed to get through. How to stop the boat getting through therefore becomes a doubly important problem. It is not so much that the boat has to be sunk, but it has got to be stopped from doing any mischief before it goes under.

Supposing a modern destroyer was hit by one 12-pdr. shell, it is extremely improbable that that 12-pdr. shell will sink her. That is why I think the Maxims might be an extremely useful adjunct to the defense, both alongside the 12-pdrs. in the batteries and also where they are never put at all, that is at the entrance to the docks; so that supposing the boat is coming up, a Maxim fire can be directed on her sufficient to kill anybody at the tubes. The danger from the boat lies entirely with the men at her torpedo tubes, and to destroy the personnel in that case would be as good as destroying the boat.

Then the question with regard to booms is a very vexed one indeed. I believe the theory in the Navy is that the Navy can always jump the most ideal of booms; but in British harbors at any rate we cannot have those, for we must have ways for getting in fairly quickly and ways for getting out fairly quickly. This means entrances, and supposing these entrances to be only opened to let ships in or out, there is always the chance of an attack being made about that time.

Supposing the booms to be an adjunct with a mine field, the Chinese at Wei-hai-Wei had some mines, and it was reported on one occasion that some of these were exploded as the boats were passing, but the Japanese say that no damage whatever was sustained by them, and they rather had a theory that the mine would probably not hurt such a little thing as a boat rushing in. But whatever kind of mine is adopted, it may be taken for granted, I suppose, that the enemy will try to countermine, and if they countermine then it appears to me that there will be a very great danger of the defense's attention being distracted by this countermining and possibly a certain amount of firing in that direction will be carried on by the enemy to secure a chance to make a second attack from some other point and so slip in.

Therefore perhaps the question might be gone into more than it is as to whether mines are or are not to be regarded as part of a harbor defense against torpedo craft, and, if so, whether a special kind of mine might not be served out to harbors intended solely to meet torpedo boat attack. On the whole I fancy that the danger of distraction that countermining operations may afford, will render the mine defense a curse rather than a blessing to the defenders.

The submarine boat presents as grave a danger perhaps as any other form of attack. We are just beginning now to worry ourselves about submarine boat attack, and the question is how is it to be met? It will presumably have to be met by booms with nets below the surface in conjunction with a series of mines, but it is a very difficult problem. The gun is no good against submarines. The boat cannot very well be shot from the shore by any existing gun. The odds against hitting it are tremendous, even if it be awash; if it is coming in submerged, it is about a million to one that the periscope will not be hit; and even were it hit, the boat would still exist. It can still pop up and then disappear again. The first question that arises with regard to the best defense of a harbor against submarines is that it will probably need an exceedingly good and skilful commander to take a torpedo boat up any harbor that we have. A thorough knowledge of the tides would hardly be his, the knowledge of the currents would not be his, and although he might possibly be able to do it in peace time, in war time, in the case of a submarine attacking a strange harbor under fire, we may, I think, rest assured that the probability is that it would get flurried. We might also be able to secure a boom with torpedo nets down below in which the boat would get caught. But unless there is a certain amount of flurry and risk to the boat, I do not see what is to prevent the boat being armed with appliances to cut through the boom.

This question of submarine attack stands to be the problem of the future. What is to be done? Whatever device is thought of, anybody who has to do with submarines will waive it aside and say, "Oh, but submarines will get in." But even if we refuse to admit that to-day, although the submarine of to-day may be a defective weapon, the submarine of the early future will possibly be something very different indeed, and I do not see what we are going to do with the means for defense available at present.

I believe that there is a very good knowledge of most of our harbors on the part of many of the Garrison gunners which they have acquired by boating and they seem to be thoroughly acquainted with every shoal. In case of attack by hostile torpedo craft this knowledge should be invaluable to them, because they would know better then where to expect attack and be better prepared to meet it.

A second point is to learn thoroughly the draughts of all probable enemies. Of course where there are, we will say, a hundred boats all drawing under 10 feet of water, it is not very much satisfaction to know that if twelve boats are attacked they are some of the hundred. But there are always a certain number of largish boats which cannot attack certain harbors. If all the draughts were known and studied, then the attacking force would be known or guessed at before it was properly seen and the defense could be conducted more satisfactorily.

Then I think it would be very necessary to study carefully what damage the enemy can do inside a harbor and guard against it. The boat would not reckon on coming out again, it would have done its work five minutes after it had got inside. The question is what is to be done with that boat when it is inside? The principal object of the defense when attack is being made, and when the boats are coming in, will be I take it, not so much to sink the boat as to stop her doing mischief. Sinking her of course is the surest way of dealing with her, but owing to the difficulty of sinking her at once it may be advisable to have a supplementary defense, and that is the reason I suggested the Maxims and Nordenfeldts. The zone of fire from Nordenfeldt bullets and Maxim's on a destroyer or torpedo boat, would be a very serious thing indeed. Supposing a Nordenfeldt bullet to get inside the engine room, it would do as much harm as a 12-pdr. A 12-pdr. of course would blow things about a great deal more but the boat would still have her way on her.

Now supposing her, instead of by that one 12-pdr., to be hit by ten or twenty Nordenfeldt bullets distributed about in various parts, of course we may ask ourselves which is going to do the more harm. We know she will ultimately sink from the 12-pdr. hit, but what will she do before she sinks? Supposing one or two bullets to get into the engines, the question is whether the total result of those or the accumulation of those may not be much more serious against the boat than the one put from the larger piece?

I think we might find our ideal defense if the gunners were all sent out in the torpedo boats and destroyers and the naval men were put in the forts. The gunners out in the boats would know all the weak points of the forts and the boats would be maneuvered to come in in the best way against the forts, and that would furnish valuable data afterwards to know from what point the greatest danger might be expected, whereas the method in which the naval men conducted operations against the boats would possibly give a few valuable wrinkles that had not been thought of before. Naval men would naturally best understand what would be likely to damage boats very considerably.

I do not think that this kind of thing is likely to come about, but there have been steps taken in that direction, which I think everybody should be extremely glad to see. Lately Garrison gunners have been out in torpedo boats watching the attack, and from all I hear I think that seeing the thing from the other point of view has been of very great assistance indeed to those who will have to defend our harbors in war time. Being in a boat slipping in, and realizing the joy of slipping in, which exists in the torpedo boat, should enable the gunner to realize very fully indeed not only the ease or difficulty, as the case might be, of the slipping in, but the meaning of what a single boat out of a dozen slipping past would do.

It might be well to add that a combined attack is a thing that might very possibly happen ; that is, an attack we will say of 12 torpedo boats or destroyers, supported by one or two cruisers, seizing a favorable moment. We will assume, that the home and foreign fleet are in touch, the cruisers of either side operating together, cruising and scouting together ; that is the time at which one or two cruisers attached to the hostile fleet might be detached in order to make a rush on a place like Portsmouth, where if the channel could be blocked up or the docks destroyed, incalculable mischief would result. If torpedo attack were supported by cruisers, and the cruisers came in and opened a heavy fire, under cover of which the boats could rush in, I think we should have an ideal attack from the attacking point of view. It is one which will be more dangerous than anything else, this attack of ships coming in unexpectedly with the object of creating a diversion, sending shells higgledy-piggledy about and round the forts, and then under cover of the smoke and confusion, torpedo boats rushing in in the hope that one boat will get through, never mind what becomes of the rest. That, I think, is the form of attack that we must especially prepare for. In it there will always be danger ; while any other form of attack will probably be doomed to failure.—*Extracts from a Lecture by Fred T. Jane, in Proceedings of R. A. Institution.*

Coast Fortifications.

Norway.—The Norwegian Government have decided to put into execution the project of establishing an important naval base on the northern coast. The site will be strongly fortified. Melbie has been suggested as the most suitable site for the new base, and fortifications will be erected all along the coast line.

Sweden.—The coast works intended for the defense of Stockholm from attack by sea have been completed during the course of the past year. The construction of fortifications for the protection of the capital from the land side is now being begun. According to the *Militaer Wochenblatt*, the southern front will comprise two works, one of which will be furnished with fortress artillery and the other exclusively with revolving-cannon or machine guns.

Field Artillery, Germany.

The question of a new material for the field artillery appears to have reached a decisive phase. The German press has made mention of various statements that the Minister of War has been led to make this year, before the budget committee as well as before the Reichstag, upon the subject of the introduction of a long recoil gun in the German army. We give below the main points of the case :

The first tests previous to 1899, were carried out first of all with a gun presented by Ehrhardt, which was found practically useless. Some modifications were made in it, and in 1899 the Imperial government ordered two pieces from Ehrhardt. Delivery of these was very much delayed, however, and it was only in 1900 it was made. At the same time Krupp also submitted a new long recoil gun and two pieces of this model were immediately ordered from that firm. These pieces were delivered very promptly so that it was possible to begin trials concurrently with the Krupp and Ehrhardt models.

At the conclusion of these tests, the government ordered one battery from each of the two manufacturers, with which it experimented at the Firing School at Juterbog. It was in 1902 that the first official decision was rendered on these guns. Both the Board on artillery tests and the Firing School definitely rejected the Ehrhardt material. Objection was made, it seems, to the lack of immobility in the Ehrhardt pieces during firing. This necessitated relaying after each round. The Krupp gun on the contrary remained perfectly steady on all kinds of ground.

It was then decided to pursue the tests on a larger scale and in a more practical manner: seven batteries were ordered from Krupp, of which three had seamless, unriveted carriages, three had carriages with riveted flasks, and one, for the horse batteries, carriages without axle seats. They were delivered to the troops in 1903 and have, in part, figured in recent Imperial maneuvers. It is said that they functioned perfectly although they have in no way been spared rough usage. The Board on artillery tests, which examined them after this trial, could discover only some slight defects (penetration of water, breaking of small springs, etc.). The seven batterries then returned to the Firing School, at Juterbog, which declared that they fulfilled all the *desiderata* of a field artillery material. The new gun was to be presented to the Emperor in the spring of 1904. It is provided with a shield.

Certain journals have claimed that the new material was a compromise between the Krupp gun and the Ehrhardt gun. Others protested against this declaration and have insinuated that the idea of a Krupp-Ehrhardt compromise has been put forth with a financial object in favor of the Dusseldorf works. This combination would, moreover, have answered a wish clearly expressed by the Reichstag, which would have desired seeing these two important German firms co-operating in the construction of a new material. It seems more probable that the compromise, if it exists, has been made between the Krupp design and a type devised by the Bureau of Artillery Construction of Spandau.

However that may be, General von Einem speaks in high terms of the new material before the budget commission, declaring that it is lighter than the French material and that it would have the benefit of all the progress in modern artillery science.

Everything seems to indicate, then, that a decision is near; also, although more than 13 millions yet need to be expended for the constitution of the reserve field artillery material provided for in 1897, the budget for 1904 allows for this purpose only the insignificant credit of 250,000 francs.

—*Revue Militaire des Armées Etrangères.*

According to the *Strasburger Post*, the transformation of the artillery material of the German army is about to be carried out. The long recoil gun with shield, says that journal, is about to be adopted. In view of the success obtained by the Japanese artillery during the present war, no one would wish to assume the responsibility of leaving our artillery armed with an obsolete weapon. It is probable that at the end of the current year, either the transformation of the present 1896 model, or the manufacture of a new material will be begun, as experiments on a large scale were carried out last year with a dozen batteries transformed by Krupp, and other definite trials are about to take place with guns, the model of which has been fixed by the Artillery Technical Section.—*Revue du Cercle Militaire.*

Attaching Artillery to Infantry Divisions, France.

On the 12th of July last, the President of the Republic signed a decree ordering that field artillery regiments should be placed, in peace time, under the orders of generals commanding infantry divisions. As a rule, a complete regiment is attached to each division. When, exceptionally, the artillery attached to an infantry division consists of a portion of a regiment, under the command of a lieutenant-colonel or a major, that officer has all the prerogatives of a regimental commanding officer, with the following exceptions:

1. He cannot alter the regulations with regard to the composition and duties of regimental boards and courts of inquiry.

2. Administration is centralised for the whole corps under the board of administration ; the lieutenant-colonel or major is responsible for the execution of the decisions of that board as regards the batteries placed under his orders.

This organization is not applicable to: 1. The 19th Artillery Brigade ; 2. Alpine batteries of the 14th and 15th Districts; 3. Horse artillery batteries of the cavalry divisions; 4. Batteries stationed in Corsica ; 5. Brigade divisions undergoing gunnery practice.

A special Ministerial instruction fixes the date on which this organization will come into force, as well as the distribution of artillery regiments, or portions of regiments, amongst infantry divisions, and defines the new powers of generals commanding the artillery. All previous regulations on the subject are abolished.—*Revue du Cercle Militaire.*

Rearmament of the Field Artillery, Portugal.

The Portuguese field artillery which has been armed with a Krupp 9 cm. gun, now of obsolete design, has, like Spain, felt the need of procuring a modern material. With this object in view, a Board of five members was appointed in 1903 to select from abroad a rapid-fire field gun. It decided to experiment comparatively with the Krupp and Schneider-Canet 75 mm. long recoil material, provided with shields.

After these trials, which have lasted eight months, the Board by a vote of four against one, has decided in favor of the Schneider-Canet material. The Portuguese government, consequently, has closed a contract with the Schneider-Canet firm for supplying 36 rapid-fire field batteries, each consisting of 4 guns and 8 caissons, or a total of 144 pieces and 288 caissons. Two of these batteries are to be delivered by the 9th of next December, twelve May 9th, 1905, and twenty-two May 9th, 1906.—*Revue d'Artillerie.*

New Japanese Field Artillery.

The *Revista di Artiglieria e Genio* gives the following description of the Japanese field gun :—

Calibre, 75 mm.; length of gun, 2200 mm., or 31 calibre ; height of line of sight from the ground, 900 mm.; diameter of wheels, 1400 mm.; width of track, 1260 mm.; muzzle velocity, 490 mm.; elevation, 5 by 25 degs.; weight of gun and carriage, 883 kg.; weight of gun limbered up, 1647 kg.; weight of shell 6 kg.; weight of charge, 0.525 kg.; number of rounds in ammunition wagon, 90.

When the gun is fired the wheels roll up on two brake shoes, the spades of which are embedded in the ground, at the same time a pull is effected by means of a rope over the axle-plates of the wheels, and is transmitted to two arms attached to a plunger fitted into the brake cylinder in the trail of the gun. The return of the piston into its right position allow the gun to roll back into its original position after recoiling. The breech mechanism is a screw mechanism, and opens from top to bottom. The gun has been designed by Col. Arisaka, and manufactured at the Krupp works, at Essen, Germany.

The main point in the design was to construct a gun which would meet with the requirements of such a small race as the Japanese and the narrow roads in that country.

The Russian General Staff has just published a brief book upon the Japanese artillery regulations, of which the *Russki Invalid* gives an account. It would appear that the regulations very greatly resemble those of the German artillery, as might have been expected, and that there is nothing very original in them. Six men are attached to each gun, and five to each ammunition wagon, so that a section of two guns and one wagon has seventeen men. In action a wagon with forty rounds is stationed about 15 yds. behind the guns, but no indication is given as to the position of the line of wagons. A battery in movement is always preceded by artillery scouts. A special rangefinder is used one or two men being detailed for the work, and when fire is opened the centre section takes the estimated elevation, the right section an elevation giving 150 yds. greater range, and the left section the same amount less than the centre section. The last named begins the fire, and according to the observation made of the two rounds, the right or left section continues. A small group of observers, consisting of one noncommissioned officer and two gunners for each battery, takes stations in advance and on the flanks to observe the results of the firing, which they transmit to the officer commanding the battery by means of flag signals. The maximum rate of fire is from five to twenty rounds a minute per battery of six pieces, but when rapid fire is used, without relaying the guns, it is possible to fire ten rounds per gun per minute. The *Russki Invalid* doubts whether the Japanese have ever attained this rate in practice.

Nitrate of Ammonium Powders and Explosives.

Of recent years the charge has been made against chemical powders that they decompose at the end of a relatively short period and do not possess that indefinite stability, so to speak, of black powder. It is probably in consequence of some such experience that Austria-Hungary, after having adopted ecrasite as well as a great quantity of nitrocellulose and nitroglycerine powders of all forms,[1] seems to be returning by degrees to mechanical powders by the recent adoption of nitrate of ammonium powders and explosives: *Ammonpulver* and *Ammonal*.

Ammonpulver.—"Ammonpulver" is a powder consisting of a mixture of ammonium nitrate, carbon and sometimes sulphur and other substances. This powder, manufactured by Mayr and Roth at Felixdorf, produces little smoke and possesses great ballistic power although only moderately quick. It

[1] See JOURNAL U. S. ARTILLERY, vol. xix., page 77.

is more difficultly inflammable than black powder; as it is also much less sensitive to mechanical influences, its manufacture, handling, and transportation are less dangerous.

It is highly hygroscopic and should always be protected with great care from humidity. For this reason it is stored in air-tight barrels of a special make, Ritter system. That which is intended for filling cartridge cases is moulded in the form of hollow cylinders which are then wrapped in paraffined paper, and, besides, the cases are hermetically sealed.

"Ammonpulver" is used satisfactorily in small arms and in rapid-fire guns. As this powder ignites with difficulty, it necessary to place in the cartridges, in contact with the cap, a priming charge of black powder. The smoke produced is light and dissipates rapidly, whatever the rapidity of fire. It has neither a disagreeable odor nor injurious effect. Most recent tests have led to a reduction of the priming charge, which diminishes still more the density of the cloud of smoke.

Regulation of the quickness of "Ammonpulver" is easier than in the case of black powder. It is obtained by varying the proportion of ingredients, the size and density of the grain. Pressures rise uniformly and normally with the velocities obtained. It cannot produce spontaneous explosions, but a suitable proportion of ingredients gives a rate of combustion sufficient to obtain very great energy. In this way very considerable explosive effects have been realized in projectiles and in blasting.

According to the tables of Captain Knobloch[1], the Austro-Hungarian navy uses "Ammonpulver":

1. In the new steel semi-armor-piercing shell,[2] 4.4 cal. (with base fuze) [*Zündergranate*], of the 30.5 cm. L/35 gun (weight of bursting charge 50 kg.);

2. In the new semi-armor-piercing shell,[3] 4.4 cal., of the 24 cm. L/22 gun (weight of bursting charge 24 kg.);

3. In the reinforced semi-armor-piercing shell (*gehärtete Zündergranate*) of the 15 cm. L/40 rapid-fire gun (bursting charge, 2.51 kg. of *Kuchen-Ammonpulver* in a flannel bag with a priming charge of 127 grams.);

4. In the armor-piercing shell and shrapnel of the preceding gun, in which the bursting charges are, respectively, 0.9 kg. and 0.46 kg. of *braunes Ammonpulver:*

5. Finally, in the drill cartridges of the 12 cm. L/35 gun (weight 6.25 kg.)

According to Scheibert and Porth's *Illustrirtes Militar-Lexikon*,[4] the composition of "Ammonpulver" for the 12 cm. and 15 cm. guns is as follows:

Ammonium nitrate	37 per cent.
Potassium nitrate	49 " "
Carbon	14 " "

[1] Die Munition der k. u. k. Land- und Schiffs-Artillerie. By W. Knobloch. Vienna. 1903. 4th edition.

[2] The old semi-armor-piercing shell of 4 cal. has the same weight as the new (455 kg.) and contains only 16.2 kg. of explosive, like the projectiles of coast guns of the same caliber.

[3] The old armor piercing shell of 2.5 cal. weighs 119 kg. and contains only 6.8 kg. of explosive.

[4] Illustrirtes Militar-Lexikon fur die k. u. k. osterreichisch-ungarische und deutsche Armee. Major J. Scheibert, Prussian Army, and Colonel W. Porth, Austrian Army. Berlin. Pauli.

The same encyclopedia[1] gives for the powders intended for the 47 mm. and 7 cm. rapid-fire guns the following proportions—

Ammonium nitrate	85 per cent.
Carbon	15 per cent.

M. von Geldern-Egmont, President of the Military Technical Committee, has patented the use of cellulose carbonized naturally: peat, dead leaves or wood, etc., mixed with ammonium nitrate with or without oxidizing substances. Since 1890 the Austro-Hungarian navy has used a similar explosive of the same inventor. This explosive, not patented, is charactised by the special kind of carbon it contains. Designated at first by the name of ammonium safety powder, it has been used since 1898 under the name *Dynammon*.

Ammonal.—We have already given some notes on ammonal,[2] which has been quite recently adopted in Austria-Hungury for bursting charges of projectiles of the 10.5 cm. howitzer, and which will, perhaps, replace ecrasite. Ammonal is manufactured by the Mayr and Roth powder works. The French patent dates from August 30th, 1900, in the name of M. Fuhrer and in it is seen for the first time the use of aluminum in the composition of explosives. A German inventor, M. Bielefeldt, took out a patent in the following year in which he claims the use of pulverized aluminum in explosives (French patent of April 11th, 1901.).

Since 1902 the Koln-Rottweiler powder works have been manufacturing two explosives using ammonium nitrate and aluminum, which bear the names *Kohlen-Anagonssprengpulver* and *Gesteins-Anagonssprengpulver*. They appear in the form of fine grains, of a gray color, and have the following composition:

Ammonium nitrate	78.5 per cent.	84.5 per cent.
Potassium nitrate	17.5 " "	1.5 " "
Wood carbon	—	8.0 " "
Vegetable oil	2.5 " "	— " "
Aluminum	1.0 " "	5.5 " "
Barium nitrate	0.5 " "	0.5 " "

Finally, an English company has recently been organized for the manufacture of ammonal.

M. F. Heise, Professor at the Academy of Mines, at Berlin, has this to say on the subject of explosives containing metals:[3]

"Recently aluminum and even magnesium have been used as constituents of explosives. These two metals produce a very high temperature in burning, and mixed in a pulverized form with an explosive they increase its effect by considerably expanding and superheating the gases that are produced.

"The Austro-Hungarian military technical committee, which has tried the use of aluminum at the suggestion of the engineer-general of artillery Hess,[4] has found that the increase of explosive effect depends greatly upon the degree of purity of the metal and the intimacy of the mixture. Too great a fineness of the metallic particles, however, presents the objection of retarding the reciprocal reactions of the constituent elements and of diminishing the duration of preservation. When powdered aluminum is mixed with black powder, the latter ignites more difficultly.

[1] Also the Schweizerische Zeitschrift fur Artillerie und Genie, February, 1904.

[2] See JOURNAL U. S. ARTILLERY, vol. xxi, page 85.

[3] Sprengstoffe und Zündung der Sprengschüsse. F. Heise. Berlin: Springer. 1904.

[4] See Neuerungen in Spreng- und Zündmitteln (Vienna, 1903), by l'ingenieur-general d'artillerie Hess.

"For some years aluminum has been produced at such a reduced price that the question of cost no longer constitutes an obstacle to the use of this metal in explosives."

According to the same author,[1] the introduction of ammonium nitrate in explosives has become general in recent years. Mixed with various substances (collodion, nitroglycerine, nitronapthaline, nitrotoluol, nitrodextrine, various nitrates, etc.), this substance has been utilized in the manufacture of the following explosives: progressite, grisoutine, Favier explosives, tritonite, densite, safety dynamite, nitroferrite, flammivore, minolite, baelenite, ammonite, amvis, electronite, bellite, etc..etc., which are used more especially in mining operations, but which on occasion may be utilized for military purposes.—*Revue d'Artillerie.*

Notes on the Russo-Japanese War.

The fighting in the Far East places in the clearest possible light the enormous advantage that rests with troops acting upon the offensive, whether it be strategically or tactically. The Japanese have operated throughout upon the strategical offensive, with the result that they have always been able to deceive their adversary as to their real object, compelling him to distribute his troops over a large area where many of them have not been required. Since the South African War there has been a tendency in some quarters to exaggerate the advantage of the defensive in tactical operations, but the Japanese seem to have demonstrated that upon nearly every occasion where troops act judiciously upon the offensive they achieve success. It was so at the Yalu, where General Sassulitch expected the Japanese to break themselves to pieces upon his principal position. It was the same at Nanshan, where General Stoessel occupied a position that was deemed impregnable, but the mobility and offensive spirit of the enemy secured a victory. General Stackelberg had a certain initiative in the action at Telissu, but the Japanese once more were able to operate upon the flanks and to compel him to retreat. It was the same at Kaiping, where General Keller's troops were defeated, and again at Ta-shish-chiao, where General Zarabaieff adopted a purely defensive programme and established himself in a carefully prepared position. The actions before Liao-yang and the great battle there embody the same idea, the Russians acting upon the defensive and the Japanese gaining every possible advantage from the character of their offensive movement.

* * *

The mobility of the artillery is as remarkable as anything else in the campaign. It has marched with the troops, occupied forward positions, and seized vantage-points from which it could pour a concentrated fire upon the enemy from a position of command, and generally has shown very remarkable qualities. The correspondent of a Russian journal, who was present at the battle of Wa-fang-kau, gives a remarkable account of what happened. He declares that the Japanese gunners had excellent maps and knew the exact ranges. They began the action by concentrating their fire upon the opposing artillery, destroying it battery by battery, the first, second, third and fourth batteries of the First Siberian Artillery Brigade being particularly exposed. The fourth battery was the first to be attacked, and within twenty minutes it was practi-

[1] See also Dictionnaire des Matières Explosives, by J. Daniel. Paris: Ch Dunod. 1902. And Notions sur les Explosifs Brisants, by L. R. Auzenat. Paris: Lavauzelle. 1901.

cally destroyed, all the guns save one being dismounted, and all the officers killed or wounded, as well as nearly every man. An attempt was made to remove the remaining gun, but a shell struck the ammunition wagon and everything was destroyed. Fire was then directed successively upon the third, second and first batteries, and, as soon as the Japanese had got the range, they discharged a rain of shells from which nothing could escape. In the four batteries ten officers and 103 men were killed. Evidently the gunnery of the Japanese is remarkably accurate.

* * *

A recent number of the *Militaer Wochenblatt* contains an interesting article on the action of the Japanese heavy field artillery at the battle of the Yalu. We extract the following:

The heads of columns of the 1st Japanese army—12th Division Guard, and 2nd Division—had reached the Yalu on April 4th. The heavy field howitzers were with the left column of the 2nd Division. These pieces are 12.7 cm. howitzers manufactured by Krupp, which Japan acquired a few years before the beginning of the war. Their weight is not very much less than that of the German 15 cm. field howitzer (which weighs, limbered up, 2700 kg.) so that it may very well be said that the Japanese 12.7 cm. field howitzer corresponds to the German heavy field howitzer.

According to latest accounts, the Japanese had 20 howitzers at the Yalu, or five batteries of four guns each. *

On the 30th of April the crossing of the river was effected at Wiju. The river at this point has a width of 400 to 500 meters. The Russian position extended from the sea to the river Ai-ho. Opposite to it was the 2nd Division and the heavy artillery. The other two divisions had no enemy in front of them on the other side of the river. They could, accordingly, throw their bridges across at Houssan and at Soukou without difficulty, effect a crossing, and then ford the Ai-ho, which is not deep at this place, and fall upon the flank of the Russians.

Very much more difficult was the condition of affairs for the 2nd Division. Opposite to it was the main Russian position and the larger part of the artillery. Although the Japanese were superior in numbers, it would not have been possible for them—in the face of the enemy, in the daytime, and under the fire of his guns—to construct their bridges and to cross the river. That they were able to be successful here was possible only on account of the overwhelming superiority of their artillery and notably on account of the aid given by their heavy field howitzers.

It may be taken for granted that the Russians did not know of these howitzers being with the 1st army. Even if they had known of their presence, it would have been difficult for them to have discovered their masked positions, assuming that the pieces had been brought up with sufficient precaution. And even if the positions had been discovered, the Russians would not have been able to do anything to the guns, because they themselves had no curved fire pieces and could not hit the howitzers with their field gun batteries. Their field mortar, of obsolete model and of little mobility, with its short range, would have been equally inefficient against the superiority of the modern long range pieces.

The howitzers took up positions southeast of Wiju, concealed from view of the enemy and protected from direct fire. Two places of observation, one on

* Some accounts say there were 36 howitzers.—TRANS.

each flank, were used and from them ranges and information concerning the enemy were transmitted to the guns by telephone. According to opinions often expressed, it would seem absolutely wrong to use indirect fire against a visible objective. Here the Japanese have, it appears, committed this supposed mistake, and with great success for themselves. Although up to the present time nothing exact in regard to the role of heavy field artillery has been learned, nevertheless we can establish with much certainty the following points:

The heavy artillery has taken first as its objective the enemy's field batteries. As, thanks to its concealed positions, it cannot be disturbed by the enemy in its methodical and accurate activity, it should very soon silence the opposing batteries at the point of crossing. A similar example of the superiority of curved fire has already been furnished by the battle of Domokos in the Greco-Turkish war, in which a heavy battery of howitzers of the Turks silenced in a very short time a division of Grecian field artillery.

Then the heavy artillery should drive off the infantry from the place where the bridge is being built, by taking the opposite bank of the river completely under its fire.

On the evening of April 30th, the bridge was finished. In the night of April 30th–May 1, the Guard crossed the river, while the howitzers were transported by means of rafts to the islands in the Yalu, in covered positions, in order to support the advance of the infantry at day-break. The fact that it was possible for the infantry to cross, without being annihilated, the broad plain of 1200 meters which was in front of the Russian position, can be attributed only to the superiority of the artillery, and, according to all accounts, above all to the heavy artillery.

The official military journal *Russki Invalid* gives the greatest credit to the Japanese howitzers. Other journals make mention of their terrible fire effect, and the German and English correspondents bring out particularly the considerable part played by these pieces in the rapid success of the crossing.

The Japanese have proven that they appreciate the importance of this new field piece, and that they know how to profit by it. That they have, in spite of transport by sea and of the horrible roads of Corea, been able to bring these heavy guns into battle, and the extraordinarily great efficacy of fire of these pieces, ought to be convincing proof of the utility of such guns for a field army.

* * *

The graphic description by correspondents from Tsing-Tao of the attack on the Tsarevitch serves to strengthen one of the lessons of the naval war. The Japanese ships seem to have made a vigorous onslaught. Especially is this the case with the Mikasa, which throughout the war has been in the forefront as Togo's flagship. Yet the armor plating of the Tsarevitch on belt, barbette, or conning-tower has not been penetrated. The Japanese ships have nearly all Elswick guns, and, although not of the most powerful length now advocated, they are more than equal to the $2\frac{1}{2}$-mile range at which the Tsarevitch was attacked. The explanation is to be found rather in the type of projectile used. They were explosive shells, and they certainly did severe execution against the officers and crew, and against the light structures of the ship. But, as in field operations, so in a naval fight, the aim is to stop the enemy, not to take life, and a few shot of armor-piercing power, to perforate the broadside at the water line, whereby the ship would have been sunk, or to penetrate into the casemates or barbettes, whereby the guns would have been disabled, would have been worth hundreds of the explosive shells. The thickest part of the Tsarevitch belt is $9\frac{3}{4}$ inches, and the Elswick 12-inch gun of 40 calibre in length develops an energy of 33,318 foot-tons, and when using the newer type of capped shot could have at 4,000 yards range penetrated a greater thickness of Krupp steel. The capped shot has often obtained this result, and the suggestion of the result in this case is that none of our ships now in commission can with ordinary shell, and with the now comparatively low velocity of 2400 feet per second, do sufficient damage to the modern Krupp armor-clad ship unless projectiles are fitted with these caps.—*U. S. Gazette.*

* * *

The statement that the Japanese fired sixty torpedoes, all of which missed, in the recent naval battle, has had a most tonic effect. A few months ago the torpedo, judiciously boomed, threatened to oust the gun altogether; now it is in considerable danger of being underestimated. Very possibly the sixty will turn out to be only one of those brilliant flights of imagination with which the Russians so skilfully met the weekly sinkings of some of their ships by Admiral Togo.

* * *

The detailed story of the sinking of the Rurik proves, what most naval men suspected all along, that she was not sunk by gun fire, but by her own crew when all hope of further fighting was past. Every gun appears to have been disabled, and this, of course, was exactly what was anticipated in the unprotected covered-in battery. No doubt the Rossia sustained losses little less grievous, but her steering gear not being injured like the Rurik's, she was able to steam away. The Gromoboi, according to the latest accounts from Vladivostok, was very little hurt. As her guns are in casemates, proof against most of the Japanese guns, this is probable enough.

Submarines.

The Italian submarine boat Delfino is built of steel plates 1.2-inch in thickness. She is cigar-shaped, her length being 78.74 feet and her beam 9.5 feet. Her displacement varies, according to the extent of her submersion, from 95 to 107 tons. Her engines are worked solely by electricity furnished by 300 accumulators. She has three propellers; one aft for movement ahead or astern, and the other two above for the work of submersion and emersion.

The little turret is glazed so that a lookout may be maintained when the boat is submerged. Her sole armament consists of two torpedo tubes forward. Her oxygen supply is not sufficient for officers and crew more than twelve in number.

Admiral Fournier having completed his inspection of the mobile defenses at Cherbourg, has issued the following memo.: — "The Vice-Admiral, Permanent Inspector-General of mobile defenses and submarine stations, congratulates the seven lieutenants commanding submarines on the result of the torpedo attacks made on the "Flamme" in his presence, all the torpedoes having struck the object aimed at and run perfectly straight. This reflects the greatest credit on the crews of the submarines at Cherbourg, both as regards the care and adjustment of the torpedoes, the accuracy of the shots, and the precision with which the boats were maneuvered by their commanders, and shows the military value of the training received under the enlightened Capitaine de fregate Mottez."

Vice-Admiral Fournier has given the following evidence on the submarine question before the Extra-Parliamentary Committee on the Navy :

"As regards the submersible type, the torpedo attacks made in his presence were completely successful. In their voyage from Cherbourg to Brest these boats encountered a heavy sea, behaving as well as torpedo boats; these results induced him to recommend the construction of more submersible boats. In comparing them with submarines proper, he considered the latter to be more useful for defensive purposes in the case of bombardment or blockade by an enemy. If the Russians had had submarines, the Japanese operations at Port Arthur would have been almost impossible. The electrically propelled submarine is silent and invisible, and no defense against its attack has up to the present been devised ; its radius of action is, however, limited, and its habitability bad, as on account of the small freeboard, even when not immersed, it is obliged to navigate closed up, necessitating a great strain on the crew.

"Also should it be necessary to send one of these boats some distance it would have to be towed, and it is found that the movements and violent and peculiar motion in this case is such that no one can resist sea-sickness.

"I am not," continued the Admiral, "as has been stated, in favor of submarines against submersibles ; I favor both types, as each has its advantages, the submarine being useful for defending a roadstead, and acting at short distances from the coast.

"The submersible is, so to speak, a double vessel, which can navigate on the surface like a torpedo boat, when its crew, being in the open air, give it a direct superiority, as regards habitability, enabling it to carry on operations at a considerable distance. If we had a sufficient number of submersibles, by a careful disposition of them we should be able to cut all the great maritime routes, and also most efficiently protect the coasts of France and our colonies.

"The length of time which it takes a submersible to make a dive has been over-stated. I have found by several trials that the time is not more than 5 minutes, which is also the estimated time for the large submarines now projected.

"Answering a question by M. Jaures, the Admiral replied that in war time, every submersible should be accompanied by a destroyer. He did not consider it to be advisable to limit naval construction to this type of vessel alone, a change might be made in ocean routes, and the radius of action of submersibles is limited, and it will always be necessary to build large ships ; in his opinion, the large warship of the future will be something between an armored cruiser and a battleship with a very great radius of action.

"Asked by M. Vazeille whether M. Pelletan had consulted him about stopping the construction of submersibles, the Admiral replied that he had not been consulted, and that after each of his inspections he had reported in favor of constructing more submersibles, and had received no reply. As regards the *personnel* of the fleet, when the new naval programme is complete there will be a deficiency in numbers, not in the ordinary seaman class, of which as many can be obtained as required, but among specially trained men."

—*Journal of the Royal United Service Institution.*

New Battleships, Nelson Class.

Tenders for the new battleships of the Nelson class were invited towards the end of August. The chief characteristic will be the great gun power. The design is to ensure a high gun platform, and in the new Nelson class there will be no guns on the main deck as in earlier ships. All of them will be on the upper deck, which will give them a more distant horizon. The guns will be more powerful. There will be two barbettes—one forward and the other aft, and in each there will be two 12-inch breech loaders. The secondary armament will consist entirely of 9.2-inch guns. In the King Edward VII. class there are four of these guns, in addition to ten 6-inch quick-firers, but in earlier ships there were twelve or fourteen 6-inch guns only. There will be in the Nelson class ten 9.2-inch guns, which will make them by far the most powerful ships afloat. Twin 9.2-inch guns will be mounted in turrets at the four quarters of the citadel, and a single gun in the center on each side. These guns will be built into the upper deck, which is to be heavily armored, the mechanism and mounting being protected by armored hoods or turrets. Thus the broadside of 9-inch Krupp armor will be utilized for protection from broadside attack. and the main armored bulkheads forward and aft for shielding the gun mountings from raking fire. The broadside armor will not be weakened by openings, and the lower parts of the gun mountings and ammunition hoists will be effectively protected. The displacement will be about 15,000 tons and the speed about 19 knots.

The Protection of Battleships Below the Waterline.

PROTECTION AGAINST SUBMARINES.

In the course of a valuable essay contributed to the Royal United Service Institution,* and recommended to be printed by the referees, Commander Murray F. Sueter calls attention to the submerged microphone, invented by Admiral Makaroff, of the Russian Navy, and supposed to indicate the whereabouts of torpedo craft or submarines. This, he says, is no new idea. Microphones have been used for many years in informing the defense of the approach of attacking boats. Unfortunately, it gives no idea of direction, distance or depth—three rather useful factors. We may say, without much fear of contradiction, that the defending ship would suffer severe nerve tension if the approach of an invisible enemy was known, and that the knowledge hardly contributes to defensive measures.

The hydroscope, by which submerged vessels are to be located by sight, needs scarcely any comment. It is extremely difficult in a submarine running submerged to see more than a few yards even in clear water, and it is unlikely that the instrument will ever be developed sufficiently to be of much value, so as to enable a surface vessel to observe a submarine under water. For the same reason, the proposal to sight submarines from balloons has proved indifferent when experiments have been carried out.

DEFECTS IN EXISTING SUBMARINES.

The chief defects of present submarines as offensive weapons are :—

1. Low speed.
2. Comparatively small radius of action.
3. Limited range of vision.
4. Enervating effect on crews.

* The subject of the entire essay, as printed in the Journal of the Institution, was "In the existing State of Development of Warships and of Torpedo and Submarine Vessels, in what manner can the Strategical Objects formerly pursued by means of Blockading an Enemy in his own Ports be best Attained ?

We may assume that these defects are not likely to be remedied entirely, but improvements may be expected. The destroyer is the development of the first torpedo boat, and similarly fast submarines will probably emerge from the embryo type.

Admiral Aube advised that submarines should be carried on board ship, and dropped at the psychological moment. Experience has, however, shown that this was not very successful in the case of torpedo boats. The Hecla was the first depot-ship in our Navy. Built originally for the merchant marine, she carried ten second-class boats in crutches on her superstructure, and was able to hoist them out in a moderate sea-way. After her came the Vulcan, which was built in 1889, and is a well armed cruiser with a speed of about 18 knots. She carries six second-class boats 60 feet long, with a speed of 16 knots, and has powerful hydraulic cranes and derricks. In 1895 the French built the Foudre, which is also a well armed cruiser of 18.5 knots. She carried at first ten aluminum second-class boats, having a speed of 16 knots, but the aluminum hulls of these boats were not a success, and this metal was afterwards replaced by steel. She resembled the Vulcan in carrying powerful cranes. Since these types have not been repeated in recent years it may be agued that they have never been considered a very great success. The increased weight of the submarine over the torpedo-boat makes it doubtful if submarines will ever be carried afloat—certainly not until electric storage batteries can be dispensed with and the design made very much lighter than at present.

EXPERIMENTS WITH SPAR TORPEDOES.

These reflections show that there is at present truth in the English view of the submarine as the weapon of the feeble Powers. The line, however, between offense and defense is hard to draw. and it is possible that ships may be compelled to come within the sphere of influence of defending submarines. Hence we may ask: What means of protection can be suggested against such a danger? Various proposals have been put forward. It has been said that a submarine can be easily destroyed by a battleship with quick-firing guns. In this case it is assumed that a submarine must always come to the surface to take bearings, and must be exposed to gun fire, if only for a few minutes. But this is unnecessary in the modern type of submarines. The approved antidote to the submarine is a spar with a guncotton charge at the end. This is attached to the quarter of a destroyer, which chases the enemy, as soon as the latter is visible. The spar is swung out, and when over the submarine it is detonated. Experiments with the spar torpedo are reported as being quite successful—when the submarine is seen! The Americans placed live animals in a submerged tank, and exploded charges at various distances. The animals were quite unhurt. An experiment, it is reported, was made recently at Cherbourg with a slightly different object. It has been said that a submarine could not fire a torpedo at a short range, because the risk of suffering in the explosion would be too great. Several sheep were placed in the Naiade which was under water, and torpedoes were exploded at different distances. Since the sheep were not hurt, officers took their places, but the explosions had no effect beyond increasing the pressure on the hull.

An admiral recently said: "We want howitzers firing shell at an elevated trajectory, which will explode at a given depth beneath the water." It is as yet impossible, however, to destroy a submarine by an explosion produced under water by gunfire. Up to the present we do not possess a single gun which can send a projectile any distance under water. When a projectile strikes the water its nose is thrown up on impact. The base of the projectile dips in lower, but scarcely more than a foot or two before ricochet occurs. A lucky shot might carry away the periscope and prevent observations, but can do no damage to the boat's power of maneuvering under water. It is often thought that the excess of speed possessed by a battleship or other surface vessel would ensure evasion. This may be so on the assumption that the presence of the enemy was apparent; but what if a fleet came within the meshes of a careful submarine boat plan? We have only to imagine the plight of a single ship within a triangle formed by three submarines with periscopes at most visible. Speed will not be of much avail, and a short time would place the ship out of action for all practical war purposes.

DESTRUCTION OF SUBMARINES—A WAITING GAME.

Good as the torpedo destroyer is, it is doubtful if this type is adapted for the new task of destroying submarines, because: 1. It has a large turning circle. 2. It offers a large target both to the surface and sub-surface vessels. 3. It is easily put out of action by gunfire, and the crew are unprotected. The destruction of submarines must be a waiting game, and they will be caught only when they come to the surface through any of the following causes:—

1. Entanglements by nets or hawsers, or injury from a guncotton charge.
2. Exhaustion of electric batteries.
3. Defects to internal mechanism.
4. Defects to external gear of diving rudders, and the like.
5. Bad fumes, producing the collapse, or partial collapse, of the crew.
6. If the periscope is shot away, a porpoise-like rise and dive may be necessary for obtaining a bearing.

The submarine destroyer should therefore possess a high speed to enable her to avoid cruisers. It is thought that she should be designed to offer a small target, as it may be necessary to work in the vicinity of an enemy's fortified port in seeking hostile submarines. A small target is also necessary to enable a destroyer to escape easy detection by submarines. The design of the modern submarine presents a line of thought as to the best form which a submarine destroyer should take. Admiral Henderson recently said in a lecture that the present shape of ships is likely to be stereotyped. But it cannot be doubted that, when the results of sub-surface navigation are better known, the present theories of construction may undergo a change. The following is a suggestion in the present case: The submarine destroyer should be a large surface boat capable of altering her trim by taking in water ballast, so as to lessen the target exposed to the enemy. The upper work should have a turtle-back shape, and armored, which will cause projectiles to glance off. Navigation should be from a conning-tower having an all-round vision, and funnels* should be abaft the conning-tower. The conning-tower would, of course, have to be armored. The upper portions of the funnels would be made telescopic, for use when travelling at high rates of speed. A mast would also have to be carried for wireless telegraphy aerial wire to be hoisted to. The construction of submarine boats would be copied in many ways, and the water tanks for lowering trim would also act as water or compressed air protection against a torpedo launched at her from a submarine. Her armament would consist of two 12 pounders and four 18-inch torpedo tubes.

* Oil motors would dispense with funnels.

PROTECTION AGAINST THE EXPLOSION OF A TORPEDO.

Such are the methods which may be suggested as best suited for fighting against submarine boats. But it is not to be expected that ships will be able to avoid torpedoes any more than they can avoid being struck by projectiles. In short, we want ships constructed with some protection against torpedo attack. Means must be taken to minimise the damage which may be caused by explosion of a torpedo some ten or twelve feet below the waterline.

The modern battleship expends quite 30 per cent. of her displacement in armor to protect her from gunfire, but the minimum fraction is devoted to defense against torpedoes. A torpedo under present conditions would destroy a very large percentage of ships struck by it, and it would appear that naval architects are not following the teaching of modern science. Perhaps the lessons learnt from the Belleisle may have influence. The Majestic pounded the Belleisle at short range for twelve minutes or so. If a crew had been on board, even during such a severe handling, the actual waterline hits might with some difficulty have been plugged, and little damage have been done to affect the stability. The reason of her settling down on the shoal off Chichester is said to have been due to water coming in from a few waterline hits plus the water pumped into her through all her fire pumps to guard against fire. There is no outlet for this latter. If we compare this with the damage done by the explosion of a torpedo, the advantage is plainly with the torpedo. The Belleisle collapsed under one explosion of the latter; it would appear that the effect outran all anticipations. Although the immediate object of the test was not realized, important data must have been given as to the destructive effect of a torpedo, as, from press reports, we learn one-sixth of the ship was destroyed, a section of which had been specially strengthened from the bow to the citadel and across to the boiler room, but the whole portion was so wrecked that divers could not enter.

The extreme accuracy of the modern Whitehead torpedo, fitted with gyroscope, or Obry apparatus, renders a change in construction necessary, and this is shown by the recognition of its increased range. The British navy now has a 3,000-yard torpedo; it is natural to expect that this will be still further increased, and recently there was a report that the Austrian Government is experimenting with a new invention which brings the range of the torpedo up to 3,800 yards. It should be remembered that all nations have adopted the gyroscope for their locomotive torpedoes, and have turned a somewhat erratic weapon into a reliable engine of war, whose influence is more and more attracting notice as the chief and most deadly weapon of modern warfare. This increase of range and of accuracy cannot be too strongly emphasized. Search lights carried by most ships are of little use outside a 2,000-yards range, and even at this distance the ray can generally be passed through in safety. It is extremely unlikely that a destroyer would be picked up outside this limit and even if she discharged her torpedo as soon as observed, the torpedo would have a fair chance of hitting, particularly if there were several ships in company.

Naval architects have not yet produced a torpedo protected ship. The only attempt is the crude torpedo bulkhead, as constructed in the Russian battleship Tsarevitch, and in some French battleships. Designers in foreign navies have had the idea of armoring the ship below the waterline as a protection, but this plan has been abandoned, and it is known that rigid armor plates, with many butting joints and armor bolts, are no defense against the shattering effect of a torpedo. The ductility of lead has received attention, and lead envelopes in the compartments have been suggested.

It was thought that American cornpith cellulose, if placed behind a plate, would swell on contact with the water, and thus fill up the hole and stop the inrush of water. It is hardly surprising to learn that the cellulose was sent into the air before it had time to get wet. The idea that coal in a bunker would stop the effect of an explosion is equally unsound, because loose coal would suffer the same fate as the cellulose. A hanging net defense is useful for a ship at anchor, and if not very effective against modern net cutters, gives the crew a feeling of security which might be useful in increasing the efficiency of night gunfire, and in lessening the strain of long watches. Nets are of little use for ships under way, unless they are prepared to steam at very slow speeds.

It has long been recognized that a cushion of water or compressed air are the best agents for minimizing the explosive effect. It may be said that there are no really reliable methods. Future designs should allow for ships having water or compressed air protection. By a greater system of cellular division, and by increased rapid flooding arrangements, with corresponding pumping facilities, it is thought that injuries from torpedo or ram might be minimized.

It seems that compressed air would minimize the effect of a torpedo explosion below the waterline more than anything else, as a large volume of air would escape when a fracture occurred and partly counteract the explosive effect. The air compressors could always be kept going in dangerous waters, and a sufficient pressure maintained in the tanks to be of great service ; this would offer no great difficulties, as the ballast tanks of a Holland submarine frequently retain air pressure for a considerable time to counteract leaks from a faulty Kingston valve or leaky rivet.

It is also difficult to foretell the value of a cushion of water without exhaustive trials. In this case, if water is present and helping the outer shell, should this plating be shattered, only the particular compartment or the adjoining one damaged, there would be no change in waterline, and if a serious leak did occur other tanks could be pumped out, thus lightening the ship.

The rearranging of bulkheads and sub-division should make a ship almost unsinkable against a torpedo attack, because whatever damage is done the inrush of water is so much located.

Battleships and cruisers should be modified and split up into cellular compartments. Whatever material might be introduced in the spaces, the most important feature is the subdivision into a tank system with a water or air service, pumping facilities, etc., well developed, and under perfect control.

—*Page's Magazine*, September.

BOOK REVIEWS.

Great Captains: Napoleon. A History of the Art of War, from the beginning of the French Revolution to the end of the Eighteenth Century. Theodore Ayrault Dodge. In four volumes. Vols I. and II. Boston and New York: Houghton, Mifflin & Co. 1904.

Colonel Dodge's works on the art of war, as exemplified by the lives of the *Great Captains*, are too well known to require comment here. Alexander, Hannibal, Caesar and Gustavus Adolphus have already appeared, and the above two volumes are the beginning of the life of the great strategist, Napoleon, the work constituting a history of the art of war, from the beginning of the French Revolution to the end of the eighteenth century and well into the nineteenth. In natural order the life of Frederick the Great should have preceded the present volumes, but the author has postponed its publication to await the appearance of the volumes on that great leader now being published by the Great General Staff of the German army.

This history of Napoleon is to the military student in many respects the most valuable extant, since the author has not only had the advantage of the study of all the more recent authorities on the subject, but has also studied the history of the art of war through the material from which he derived his works on the earlier *Great Captains*, and has thus a juster appreciation of the condition of the art of war as it existed at the time when Napoleon first put his master hand on it, and evolved new phases of that art,—the *modern* system of troop leading and of strategy.

The two volumes before us carry the history to Eylau and Friedland (1807), and constitute a grand epitome of the art of war as illustrated by the great master's methods of conducting campaigns.

In the author's own words:

"More space has been given to the strategic operations of Napoleon than to the grand tactics of his battles. Wonderful as the latter were, the strategic marches were yet more so. They are not in most histories so amply treated, whereas the keynote of Napoleon's successes was that his strategy so led up to battle that victory became decisive; and to the military student the strategic maneuvers are of perhaps greater interest."

The treatment of the subject-matter is so comprehensive and the author's style is so popular and fascinating, that his works are of interest to all—the general reader as well as the military student—and will be found a valuable aid in general education as well as in the study of history.

The picture presented in these volumes is made all the more complete by the numerous illustrations, comprising many interesting cuts of uniforms, arms and weapons of the times, besides all the necessary maps and plans of battles, and many portraits of the marshals and generals celebrated at the time. The interest in the descriptions of battles is, moreover, enhanced by the fact that the author visited many of the battlefields in person, and thus obtained a nearer view of the landscapes depicted, and a fuller appreciation of the more important details in the topography.

The work opens with a graphic description of the state of *army organization* and of the condition of *tactics* and *administration* at the beginning of the modern era in the art of war, namely, the French Revolution. These elements resulted naturally in two ways: In the first place, they were the natural development of the conditions as they existed under Frederick the Great, but, in the second place, these conditions and developments were greatly modified and improved by the spirit of the Revolution. The greatest improvement effected by the latter was in the *mobility* of the new armies, but other changes also affected the general result, especially in France.

"To resume what has been said, in this period in France a new system arose, suited to the changed conditions, in which the people took part as such, and not as mercenaries. * * * Tactically, open order came into use, with better fire and less loss of life as a result, and it was sustained by columns and squares for attack. The French troops surpassed all others in their new system. Administratively, the creation of divisions was the most important step; and staff duties were made more prominent. Victualing by requisition instead of by magazines grew into use. Tents gave way to huts and other temporary shelter; and the train was markedly cut down. Much increased speed followed the change."

If to this we add the increase in field artillery, and in *light* infantry and *light* horse, which took place at the same time, we have a summary of the great changes effected, and can more readily understand how the master mind of a Napoleon could take advantage of these improvements and teach the world how to utilize them.

The wars of the French Revolution (1792-1795) are treated at some length before the author takes up the life of the great Corsican. The reader is thus in full accord and sympathy with the spirit of the times in which he began to act his part in the world's drama.

It will be impossible in this brief notice to follow the career of Napoleon through his many brilliant campaigns following so rapidly one upon the other, nor is this necessary, as the world is quite familiar with them, but we will content ourself with a few extracts to indicate the author's style and his method of treatment of the subject:

AT THE BRIDGE OF LODI, MAY 10, 1796.

It appears that the storming of the bridge of Lodi was what first gave Bonaparte the idea that he was cut out for great things. Though a handsome affair, it was one which has been many times equaled by other troops; but the young general's vast imagination had been set at work; and later, at St. Helena, the emperor said: "Vendemiaire and Montenotte had not warranted me in considering myself an exceptional man. Only after Lodi did the idea come to me that henceforth I should be a decisive player on the political boards; then arose the first sparks of high ambition." This seems to exhibit a somewhat curious limitation of judgment; for while Lodi was a bold, it was not a great feat of arms.

Bonaparte had imagined that Beaulieu in force stood beyond the river to defend the position of Lodi; and even on the evening of the fight he clung to the idea that he had beaten the whole Austrian army. His resolve under these circumstances to carry the bridge was an act of excessive hardihood, if not rashness, to be gauged by history as many other rash assaults have been—as Gustavus' assault on the Alte Veste, or Sherman's on Kenesaw, have been alternately praised or blamed. Good fortune seconded the courage of his grenadiers. * * * But if Bonaparte merely desired to give a lesson in daring to his opponents, he certainly gave it in good style.

CAMPAIGN OF 1797.

In the opening of this remarkable campaign from Nice to Leoben, Bonaparte had by his operations enunciated and proved the value of the mass theory. In the operations from the Mincio eastward, he had apparently put aside the mass theory, and had divided his forces. This has led to the expression of opinion by some historians that Bonaparte did not believe in or act on his own maxims, that every campaign must open up a new theory of action, and that after all nothing can ever be done by rule. This is in only a narrow sense true. * * * As a fact, no one adhered more fully to his theory of war than Napoleon. * * * And if we study the situation, we readily see, as has been already explained, that the sending of Joubert up the Adige and down the Drave, while he marched east with the main body, was not a division of forces, but a scrupulous care for his base. Joubert was defending off from it the Tyrol army.

AUSTERLITZ.

By 2 p.m. the Russians were surrounded by Davout on the west, Vandamme on the east, and St. Hilaire and Legrand on the east and north. Pribichevski's division, after frightful losses, laid down its arms. Half of Langeron's division was captured, and the other half managed to join Buxhovden. This general, who had been wasting his morning in essays on Tellnitz, when he could have accomplished much more by joining the other divisions fighting at Sokolnitz, with Doctorov's division, strove to reach an outlet to Aujesd by a path between the two ponds. He had no idea that the French were on every side of him. No sooner had his column reached the vicinity than Vandamme debouched from Aujesd and cut him in two. Buxhovden with the head of the column kept on his way, and abandoning his guns, reached Austerlitz; the rear under Doctorov was penned up on all sides, and sought refuge between the ponds. Some two thousand, attempting to cross on the ice, were destroyed by the French artillery, the shot of which broke their flimsy footing. * * * Part of Doctorov's eight thousand men reached Satschan under the fine handling of Klenmayer's cavalry and got away via Neudorf. Guns were abandoned in batteries, and what was left escaped to the mountains on the southwest. This destruction of the allied left wing the emperor had watched from the chapel.

The work is beautifully printed in large, clear type on excellent paper, and the volumes are substantially and tastefully bound; the numerous maps and plans of battles facilitate the study of the operations, and the illustrations still further add to the interest and entertainment of the reader.

The scope of the work is limited to the *military* life of Napoleon, and it endeavors to trace through his military deeds the developments in the art of war during his active career. The work, therefore, has a legitimate *raison d'être*, in as much as this particular field (in spite of the many lives which have been published) has never before been covered by a single work. In this respect it stands alone and is virtually authoritative—the best and most complete interpretation of Napoleon's life work in the light of the developments in the art of war, and the most complete exemplification of the principles of that art as illustrated by his campaigns.

Die wachsende Feuerkraft und ihr Einfluss auf Taktik, Heerwesen und nationale Erziehung. von Reichenau, Generalleutnant z. D. Berlin: Vossische Buchhandlung. 1904.

The work before us is one of the most important that has appeared within recent years in the domain of tactics, and its author, Lieutenant-General von Reichenau is a recognized authority of international reputation.

Its main purpose is to emphasize the constantly increasing *power of fire arms* and of *fire effect*, and to investigate their influence on tactics, organization and the system of national training of armies.

The author contends that the future increase in strength of the world's great armies will consist in improvements in their *quality* rather than in any material increase of numbers, since the possibility of supply and utilizing fully the present enormous masses, counting millions of men, has its limitations, and it is doubtful if a simple increase of numbers would increase their power of action at all.

The most effective line of development is in familiarity with the fire arm, and the ability to use it tactically.

This is the leading thought in the author's argument.

Whatever may be the present views as to the bayonet, saber and lance, there is no doubt that the constantly increasing power of fire arms is slowly but surely relegating these weapons, and the mode of attack which employ them, to the past. The greater the increase in fire effect, the more limited the opportunity for the saber, lance, or bayonet attack.

The author discusses the probable lines along which improvements in fire arms will take place, and considers the perfection already attained in the magazine rifle, the automatic pistol, the rapid-fire field gun, and the latest machine gun, concluding that in future the most important element in war is the *fire arm*, and that victory will depend on the effective use of this arm alone.

After a very thorough examination of the general principles of the use of fire arms, and a careful study of the tactics of the three arms separately, as well as of the arms combined, the author proceeds to the great purpose of his essay, namely, the proper *training* of armies to attain the degree of perfection desired.

As a philosophic treatment of the subject Lieutenant-General von Reichenau's work is classical, and represents the highest form of thought in the domain of the tactics of the present and immediate future.

Exterior Ballistics. By Philip R. Alger, Professor of Mathematics U. S. Navy. 166 p. O. Baltimore; The Friedenwald Co. 1904. Price, $1.25.

This work was prepared for use as a text-book for the Naval Academy, and, as the author states in his preface, its scope is correspondingly limited. High angle fire has been omitted entirely for the assigned reason that it is not likely to occur in naval practice. This is undoubtedly true for the larger guns used exclusively on shipboard. But may it not happen in the future as in the past that ships' crews may be called upon to engage in siege operations on land with the smaller rapid-fire guns or with siege howitzers? If such should be the case formulas and tables for high angle and curved fire would be very useful. The absence of this important division of the subject seems to make the title of the work rather too comprehensive.

The first chapter begins with the definitions necessary to the study of ballistics and is followed by demonstrations of the more important properties of the trajectory in a non-resisting medium. The definitions of "line of position" and "angle of position,"—to the former of which the angles of elevation and of projection are referred,—are particularly good and should be universally adopted.

A partially new system of notation has been employed in this book which must be first learned by an army officer reading it, though he may be thoroughly conversant with the subject treated. No criticism of the notation here employed is intended; but it would be well if a uniform notation were used by our army and navy writers on ballistics. The author's use of R to represent both "range" and "resistance" is a little confusing.

The second chapter, on the resistance of the air, after a short historical sketch, gives on page 19, what the author calls "Mayevski's equations,"—seven in number. The *last five* of these equations, *expressed in meter-kilo units*, are due to Mayevski and were published in the Révue d'Artillerie for April, 1883. They were reduced to foot-pound units by Captain Ingalls, were printed in the second edition of his Exterior Ballistics (1885), and are the basis of Ingersoll's tables for the navy. The *first two* of these equations for velocities greater than 1800 f.s. are due to Zaboudski. They were also reduced to foot-pound units by Captain Ingalls, and the entire seven equations, as here given, were first printed in the introduction to Ingalls' Ballistic Tables (Artillery Circular *M*, 1900). It is difficult to see why the "-10" at the end of the logarithms of the constants A_1 A_2, etc., should be enclosed in parentheses. For example, the first one is printed:

$$\log A_1 = 7.6090480\ (-10),$$

while its value is 7.609480—10; that is, -2.3909520.

In chapters III. and IV. are deduced formulas for the elements of very flat trajectories based upon the Newtonian or quadratic law of resistance. Upon this hypothesis, as shown by Newton in his Principia, an exact expression for the length of an arc of a trajectory may be found in terms of the inclinations of the extremities of the arc and of the corresponding horizontal velocities of the projectile.* Replacing this arc by its projection on the axis of abscissas, as we can do without material error when it is but slightly inclined, an equation between the co-ordinates of the arc may be deduced by a simple integration. The expressions for the range, time of flight, angle of fall, striking velocity, etc., deduced by Professor Alger by this method are quite simple and can often be employed to advantage in the absence of the auxiliary tables used in the army.

The following statement on page 37 seems to be erroneous: "With flat trajectories, and especially when h is small, the danger space is given with sufficient accuracy by the formula:

$$D = h \cot \omega."$$

The fact is the flatter the trajectory the less reliable is this formula. For example, the maximum ordinate of the 600-yard trajectory of the magazine rifle is 5.5 feet, and therefore the entire range is danger space against infantry; while the danger space computed by the above formula is only 379 feet.†

Chapters V. and VI. are taken up with the computation and uses of the ballistic tables of Siacci's method. In these chapters Professor Alger gives the working expressions for computing the space, time, inclination and altitude functions pertaining to the method and some examples of their use. These expressions were first worked out by Captain Ingalls in the winter and spring of 1896, preparatory to the computation of his new tables based on the Zaboudski-Mayevski laws of resistance, and were first published in his Handbook (edition of 1900), pages 244-247. The labor involved in these calculations was considerable, and their adoption by Professor Alger should have been accompanied by some recognition of their origin.

The following erroneous statement occurs on page 57: "The equations from which A_z [altitude function] is calculated are obtained by substituting the successive values of A and n in

$$A_z = -\frac{2g}{n A_2} \int \frac{dz}{z^{2n-1}}$$

and integrating exactly as was done in 47, where the values of T_v were being found. The results are as follows." Then follow the seven expressions for

* Artillery Circular N, pages 239-241.

† Artillery Circular N, page 99.

the altitude function, copied from Ingalls' Handbook (Artillery Circular N) pages 245-247. Professor Alger could not have written this had he actually worked out these expressions. The correct formula for computing these functions, is, using Alger's notation,

$$A_1 = -\frac{2g}{nA^2}\int\frac{dz}{z^{2n}-1} - \frac{Q_1}{A}\int\frac{dz}{z^n-1}\,*$$

where Q_1 is the constant entering into the corresponding inclination function. For the first interval of the table, that is from 3600 f.s. to 2600 f.s., Q_1 was purposely made zero, as it could be at the beginning of the table, in order to lessen the labor of computing the altitude functions for this interval. From this fact it is easily seen that the criticism contained in the foot-note on page 56 is not well taken. In the ballistic table prepared for the 1885 edition of Ingalls' Exterior Ballistics the suggestion of this foot-note was actually carried out. But one learns, or should learn, wisdom from experience, and so in preparing the tables of 1900 a great deal of labor was saved by omitting this troublesome constant. Of course this could not be done for the second and subsequent intervals of the table, and for these the expressions for the altitude function contain *three* terms instead of *two*, as in the first interval.

On page 52 it is stated that the equation

$$d\ (v \cos\phi) = \frac{A}{gC} V^{n+1}\, d\phi$$

cannot be integrated. This equation may, at a glance, be changed to the form

$$\frac{d(v\cos\phi)}{(v\cos\phi)^{n+1}} = \frac{A\, d\phi}{gC\cos^{n+1}\phi}$$

the first member of which can always be integrated, and the second member also when n is an integer. When n is not an integer the second member can still be integrated in a series which converges rapidly for all the values of the variable angle employed in direct fire.† The chapter ends with some judicious remarks on the mean value of $\sec^{n-1}\phi$ adopted by Siacci in order to render the differential expressions for ϕ, t, x, and y integrable, and on the errors committed by making this change.

The reader will find examples of trajectories computed by Siacci's method, and also by quadratures for comparison, in the appendix to the second (New York) edition of Ingalls' Handbook 1890. The following additional computations have been made showing the agreement between the velocities at the ends of certain arcs, computed by the exact formula and by Siacci's approximate formula.

$$\text{Let } V = 2800 \text{ f.s., } C = \frac{850}{144} \text{ and } \phi = 10^\circ.$$

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* Artillery Circular N, page 243.

† For the general expression for v see Artillery Circular N, page 227.

INCLINATION OF ARC.	VELOCITY BY EXACT FORMULA.	VELOCITY BY SIACCI'S METHOD.	DIFFERENCE.	VALUE OF n.
10°00.′00	2800 f.s.	2800.0	0	1.55
9 5. 63	2600 f.s.	2602.6	+ 2.6	1.7
2 22. 79	1800 f.s.	1805.1	+ 5.1	2
— 7 9. 00	1370 f.s.	1372.8	+ 2.8	3
—13 49. 00	1230 f.s.	1234.3	+ 4.3	5
—17 44. 83	1180.8 f.s.	1192.2	+11.4	

$V = 1800$ f.s., $C = 4$, $\phi = 10$.

10°00.′0	1800	1800	0	2
4 3. 7	1370	1372	+2	3
0 20. 2	1230	1230	0	5
—14 29. 7	1026	1026	0	

$V = 1800$ f.s. $C = 4$, $\phi = 20°$.

20°00.′0	1800	1800	0	2
14 39. 3	1370	1382	+12	3
11 23. 5	1230	1238	+ 8	5
— 7 00. 0	970	951	—19	3
—29 39. 7	942	936	— 6	

$V = 1800$. $C = 4$, $\phi = 30°$.

30°00.′0	1800	1800	00	2
25 19. 6	1370	1400	+30	3
22 32. 0	1230	1256	+26	5
8 33. 9	970	938	—32	3
42 55. 7	947	945	— 2	

The last angle given in the first column of each of these tables is the angle of fall. It will be seen that when the final arc of a trajectory is described with a resistance varying as the cube of the velocity, Siaçci's method gives the striking velocity very nearly correct even when the angle of departure is as great as 30°.

Chapters VII. and VIII. are devoted to the solutions of ballistic problems. As the work contains no tables of the auxiliary functions (indeed no mention is made of these labor saving devices) some of the problems are solved by the laborious tentative processes so well known to the older artillery officers of our service, and which were given in the 1885 edition of the Fort Monroe text book. As an instructive example of the difference between the old and new methods of solving ballistic problems, take the example worked out on pages 74 and 75. The first thing to be done by both methods is to compute the auxiliary quantity A, or what is the same thing, sin $2\phi/C$. This is found to be 0.05180. With this by the new method we find by simple interpolation from the proper table,

$$Z = \varDelta\ S = 4800 + \frac{14300}{160} = 4889.4.$$

Compare this with page 75.

It may be, and has been, objected to these auxiliary tables that they are very voluminous. So they are. But as they have been computed and published there seems to be no valid reason why midshipmen should not have the benefit of their use. If only the auxiliary quantity called "A" were retained and all the others discarded, there would be a great saving of labor in the solution of some of the most important ballistic problems, and the table would not then be very bulky.

The author has adopted the method given in Artillery Circular N, page 57, for determining an approximate value of u_ω by means of the time functions. He has also adopted two-thirds of the maximum ordinate for the mean height of the trajectory, first employed by Ingalls.

Of the remainder of the work, Chapter XII. on Range Tables, is very interesting and valuable. The last two chapters on the accuracy and probability of gun fire are well written and contain about all that it is necessary for an artillerist to know on this important subject. The author has made considerable use of the table on page 163 of Ingall's Handbook, (Artillery Circular N, of 1900). Also of example 16, page 175. He has thus saved himself a great deal of tedious labor.

The text is followed by three tables. The first is a table of the ballistic functions and extends from u=3600 f.s. to u=500 f.s. It is reprinted from Ingalls' Ballistic Tables (1900) for which due credit is given in the preface. The table is well printed, but its use would have been less fatiguing to the eye if the same type used in the text had been employed. The second table contains the corrections to be applied to the ballistic coefficient for changes in the density of the air from the standard density of half-saturated air. The third table gives the altitude factors computed by the formula

$$f = \left(1 - 0.29\ \frac{h}{H}\right)^{-2.451}.$$

The author does not show how this formula is deduced, but as it would make the density of the air zero at a height of 18.9 miles it cannot be generally true. If it is correct up to a height of 12900 feet, the limit of the author's table, it would be interesting to know when and why it ceases to be correct.

The work is well provided with illustrative examples, many of which are fully worked out. The press work and paper are all that could be desired. The breaking up of formulas—putting half on one line and the remainder on the next—which frequently occurs, cannot be pleasing to a mathematical eye.

JAS. M. INGALLS,
Colonel U. S. Army, retired.

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*"La guerre est un métier pour les ignorans,
et une Science pour les habiles gens."*

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COAST DEFENSE.

CHAPTER I.

GENERAL CONSIDERATIONS.

The defense of the seacoast of a nation is entrusted to the coast fortifications and to the navy, the part taken by the latter being determined by the extent and character of the seacoast, the size of the mercantile marine, foreign possessions, whether or not the nation is self-sustaining, and the foreign policy of the government.

To a nation like England whose existence depends upon the maintenance of her commerce, a supreme navy is a necessity. But even England with her two-Power standard finds it necessary to provide strong coast fortifications, in order to free the fleet, defend the naval bases, and protect the vital points along the coast in the case of a temporary loss of sea power. The necessity is recognized not only of securing her naval bases, but of defending her important cities against attack during the period at the outbreak of war when the command of the sea is unsettled. The command of the sea will not be determined at once; it must be gained by force of arms, and even a navy the size of England's should not be compelled to leave behind a portion of its ships for home defense. Lieutenant-Colonel May, R.A., writing in 1903 says: "No prudent statesman would be content with nothing at home behind the navy. If naval bases are to be fortified to gain time it is necessary to make our central citadel secure against unforseen contingencies also. Otherwise, the appearance of a few hostile cruisers off our coast would create a panic. Our fleet would be ordered back to home waters, and, in place of going to meet their opponent, they would have to wait for him to come to them."

These considerations have demanded of England the provision of heavy coast fortifications for home defense, and the same is true of all other European Powers, those having the largest navies being the ones having the best coast defenses. It is sometimes urged by ardent naval advocates that with a large navy there is no place for coast fortifications in home defense. That England, with a navy greater than the combined navies of any other two Powers and a limited seaboard, feels compelled to provide such fortifications, shows the fallacy of this argument. How much more marked is this necessity for us? If for any reason the interests of our country should demand a navy superior to that of any other, this in itself would be far from insuring the protection of our coast. If our supremacy at sea was temporarily lost, or for a short period was unable to assert itself at the right place, our ports would be endangered. The great extent of our seaboard on both sides of the continent and the distance of our eastern possessions, all calling for a wide division of our naval forces, would make provision necessary against these contingencies, whatever the strength of our navy. This extent of coastline also renders it very unlikely that our fleet would be able to fall in with a fast and homogeneous squadron of the enemy bent on the attack of our coast. A portion of the coast might be guarded but all of it could not. In the absence of fixed coast defenses a raid on any one of our important seacoast cities would result in great damage and a disastrous moral effect. This too is not proper work for the fleet which should be left free for offensive operations. Coast fortifications increase at once both our offensive and defensive powers. If the naval resources are to be applied to the best effect, our fixed defenses should be such as to require that no ships be needed to supplement them. Any means that can be obtained to secure this end is an addition to our naval power.

"One of these lessons of the Spanish-American war was the demonstration of the value of coast defenses in supplementing naval action which it affords. The absence of coast defenses then so injuriously affected the action of the American fleet, and supplies so excellent an illustration of how ships and forts may be of mutual support, that a few words on a subject intimately connected with home defense may be added here.

"Those who decry fixed defenses on the coast are wont to dwell on the superior value of mobile naval forces, and their arguments have often been met with the reply that if the defense of our coasts were to be entrusted to ships alone there would be a considerable risk that the defensive force would very probably be removed, and would leave its charge open. It is perfectly consistent with the full recognition of the powers of mobile forces, such as I myself have just expressed, to point out that in the case of naval forces a distinct danger in thus leaving important places open does exist. The peculiar characteristics of fleets and ships, exhibited more especially in their powers of evasion which have been dwelt upon in a previous chapter, lie at the root of this form of risk; but that it does exist in more than theory is vouched for by the experiences of the Americans on their Atlantic seaboard during the late war.

"Stationary objects such as seaports, harbors and estuaries can be defended by stationary works, and stationary works are both more economical and more effective than floating batteries. Naturally, then, they should be called in to our aid when possible, more especially when by doing so we shall release other forces for active duties, but also because they cannot be taken from their special tasks.

"During the American war the six monitors intended for coast defense were diverted from that object and sent to distant points. Two even went as far as Manila. The long coastline of the United States was notoriously inadequately defended. What produced uneasiness in professional men quickly engendered panic amongst the populace. We read of unmeasured, irrational, unworthy terrors amongst the inhabitants of the Atlantic seaport towns. Contemptible very possibly, and ill-founded beyond doubt, but still real, actual, transitive, and therefore not to be disregarded by a popularly constituted government.

"A government whose existence depends upon an electorate cannot disregard popular clamor and the feelings of the multitude, and without some permanent protection to our coast it would be in the power of an enemy seriously to embarrass the policy of our country by working on the weaknesses, fears, and ignorance of the population.

"Because the American coast defenses did not inspire the masses with confidence, the government had to use the navy to supplement them and make good their inadequacy; and the fleets, whose true rôle, as has been explained, should have been an offensive one, had to be content in the first place with a defensive attitude." *

It is now generally conceded that harbor defense vessels have little value. With their slow speed, limited radius of action and unseaworthiness, they could, when united in a fleet, command but a very limited portion of the coast. If distributed and assigned to harbors they are far less efficient than fixed defenses, as they have a much smaller and less accurate fire than the latter, are decidedly more vulnerable and are much more costly, both as to first cost and to that of maintenance.

In addition to the defense of purely commercial ports, a navy requires well protected coaling stations and naval bases. Fuel is as necessary to a fleet as food to an army, and the former, unlike the latter, cannot draw its supplies from the theatre of operations. Coal, however, is bulky and is what ships will most urgently require. Coaling stations, therefore, well defended, should be provided on all routes leading to possible theatres of war. There must be provided also well defended naval bases, well provisioned and supplied with coal and ammunition, from which offensive operations could be undertaken, and in which, in the event of a temporary disaster, a fleet could find shelter and accommodations for repairs, and be enabled to await in security the arrival of reinforcements.

The first necessity in home defense is, therefore, a system of coast fortifications sufficient to free the fleet, give confidence to the population of the country, afford bases to the navy, and last and most important, protect our important cities, whether during the absence of our fleet or in the case of a temporary, or a complete and final loss of sea power.

Our needs in the way of home defense may be judged from a consideration of our seaboard. "The seaboard of the United States on the Atlantic and Gulf coasts exceeds 3000 miles, on the Pacific, not including Alaska, it is half as much more.

"Northward from New York City the shore is generally bold, with many good harbors; but southward, and including the Gulf, the coast is bordered by a cordon littoral of sand, through which entrances deep enough to admit modern ships of war are few in number and generally difficult of navigation. On the Pacific coast the shore is bold and so closely bordered by mountains difficult of passage as to leave only three or four important harbors until Puget Sound is reached.

* From "Principles and Problems of Imperial Defense," Lieut-Colonel E. S. May, R.A.

"Upon the whole extent of the Atlantic, Gulf and Pacific coasts, there are about thirty ports which demand local protection for their cities now exposed to occupation or destruction, and of these about a dozen are so important as centers of commercial wealth that the entire country has much at stake in their security. Nine out of this number are also important as containing naval stations and depots of supply."

"Strategic considerations of a special character are suggested in connection with Portland Harbor; they give it a prominence to which the wealth and importance of the city itself could advance no claim.

"It is the terminus of the Grand Trunk Railroad and the natural winter outlet of the dominion of Canada. Its importance is perfectly appreciated by Great Britain. Colonel Strang, R.A., in a lecture before the Royal United Service Institution in 1897 used the following language: "Without the Canadian Pacific, Canada is a *cul-de-sac*. The struggling nationality resembles a young giant whose careless parents allowed one nostril to be stuffed up by the loss of the unfrozen seaports of the State of Maine; and now, after giving up Oregon and the San Juan passage, that other Canadian nostril, we are threatened with the secession of British Columbia, which can neither be defended nor traded with. Fortunately at Halifax we have retained some of the *ultimae rationes regum et populorum*. We need not, therefore, discuss the defense of this fortress and harbor, which, however valuable in other senses, can in no sense be considered a safe base for operating in the inland defense of Canada; for the treaty of 1842, which handed over the State of Maine, sends a wedge of territory up to within a few miles of the inter-colonial railroad which a handful of troopers could at any moment render unserviceable in a night, thus cutting off retreat to Halifax or succor from thence to the upper provinces. It is true that detachments were sent from Halifax during the Trent difficulty, but the United States were at that time disunited States.

"The value of Portland as a temporary British naval station during a war with the United States would be sure to attract attention; and if, in case of heavy American reverses, our opponent should be in a position to demand a land indemnity as one of the conditions of peace, as did Germany in the late war with France— to whom the idea doubtless seemed as preposterous at the outset as it does to us to-day—probably no section of the country would be so likely to be desired as this magnificent port.

For this reason it behooves us to hold it strongly against any possible attack. If Metz and Strassbourg had been unoccupied by a German army when the terms of peace were agreed upon, they might have escaped their fate.

"The strategic importance of Boston in a naval war is self-evident. A small force here would cover the entire coast from Cape Cod to New Brunswick against marauding expeditions detached from a fleet operating against New York. It forms the natural base for fitting out offensive operations against Halifax and the St. Lawrence. Lastly, when properly defended, it would afford refuge to the whole fleet of New England fishing and coasting vessels.

"Narragansett Bay covers the entrance to Long Island Sound and all the small harbors on its shores. An enemy passing Montauk Point would leave his communications at the mercy of a much smaller fleet lying here behind land defenses affording security against direct attack. Gardiners Bay, at the eastern end of Long Island would be perhaps a better position; but it is not so easily defended by forts, and it lacks the importance of Narragansett Bay in other respects. Admiral Simpson, in whose professional judgment I have great confidence, has always urged the importance of a large naval establishment at New London, not only from its natural advantages, but also from its strategic relations to Long Island Sound. Should such an establishment ever be created there, the local question of its land defenses would be simple.

"The supreme importance of New York, the commercial metropolis of our Atlantic seaboard, is unquestioned. No demonstration is needed either as to the necessity of local defense or as to the facilities the port offers for offensive sallies in every direction.

"The approaches to Hampton Roads are to be strongly fortified, thus directly covering the navy yard at Norfolk and the city of Richmond, and giving our fleet (supposed to be smaller than that of the enemy) a secure position whence it may issue at will to operate upon his lines of communication if he attempts to enter the bay. Such a disposition will compel him to mask our naval force with a superior fleet before he can attempt interior operations. The only great cities upon the waters of Chesapeake Bay north of Hampton Roads are Baltimore and Washington, and both admit of strong local defense at moderate cost. The existence of such a naval place d'armes at the entrance will therefore probably deter the enemy from making any serious attempt upon the shores of the bay.

"The fleet charged with the general defense of the Gulf Coast would find its principal base on the Mississippi; where, stationed centrally, it could operate at any point between the Capes of Florida and the Rio Grande so soon as the telegraph made the approach of the marauders known. It goes without saying that, in case of war with Spain, Key West would become a place of great strategic importance by reason of its vicinity to Cuba, and the facilities it offers as a base for land operations against that island and for blockading its coasts. Controlling as it does the narrow channel leading from the South Atlantic Coast to the Gulf of Mexico, it must be firmly held in any maritime war, and especially in one with France or Great Britain, which have possessions in the West Indies.

"The relations of San Francisco to the Pacific Coast are similar to those of New Orleans to the Gulf of Mexico; and in addition it would be our base for any offensive operations on the Pacific, at least until a new fortified position at Puget Sound is demanded by the growth of population in that direction." *

The following discussion of naval bases and coaling stations, with an accompanying map, taken from "Imperial Defense" by Lieutenant-Colonel May, R.A., is here inserted, as it shows the necessity for them and affords an excellent study of the principles governing their location.

"A naval base, and the dependence of ships upon it, bears, for example, only a special resemblance to the term as we use it in relation to land forces. Soldiers are accustomed to look to their bases for supplies of all sorts, and only a disaster or bad management is ever expected to interfere with their due delivery. The navy secures the channel of supply so absolutely that the flow proceeds as it would in times of peace. Ammunition, rations, even forage, occupy only a comparatively small space, and the quantities piled up on the wharves furnish commanders with resources that are practically unlimited. Food and ammunition form for the navy, however, only a small part of its needs. Coal is what ships will usually most urgently require, and coal is bulky, and is prone to deteriorate in store. So that even one of our greatest bases can only furnish a great fleet with a reserve that, were the needs of an army in question, would be looked upon as trivial. Provisions and ammunition for three months is but a moderate amount for a base on shore to hold. Yet three months' coal always ready for our biggest fleet is an impossible demand. So that a base abroad can never represent

* "Defense of the Seacoast of the United States," General H. L. Abbot.

the same thing to a fleet as to an army. In peace time replenishment from home keeps the reservoir full, and the fleet need look no further than its immediate base, but in war time it will be different, and the navy, until it has completely cleared the seas of its opponent, will often have to regard England or some coal producing region as its true support. When supplies can come to it direct from thence it will often be desirable that they should do so. Thus a fleet in European waters, even though one of our great coaling stations be nearer to it, may prefer to lean on assistance from home.

"Again, in the case of land forces, the conveyance of food and ammunition from the base, and between the various posts, either imposes an amount of labor on the soldier that seriously interferes with his efficiency, or so encumbers the columns with transport that, while individuals may be well fed and unexhausted, the mobility of the force they compose is destroyed. The conceptions of the general are circumscribed by supply. The brain may guide the army, but food regulates the rate of progress. On the water rations and fighting power move with equal rapidity; the services of combat and supply are combined, only the pace of the fighting-line governs the schemes of the Admiral. At half, or at full speed, on the day of battle, or the day before it, or day after it, in pursuit or in retreat, life on board ship follows generally its uniform course, the seaman gets rest and food with the accustomed regularity, the screw throbs with the same monotony, the ship steams on.

"Moreover, there is no fixed road between any two points. A vessel may leave New York for London, and reach its destination either by steaming round the north of Scotland, or past the Lizard. From Durban to Colombo your course may run either west of Madagascar, or east of Mauritius, as the fancy moves you. On their way to the Cape during the late war, some of our transports touched at Madeira, and some at St. Helena. While on shore we are sometimes at fault because there is no path; at sea is it the number of paths that bewilders us.

"The prevalence or cessation of particular winds, however, formerly set limits to this freedom of movement, and sailing vessels had to study the currents of the air as well as those of the sea, while, now that coal has given greater independence, fuel still circumscribes the activity and enterprise of the most modern ship. Coal-endurance would, indeed, directly govern the number and situation of coaling stations, were it not that many of them were called into existence under conditions quite different

from those which obtain amongst us to-day. As it is, however, there does exist a close relationship between coal-endurance and their positions, and it is this relationship that, indeed, enables us to grapple with certain problems of Imperial defense, which would otherwise present almost insuperable difficulties.

"The protection of a world-wide commerce, and the shadowing of hostile ships, were war vessels really as untrammelled in their choice of a course as the openness of the sea suggests to us—might well prove puzzles for the quickest brain. We should find ourselves contending with the resources of nature as well as those of men. Our foe might be as ubiquitous as the sea itself.

"The aid of coal vessels would not be a source of supply which cruisers that had evaded our fleets could usually count upon, and their own coal capacity could only give them a comparatively short life. But how long will that life be? Opinion amongst those who are not experts will usually be found singularly divergent in the matter, even when ships of the same type are under discussion. It is, indeed, impossible to lay down a fixed standard, because the size, the speed, the purpose for which the vessel is intended, are all factors in the problem, and work out different results.

"Nevertheless, some general information on the subject can be obtained, and some basis for discussion can be supplied by a reference to the coal capacity, which is deemed desirable in the case of various types of warships.

"The excellent "Naval Pocket-Book," founded by Mr. Laird Clowes and edited by Professor Laughton, will supply the information in the case of any particular ship belonging to our own or foreign navies, and will help inquirers greatly. We find, for example, the distance in knots which a given quantity of coal will carry a given ship at a given rate of speed. But the actual speed of ships must vary greatly under different conditions of weather, and according to the cleanliness, or otherwise, of their bottoms. The skill and economy of engineers varies also, and there is an art in utilizing fuel for steamships to the best advantage, just as there is in any other profession.

"The whole question of coal reserves is, however, a very difficult one. The supply of such a fleet as that which we keep in the Mediterranean demands, is so enormous that more than a few weeks' fuel for its furnaces could not be stored in any one place; and while in peace time replenishment could be kept up from England, this would not always be an easy matter in war. The close proximity of a supply of coal such as could only be assured by coal ships, might again sometimes become a necessity. Otherwise, an opponent steaming with full bunkers out of port would be in better fighting trim than the ships that awaited him. Hence it follows that, even if unexhausted, our great coaling stations might not be found sufficiently near at hand, and in such cases coal ships would have to be sent from home to accompany and feed the fleet with fuel.

"However great the coal capacity of a ship may be, she will sooner or later be compelled to renew her supply of fuel. Hence the number and distribution of the coaling stations open to her are a matter for us to study. The most elusive and swift cruiser is yet circumscribed in this respect; and, just as its counterpart, the otter must occasionally emerge from its hidden course to breathe, so must the marauding vessel sometimes seek the shore and coal. At localities, therefore, where we know that our opponents possess refuges and ports, we may waylay and engage them. We find in the existence of such localities a basis on which to work—the known quantity which may help us to solve the equation. Of course, our own ships find their freedom of movement circumscribed in a similar manner, but to a lesser extent, because we have been earlier in the field than others, and are, as regards coaling stations, more liberally furnished than are they.

"The risk of hostile vessels seizing on coal at the ports of weak neutrals still remains to be examined. A sea power strong enough to fight us at all would very likely feel sufficiently strong to override equity and international law, and coal her ships by force when necessary. But this opens up a wide branch of the question which we cannot here deal with, and involves considerations which are beyond the scope of these pages.

"Ships of war have other needs to be provided for, however, besides coal. The floating army, like that on shore, demands water, rations, clothing, ammunition and articles of equipment. Ships require periodical refitment, cleaning and repair. Their guns must be frequently examined, for the lives of our modern ones are but short.

"(A protracted war would necessitate the renewal of some; all would scarcely come out of a great action scatheless. Dry docks are indispensable too, and so are depots and work shops. Wide anchorages that will accommodate many vessels, harbors into which they may put for shelter and rest, are demanded also. Such requirements are felt by every great maritime power, and, therefore, in addition to coaling stations, such places as Gibraltar or Halifax or Toulon, and the stores and docks and work shops they contain, form valuable possessions that must be secured in the strongest possible manner.)"

"In this connection it may be noted that, so far from having too many of such strongholds, we with our world-wide responsibilities, have still too few. A great Imperial dock yard and arsenal in the South Pacific, which would help local capabilities to be equal to the maintenance of our naval power at the Antipodes, is one of the requirements of Imperial defense which is urgent on us."

The article by Captain Mahan, U.S.N., "The Strategic Features of the Gulf of Mexico and the Caribbean Sea," is here reprinted almost in full,* not only because of the study presented, but also because of the peculiar importance of these waters to our own country.

"The Carribean is pre-eminently the domain of sea power. It is in this point of view—the military or naval—that it is now to be considered. Its political importance will be assumed, as recognized by our forefathers, and enforced upon our own attention by the sudden apprehensions awakened within the last two years.

"It may be well, though possibly needless, to ask readers to keep clearly in mind that the Carribean Sea and the Gulf of Mexico, while knit together like the Siamese twins, are distinct geographical entities. The Gulf of Mexico is very clearly defined by the projection, from the north, of the peninsula of Florida, and from the south, of that of Yucatan. Between the two the island of Cuba interposes for a distance of two hundred miles, leaving on one side a passage of nearly a hundred miles wide—the Strait of Florida—into the Atlantic, while on the other, the Yucatan Channel, somewhat broader, leads into the Caribbean Sea. It may be mentioned here, as an important military consideration, that from the mouth of the Mississippi westward to Cape Catoche—the tip of the Yucatan Peninsula—there is no harbor that can be considered at all satisfactory for ships of war of the larger classes. The existence of many such harbors in other parts of the regions now under consideration practically eliminates this long stretch of coast, regarded as a factor of military importance in the problem before us.

"In each of these sheets of water, the Gulf of Mexico and the Caribbean, there is one position of pre-eminent commercial importance.

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"In the Gulf the mouth of the Mississippi is the point where meet all the exports and imports, by water, of the Mississippi Valley. However diverse the directions from which they come, or the destination to which they proceed, all come together here as at a great crossroads, or as the highways of an empire converge on the metropolis. Whatever value the Mississippi and the myriad miles of its subsidiary water-courses represent to the United States, as a facile means of communication from the remote interior to the ocean highways of the world, all centres here at the mouth of the river. The existence of the smaller though important cities of the Gulf Coast does not diminish, but rather emphasizes by contrast, the importance of the Mississippi entrance, They all share its fortunes, in that all alike communicate with the outside world through the Strait of Florida or the Yucatan Channel.

"In the Caribbean, likewise, the existence of numerous ports, and a busy traffic in tropical produce grown within the region itself, do but make more striking the predominance in interest of that one position known comprehensively, but up to the present somewhat indeterminately, as the Isthmus. Here again the element of decisive value is the crossing of the roads, the meeting of the ways, which, whether imposed by nature itself, as in the case before us, or induced, as sometimes happens, in a less degree, by simple human disposition, are prime factors in mercantile or strategic consequence. For these reasons the Isthmus, even under the disadvantage of land carriage and transhipment of goods, has ever been an important link in the communications from East to West, from the days of the first discoverers and throughout all subsequent centuries, though fluctuating in degree from age to age; but when it shall be pierced by a canal, it will present a maritime centre analogous to the mouth of the Mississippi. They will differ in this, that in the latter case the converging water routes on one side are interior to a great state whose resources they bear, whereas the roads which on either side converge upon the Isthmus lie wholly upon the ocean, the common possession of all nations. Control of the latter, therefore, rests either upon local control of the Isthmus itself, or, indirectly, upon control of its approaches, or upon a distinctly preponderant navy. In naval questions the latter is always the dominant factor, exactly as on land the mobile army—the army in the field—must dominate the question of fortresses, unless war is to be impotent.

"We have thus the two centres round which revolve all the military study of the Caribbean Sea and the Gulf of Mexico.

The two sheets of water, taken together, control or effect the approaches on one side to these two supreme centres of commercial, therefore of political and military, interest. The approaches on the other side—the interior communications of the Mississippi, that is, or the maritime routes in the Pacific converging upon the Isthmus—do not here concern us. These approaches, in terms of military art, are known as the "communications." Communications are probably the most vital and determining element in strategy, military or naval. They are literally the most radical, for all military operations depend upon communications, as the fruit of a plant depends upon communication with its root. We draw therefore upon the map the chief lines by which communication exists between these two centres and the outside world. Such lines represent the mutual dependence of the centres and the exterior, by which each ministers to the others, and by severance of which either becomes useless to the others. It is from their potential effect upon these lines of communication that all positions in the Gulf or the Caribbean derive their military value, or want of value.

"The positions which are indicated on the map by the dark squares have been selected, after a careful study of the inherent advantages of the various ports and coast-lines of the Caribbean Sea and the Gulf. It is by no means meant that there are not others which possess merits of various kinds; or that those indicated, and to be named, exhaust the strategic possibilities of the region under examination. But there are qualifying circumstances of degree in particular cases; and a certain regard must be had to political conditions, which may be said to a great extent to neutralize some positions. Some, too, are excluded because overshadowed by others so near and so strong as practically to embrace them, when under the same political tenure.

"In the United States, Pensacola and the Mississippi River have been rivals for the possession of a navy yard. The recent decision of a specially-appointed board in favor of the latter, while it commands the full assent of the writer, by no means eliminates the usefulness of the former. Taken together, they fulfil a fair requirement of strategy, sea and land, that operations based upon a national frontier, which a coast-line is, should not depend upon a single place only. They are closer together than ideal perfection would wish; too easily, therefore, to be watched by an enemy without great dispersal of his force, which Norfolk and New York, for instance, are not; but still conjointly, they are the best we can do on that line, having regard to the draught of water for heavy ships. Key West, an island lying off the end of the Florida Peninsula, has long been recognized as the chief, and almost the only, good and defensible anchorage upon the Strait of Florida, reasonable control of which is indispensable to water communication between our Atlantic and Guif seaboards in time of war. In case of war in the direction of the Caribbean, Key West is the extreme point now in our possession upon which, granting adequate fortifications, our fleet could rely; and so used, it would effectually divert an enemy's force from Pensacola and the Mississippi. It can never be the ultimate base of operations, as Pensacola or New Orleans can, because it is an island, a small island, and has no resources—not even water; but for the daily needs of a fleet—coal, ammunition, etc.—it can be made most effective. Sixty miles west of it stands an antiquated fortress on the Dry Tortugas. These are capable of being made a useful adjunct to Key West, but at present they scarcely can be so considered. Key West is 550 miles distant from the mouth of the Mississippi, and 1200 from the Isthmus.

"The islands of Santa Lucia and of Martinique have been selected because they represent the chief positions of, respectively, Great Britain and France on the outer limits of the general field under consideration. For the reasons already stated, Grenada, Barbadoes, Dominica, and the other near British islands are not taken into account, or rather are considered to be embraced in Santa Lucia, which adequately represents them. If a secondary position on that line were required, it would be at Antigua, which would play to Santa Lucia the part which Pensacola does to the Mississippi. In like manner the French Guadeloupe merges in Martinique. The intrinsic importance of these positions consists in the fact that, being otherwise suitable and properly defended, they are the nearest to the mother countries, between whom and themselves there lies no point of danger near which it is necessary to pass. They have the disadvantage of being very small islands, consequently without adequate natural resources, and easy to be blockaded on all sides. They are therefore essentially dependent for their usefulness in war upon control of the sea, which neither Pensacola nor New Orleans is, having the continent at their backs.

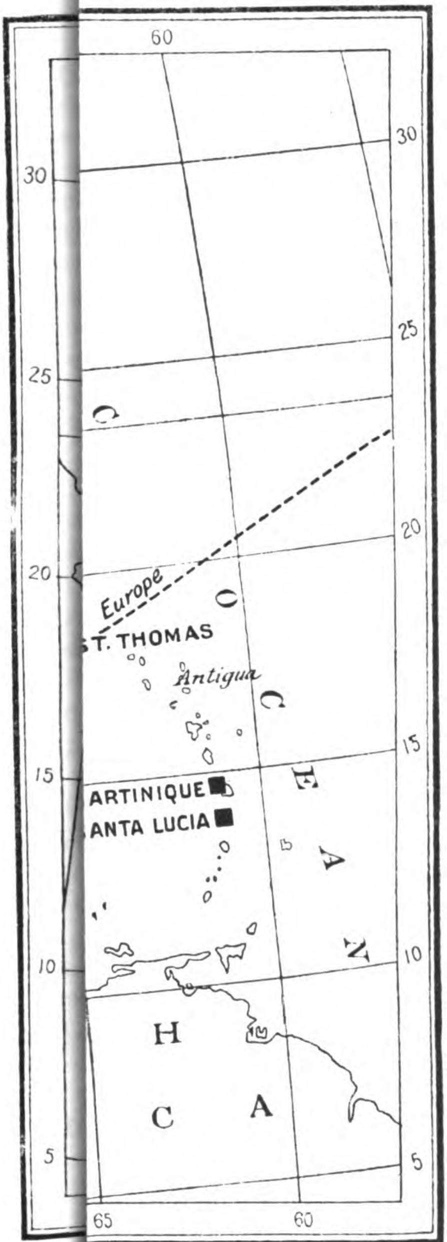
"It is in this respect that the pre-eminent intrinsic advantages of Cuba, or rather of Spain in Cuba, are to be seen; and also, but in much less degree, those of Great Britain in Jamaica. Cuba, though narrow throughout, is over six hundred miles long, from Cape San Antonio to Cape Maysi. It is, in short, not so much an island as a continent, susceptible, under proper development, of great resources—of self-sufficingness. In area it is half as large again as Ireland, but, owing to its peculiar form, is much more than twice as long. Marine distances, therefore, are drawn out to an extreme degree. Its many natural harbors concentrate themselves, to a military examination, into three principal groups, whose representatives are, in the west, Havana; in the east, Santiago; while near midway of the Southern shore lies Cienfuegos. The shortest water distance separating any two of these is 335 miles, from Santiago to Cienfuegos. To get from Cienfuegos to Havana 450 miles of water must be traversed and the western point of the island doubled; yet the two ports are distant by land only a little more than a hundred miles of fairly easy country.

"Regarded, therefore, as a base of naval operations, as a source of supplies to a fleet, Cuba presents a condition wholly unique among the islands of the Caribbean and of the Gulf of Mexico; to both which it, and it alone of all the archipelago, belongs. It is unique in its size, which should render it largely self-supporting, either by its own products, or by the accumulation of foreign necessaries which naturally obtains in a large and prosperous maritime community; and it is unique in that such supplies can be conveyed from one point to the other, according to the needs of a fleet, by interior lines, not exposed to maritime capture. The extent of the coast line, the numerous harbors, and the many directions from which approach can be made, minimize the danger of total blockade, to which all islands are subject. Such conditions are in themselves advantageous, but they are especially so to a navy inferior to its adversary, for they convey the power—subject, of course, to conditions of skill—of shifting operations from side to side, and finding refuge and supplies in either direction.

"Jamaica, being but one-tenth the size of Cuba, and one-fifth of its length, does not present the intrinsic advantages of the latter island, regarded either as a source of supplies or as a centre from which to direct efforts; but when in the hands of a power supreme at sea, as at the present Great Britain is, the questions of supplies, of blockades, and of facility in direction of effort diminish in importance. That which in the one case is a matter of life and death, becomes now only an embarassing problem, necessitating watchfulness and precaution, but by no means insoluble. No advantages of position can counterbalance, in the long run, decisive inferiority in organized mobile force—inferiority in troops in the field, and yet much more in ships on the sea.

"Regarded sorely as a naval position, without reference to the force thereon based, Jamaica is greatly inferior to Cuba in a question of general war, notwithstanding the fact that in Kingston it possesses an excellent harbor and naval station. It is only with direct reference to the Isthmus, and therefore to the local question of the Caribbean as the main scene of hostilities, that it possesses a certain superiority which will be touched on later. It is advisable first to complete the list, and so far as necessary to account for the selection, of the other points indicated by the squares.

"Of these, three are so nearly together at the Isthmus that, according to the rule before adopted, they might be reduced very properly to a single representative position. Being, however, so close to the great centre of interest in the Caribbean, and having different specific reasons constituting their importance, it is essential to a full statement of strategic conditions in that sea to mention briefly each and all. They are, the harbor and town of Colon, sometimes called Aspinwall; the harbor and city of Cartagena, 300 miles to the eastward of Colon; and the Chiriqui Lagoon, 150 miles west of Colon, a vast enclosed bay with many islands, giving excellent and diversified anchorage, the shores of which are nearly uninhabited. Colon is the Caribbean terminus of the Panama railroad, and is also that of the canal projected, and partly dug, under the De Lesseps scheme. The harbor being good, though open to some winds, it is naturally indicated as a point where Isthmian transit may begin or end. As there is no intention of entering into the controversy about the relative merits of the Panama and Nicaragua canal schemes, it will be sufficient here to say that, if the former be carried through, Colon is its inevitable issue on one side. The city of Cartagena is the largest and most flourishing in the neighborhood of the Isthmus, and has a good harbor, With these conditions obtaining, its advantage rests upon the axiomatic principle that, other things being nearly equal, a place where commerces centres is a better strategic position than one which it neglects. The latter is the condition of the Chiriqui Lagoon. This truly noble sheet of water has every naturally adaptation for a purely naval base, but has not drawn to itself the operation of commerce. Everything would need there to be created, and to be maintained continuously.



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"It lies midway between Colon and the mouth of the river San Juan, where is Greytown, which has been selected as the issue of the projected Nicaragua Canal; and therefore in a peculiar way, Chiriqui symbolizes the present indeterminate phase of the Isthmian problem. With all its latent possibilities, however, little can be said now of Chiriqui, except that a rough appreciation of its existence and character is essential to an adequate understanding of Isthmian conditions.

"The Dutch island of Curaçao has been marked, chiefly because with its natural characteristics, it cannot be passed over; but it now is, and it may be hoped will remain indefinitely, among the positions of which it has been said that they are neutralized by political circumstances. Curaçao possesses a fine harbor, which may be made impregnable, and it lies unavoidably near the route of any vessel bound to the Isthmus and passing eastward of Jamaica. Such conditions constitute undeniable military importance; but Holland is a small state, unlikely to join again in a general war.

"The same probable neutrality must be admitted for the remaining positions that have been distinguished: Mujeres Island, Samana Bay, and the Island of St. Thomas. The first of these, at the extremity of the Yucatan Peninsula, belongs to Mexico, a country whose interest in the Isthmian question is very real; for, like the United States, she has an extensive seaboard both upon the Pacific and—in the Gulf of Mexico—upon the Atlantic Ocean. Mujeres Island, however, has nothing to offer but situation, being upon the Yucatan Passage, the one road from all the Gulf ports to the Caribbean and the Isthmus. The anchorage is barely tolerable, the resources nil, and defensive strength could be imparted only by an expense quite disproportionate to the result obtained. The consideration of the island as a possible military situation does but emphasize the fact, salient to the most superficial glance, that, so far as position goes, Cuba has no possible rival in her command of the Yucatan Passage, just as she has no competitor, in point of natural strength and resources, for the control of the Florida Strait, which connects the Gulf of Mexico with the Atlantic.

"Samana Bay, at the northeast corner of Santo Domingo, is but one of several fine anchorages in that great island, whose territory is now divided between two negro republics—French and Spanish in tongue. Its selection to figure in our study, to the exclusion of the others, is determined by its situation, and by the fact that we are seeking to take a comprehensive glance of the Caribbean as a whole, and not merely of particular districts. For instance, it might be urged forcibly, in view of the existence of two great naval ports like Santiago de Cuba and Port Royal in Jamaica, close to the Windward passage, through which lies the direct route from the Atlantic seaboard to the Isthmus, that St. Nicholas Mole, immediately on the passage, offers the natural position for checking the others in case of need. The reply is that we are not seeking to check anything or anybody, but simply examining in the large the natural strategic features, and incidentally thereto noting the political conditions, of a maritime region in which the United States is particularly interested; political conditions, as has been remarked, having an unavoidable effect upon military values.

"The inquiry being thus broad, Samana Bay and the Island of St. Thomas are entitled to the pre-eminence here given to them, because they represent, efficiently and better than any other positions, the control of two principal passages into the Caribbean Sea from the Atlantic. The Mona Passage, on which Samana lies, between Santo Domingo and Puerto Rico, is particularly suited to sailing vessels from the northward, because free from dangers to navigation. This, of course, in these days of steam, is a small matter militarily; in the latter sense the Mona Passage is valuable because it is an alternative to the Windward Passage, or to those to the eastward, in case of hostile predominance in one quarter or the other. St. Thomas is on the Anegada Passage, actually much used, and which better than any other represents the course from Europe to the Isthmus, just as the Windward Passage does that from the North American Atlantic ports. Neither of these places can boast of great natural strength nor of resources; St. Thomas, because it is a small island with the inherent weaknesses attending all such, which have been mentioned; Samana Bay, because, although the island on which it is is large and productive, it has not now, and gives no hopes of having, that political stability and commercial prosperity which bring resources and power in their train. Both places would need also considerable development of defensive works to meet the requirements of a naval port. Despite these defects, their situations on the passages named entitle them to paramount consideration in a general study of the Caribbean Sea and the Gulf of Mexico. Potentially, though not actually, they lend control of the Mona and Anegada Passages, exactly as Kingston and Santiago do of the Windward."

In the Pacific the position occupied by the Hawaiian Islands is a singularly commanding one. Unlike the other island groups in that ocean they stand in a state of comparative isolation. Their distance from San Francisco is twenty-one hundred miles, and, if a circle be described with approximately that radius, it will be found to contain only a few unimportant islets, while near its circumference lie the Gilbert, Marshall, Samoan, Society and Marquesas groups, all under European control except Samoa, in which we have a part influence. The position of this group with reference also to the great commercial routes, not only those of the present but those resulting from the opening of the Isthmian Canal, gives it a remarkable importance. The route from the Isthmus to China and Japan as well as that from British Columbia to Australia passes through or close by this group. And last and most important it is the first stepping-stone in our communication with the Philippines.

The capture of this group by an enemy would greatly endanger our Pacific coast, destroy our Pacific trade and effectually break our line of communications with the Far East.

Guam as the only remaining stepping-stone in our communications with the Philippines should be fortified. While greatly inferior both as to position and resources to Hawaii, yet the fact that it is the only available point more or less intermediate between the latter and the Philippines gives it a pronounced value.

The necessity of an impregnable naval base in the Philippines is self evident. In time of war our fleet in the Far East would be compelled to rely on this base for all repairs and supplies of all kinds, as well as for protection in the event of disaster, temporary or permanent. Subig Bay, 30 miles from Manila, has been selected by the Naval Board as the best site for this base. Manila as the commercial and military centre of the Philippine Islands requires strong fixed defenses. Luzon, with its resources and with Manila well defended against naval attack, would probably be able to hold out during the continuance of a short war even if our sea power in the Pacific were lost. In any event the enemy to secure its control would be compelled to employ a combined land and sea force of such size as seriously to exhaust his strength, and lessen the forces which he might employ in other directions. Without fixed defenses Manila, in the event of a naval disaster, would be at the mercy of the enemy's fleet as in 1898.

Kyska in the Aleutian Islands has been selected by the Naval Board as our naval base in the Northern Pacific. The position of this and its neighboring islands is, with respect to that part of the Pacific, a commanding one. With no possible rivals north of Honolulu, situated almost equally distant from the important ports of Northeastern Asia and from Puget Sound, and within less than one thousand miles of the route joining these places, their value as a base if well fortified is unquestioned; while their possession by a possible enemy would constitute almost as grave a menace to our Pacific coast as would his possession of the Hawaiian Islands.

CHAPTER II.

NATURE AND EXTENT OF ARMAMENT.

The points for which coast defenses are necessary having been determined, the nature and extent of the armament at each must be decided upon. These depend, in the general case, upon the force from which attack may reasonably be expected. This for any point may be decided from a consideration of its geographical position with respect to possible bases of an enemy and the results of a successful attack.

Our Atlantic ports are all within short distances of foreign bases in the Western Atlantic, and are all about equally accessible to an enemy operating from a base in Europe. The ports on the Pacific, however, at the present time are more isolated, and an attack of as strong a force as that which may be expected on the Atlantic is unlikely.

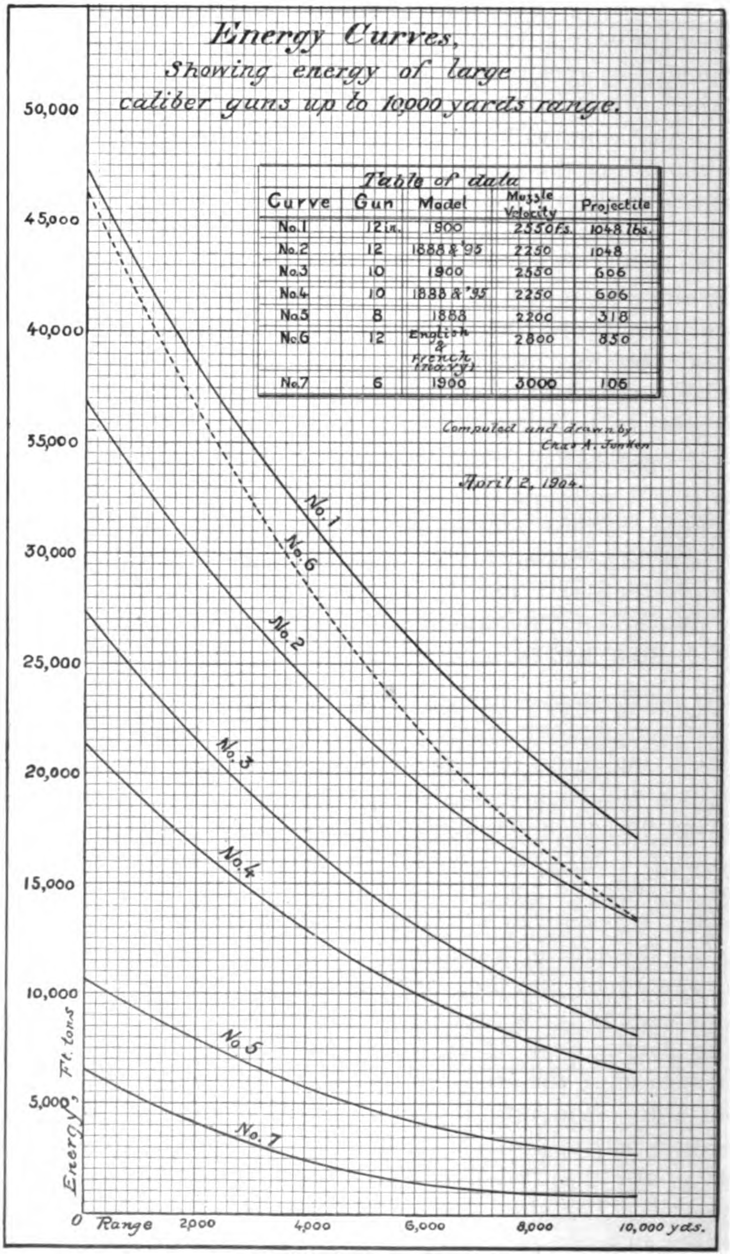
The cutting of the Isthmian canal or a radical change in political conditions in the Far East would necessitate preparation against a force stronger than now may be expected.

An assumption can be thus made as to the strength of the force which may attack a place, although the actual number of guns which can be brought against its defense is limited by local conditions, as the length of front along which the enemy can deploy, the nature of the channel and the strength of the current. Again, local conditions, both hydrographic and topographic, so materially affect the nature and extent of the defenses, and differ so widely, that general principles only can be laid down and their application to individual ports must be left to a board of officers of sound judgment.

Guns.—Warships offer several kinds of vertical targets, distinct as to vulnerability, which may be grouped as follows: 1°, the heavy belt and turret armor of battleships; 2°, the secondary armor of battleships and the main armor of armored cruisers; and 3°, torpedo and other small boats and the upper works and fighting tops of battleships and cruisers. Each class fixes a basis for determining the caliber and power of guns necessary for its successful attack. In examining the various types as to their suitability, it must be remembered that in an engagement normal impact will rarely, if ever, be obtained. It is estimated by recent authorities that an angle of impact of 30° with the normal will be an average best, and that not more than 10 per cent. will strike within 15° of the normal. Under these conditions the capped projectile will not have the same advantage over the uncapped as at the proving ground, and, in the majority of hits obtained, will be little or no more effective than the latter. The advantage conferred by the cap begins to fall off at an obliquity of 15°, and is entirely lost at an angle of 30°. Capped projectiles also to be effective must have a striking velocity exceeding 1800 f. s. With velocities exceeding 1800 f. s. and within 15° of the normal, caps confer an advantage of about 15 per cent.

In the application of perforation formulas to Krupp cemented armor it will be found that the several formulas give results differing more or less widely, and no formula has been found to agree with experiment for all thicknesses of armor plate and all striking velocities. The U. S. Navy and Krupp formulas for K. C. plates and Tressider's formula for W. I., with a suitable factor applied, will be used in the following discussion :

Large caliber guns.—Modern battleships carry twelve inches of K. C. armor on their big gun turrets and barbettes, the same thickness, including the resistance of the sloping deck, on their water line, and have their vitals protected by what is equivalent to, including belt, sloping deck and coal, about sixteen inches of this armor. Seriously to cripple a ship the main armor must be perforated ; to put her out of action the vitals must be reached. It is only by reaching the vitals that a determined attempt on the part of a squadron to force a harbor entrance can be prevented by gun-fire. The destruction of the superstructure, damage to the secondary armament, etc., may cause an attacking fleet to draw off in case there is little at stake, but not if the success of the attack is essential. The power of the large caliber guns evidently should be such as to reach the vitals of modern battleships. The shortness of the engagement necessitates also that this should be accomplished at as long range as possible. The time during which an attacking fleet will be under fire in a run-past will probably not exceed twenty minutes, and many hits from one gun cannot be expected, but of these as many as possible should be capable of reaching the vitals.



Curve	Gun	Model	Muzzle Velocity	Projectile
No. 1	12 in.	1900	2550 f.s.	1048 lbs.
No. 2	12	1888 & '95	2250	1048
No. 3	10	1900	2550	606
No. 4	10	1888 & '95	2250	606
No. 5	8	1888	2200	318
No. 6	12	English & French (navy)	2800	850
No. 7	6	1900	3000	105

Again, while at short ranges ships' guns have about the same accuracy as those on shore, and the far greater number of the former may result at such ranges in the overwhelming and silencing of the latter, in the earlier stages of the action the accurate range-finding possible in coast fortifications and the stability of the gun platforms permit an accurate fire at ranges at which warships are unable to engage successfully. These last are advantages inherent in coast fortifications and compensate in a measure for the great superiority in volume of fire which will be possessed by the attacking fleet, but to realize them the large caliber guns must be effective at long range. It is imperative then that the shore batteries should be able to open not only an accurate, but also an effective fire at the earliest moment. With this end in view the large caliber gun must be selected. The weight of gun and mount, in the navy a question of the greatest moment, in coast fortifications need not be considered. To consider any gun as the proper type for the work when another more powerful and with about an equal rate of fire is available, is to forfeit by so much the natural advantages of coast fortifications, to lessen the value of accurate range-finding, and to leave less margin for the development in armor and armament of a future enemy.

The shortness of the engagement necessitates also a rapid rate of fire. Experience here and abroad points to the 12-inch as the maximum caliber consistent with a comparatively rapid rate of fire.

The following table shows the limiting ranges at which perforation of the several thicknesses of armor stated will be obtained by the large caliber guns now supplied by our ordnance department. These values are obtained by the U. S. Navy formula for K. C. armor,* an advantage of 15 per cent. being allowed capped projectiles under the conditions heretofore noted :

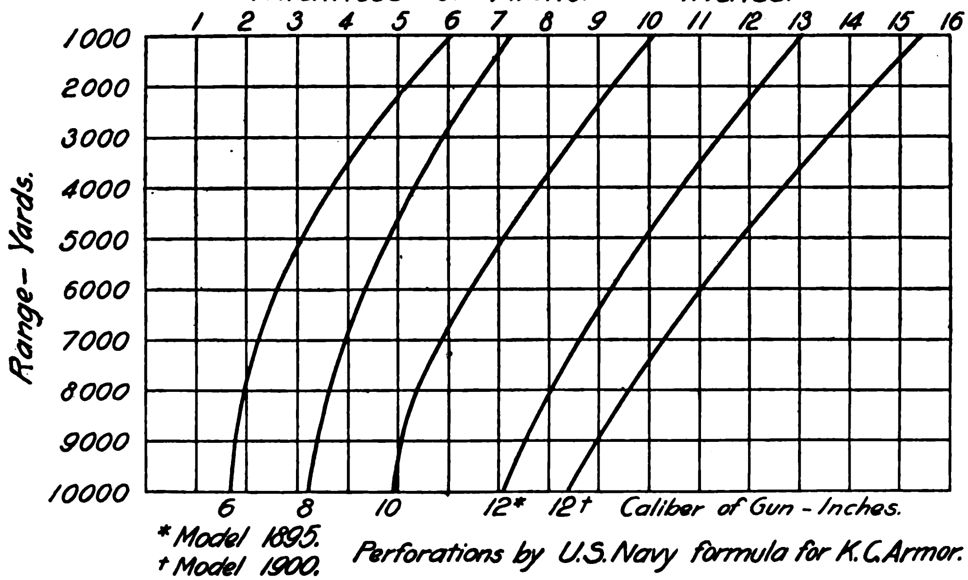
LIMITING RANGES—YARDS.

Thickness of K. C. armor.	12 inches, ang. of impact, 30°	12 inches, ang. of impact, 15°	16 inches, ang. of im. pact, 30°	16 inches, ang. of impact, 15°
12-inch, Model 1900.	4689	6763*	445	4134
12-inch, Models 1888 and 1895.	2177	4251*	——	1622
10-inch, Models 1888 and 1895.	——	1880	——	——
8-inch, Model 1888.	——	——	——	——

* Ballistic coefficient uncorrected for altitude.

ARMOR ATTACK SHEET.

For Krupp Cemented Armor and Angles of Impact with the Normal of 30°.



Note:– 50 per cent of the hits obtained will strike at angles with the normal of about 30°. At angles of impact with the normal of 15° or less and with striking velocities exceeding 1800 f.s., caps confer an advantage of about one-sixth.

Practical Rule.

For normal impact, uncapped projectiles, increase above perforations one-sixth. For normal impact, capped projectiles, striking velocities above 1800 f.s., increase above perforations one-third.

Guns.

6" Model 1900, M.V. = 3000, W = 106.
8" Model 1888, M.V. = 2200, W = 318.
10" Model '88 & '95, M.V. = 2250, W = 606.
12" Model '88 & '95, M.V. = 2250, W = 1048.
12" Model 1900, M.V. = 2550, W = 1048.

Computed and arranged by
1st Lieut. S. D. Embick, A.C.

Drawing by Cpl. T.M.R. Herron, 123rd Co. C.A.,
School for Master Gunners, Class 1904.

Krupp's and Tressiders's formulas give for the perforation of the same thicknesses by the 12-in., model 1900, the following:

12″, Model 1900, Krupp formula	2717	6763*		1953
12″, Model 1900, Tressider formula	4740	6763*	984	4249

These tables show clearly that the 12-inch, model 1900, is the type required.

A comparison of the energy curves of this gun and the present 12-inch gun of the English and French navies shows also that this gun has the necessary advantage in reach over 12-inch ships' guns.

Medium caliber guns.—The armor of battleships next in thickness to the main armor is that about six inches thick, which covers the guns of about that caliber. The large number of such guns, from 6 to 8 inches, carried by battleships, some of which have a broadside fire of from ten to eleven of these pieces, demands that provision be made in coast fortifications for the perforation of this armor and the silencing or disabling of as many as possible of the guns in rear, in order to prevent a smothering fire from being brought to bear at close ranges. The large number of these guns and the close ranges calls also for as rapid a fire as possible on the part of the coast guns opposing them, but this must be made subordinate to power since perforation is essential.

An examination of the 6-inch, model 1900, gun by the U. S. Navy formula gives the following limiting ranges for the perforation of 6-inch K. C. armor at the angles of impact stated:

LIMITING RANGES—YARDS.

Thickness of K. C. armor.	6 inches at an angle of 30°.	6 inches at an angle of 15°.
6-inch, Model 1900.	1043	2564

This formula gives a very high figure of merit to plates of medium thickness. For the same perforations Krupp's and Tressider's formulas give the following ranges:

* These values result from the assumption that caps give 15 per cent. advantage with 1800 f. s. striking velocity, and no advantage with a lower striking velocity.

Krupp formula	1634	3600
Tressider formula	1904	3439

Assuming that the last formula is the one applicable to 6-inch armor, it is seen that at ranges of even 3400 yards, the 6-inch gun is effective only under conditions the most favorable to the gun, that even then there is no margin for accomplishing damage after perforation and that the gun will fail if the impact is more oblique. In all battleships recently laid down this fact has been recognized and the secondary guns have run up to 7.5 and 8 inches in caliber. Our own naval authorities state that no gun under seven inches in caliber will, under battle conditions, do effective work against moderate armor. Brassey, 1903, states that "such a gun as the 6-inch will seldom find any armor against which it has a reserve of piercing power, at any rate, not for new ships. "The high velocity 6-inch is barely effective against hard-faced 5-inch plating" (this refers to a range of 3000 yards). "Before long, as the new ships with thicker armor become more numerous, the battleship guns of this caliber will be reduced to spattering the outside of an opponent's armor with fragments of shell."

Increase reach for the coast fortifications is here even more necessary than in the case of the large calibers, as the same conditions exist in this case in a more pronounced manner.

Examining an 8-inch gun, M. V. = 2800 f. s., using Tressider's formula, we obtain the following limiting ranges for the perforation of this armor:

Thickness of K. C. armor.	6 inches at an angle of 30°.	6 inches at an angle of 15°.
8-inch, (M. V. = 2800).	5733	6670

These results show that this gun would be effective against 6-inch K. C. armor and at such ranges as to put it on the same footing as the 12-inch, model 1900, against their respective targets. While the 6-inch gun has more or less of an advantage in rate of fire and is the largest caliber whose projectile can be man-handled without difficulty, a slower rate of fire must be accepted, if necessary to obtain an increased power where such increase is essential. In this connection, the fact that five aimed rounds have been fired in thirty-one seconds from a 7.5-inch gun shows that even with such calibers a slow rate of fire is not imperative. The gun which should be sought for in any case is that which will deliver the greatest effective fire against its own target. If both of the guns discussed are mounted on disappearing carriages, the loss in rate of fire in passing from a 6 to an 8-inch will be slight. The fact, as shown in a few of the more recently designed battleships, that the tendency is to increase the thickness of the secondary armor to seven inches, emphasizes the futility of the 6-inch for this work. Major Birnie of the Ordnance Department states that an 8-inch, model 1900, gun is required to complete the present system and bring it up to date in comparison with other standards. The 8-inch is evidently the caliber demanded and there is every reason to urge why it should have a muzzle velocity of 3000 f. s. With a given caliber of gun an increase in muzzle velocity gives an increase in power and an increased accuracy due to a flatter trajectory; this, too, with the same rate of fire, the same personnel, and with, in coast fortifications, no disadvantage resulting from increased weight. Krupp has constructed an 8.27 inch gun, W = 308.6, with 2992 M. V., and Vickers Sons & Maxim a 9.2-inch, W = 380, with 3209 M. V.

In Jane, 1903, Colonel Cuniberti, Chief Constructor of the Italian Navy, proposes a battleship of 17,000 tons carrying twelve 12-inch guns and with 12 inches of armor protecting belt, turrets and lower deck redoubt. All calibers intermediate between 12 inches and three inches are eliminated. The practicability of the design of a 20,000 ton battleship carrying twelve guns of 12-inch and 10-inch caliber, all to be protected by heavy armor, is being considered by our Navy Department. As in the ships proposed by Colonel Cuniberti, there are no intermediate calibers between the 10-in. and the 3-in. Similar designs are recommended by the Vickers' firm. If battleships of this or similar types are generally adopted it is evident that the 8-in. for fixed defenses would become a type of doubtful value having no rôle to which it is adapted. It would be entirely inadequate against such armor while too slow and unnecessarily heavy for the attack of superstructure or the defense of mine fields. It would seem that the proposed changes in the thickness and disposition of armor could best be met by the coast artillery by continuing our present policy of installing high-power 12-inch guns, excluding, however, all lesser calibers for armor attack.

Another task for the defense which requires a medium caliber gun with a high rate of fire is the defense of the outer lines of the mine field against boat attack. The destruction of the mine field, or as much of it as possible, would be attempted at night under the most unfavorable conditions for the defense. The vessels engaged would probably be torpedo boat destroyers, and small swift cruisers under 3000 tons. The 15-pounder would be effective against the former, but against the latter a heavier gun will be required. The limited time during which these boats will be under fire, and their high speed calls for a rate of fire greater than can be obtained with the 8-inch. The model 1900, 6-inch, or the model 1900, 5-inch, with their high rate of fire and flat trajectory seem well adapted for this work and will also prove very effective against the superstructure and unarmored portions of battleships at all ranges.

Small caliber guns.—These guns are needed to prevent a forced passage of the harbor entrance by torpedo boats and torpedo boat destroyers and to defend the mine field against attack by these boats. The great speed of these boats and the inability of the searchlights to pick them up at any but close ranges requires a high rate of fire and a flat trajectory. While very little penetration is required in this case, since the steel plates of these boats are never more than one inch thick, the gun selected should be sufficiently powerful to sink or disable the boat if it hits it. It is generally conceded that the 15-pounder is the type required for defense against torpedo boats.

To repel landing parties and to supplement the 15-pounders at at very close ranges in defense against torpedo-boat attack, an automatic gun such as the Vickers-Maxim one-pounder, now undergoing test by the Ordnance Department, should be supplied.

Mortars.—High angle fire possesses the advantage that it can be directed to hit any point between the inner and outer limits of its range. Intervening high or wooded land does not affect its fire, and, if range stations be provided covering them, all water areas within range may be rendered untenable to an enemy's fleet. It is thus able to prevent a bombardment of the inner harbor from waters out of the line of direct fire and to cover waters from which the batteries could be taken in reverse. When properly protected it cannot be silenced. Modern battleships, while well protected against direct fire, offer a large horizontal target with comparatively little protection against high angle fire. The armored deck, rarely over three inches in thickness, is the only protection to be perforated by a high angle projectile to reach the vitals. The 12-inch mortar adopted in our service is capable of perforating an armored deck of this thickness at ranges of from 4500 to 12000 yards. A hit within these limits will reach the vitals. While within 4500 yards perforation of the armored deck cannot be obtained, yet the enormous destructive effect of the explosion of a torpedo shell, containing as it does nearly 140 pounds of high explosive, on the deck of a warship is such as to render all anchorages within the ranges of 3000 to 4500 yards untenable to an enemy's fleet. With the new carriage giving 70 degrees' elevation the inner limit of mortar fire will be reduced to 2000 yards.

Submarine mines.—The function of submarine mines is, in connection with the fixed armament, to close a channel to an enemy's fleet. They are designed to attack the sub-water parts of warships and the charge should be sufficiently powerful to blow a hole in the bottom and sink any ship that strikes, or passes near the mine. The condition that mines must be arranged to admit of the safe passage of our own vessels, while they can instantly be rendered dangerous to the enemy, requires the adoption of mines electrically controlled from shore.

The types of mines adopted in our service are fully described in official publications, and we are here concerned only with the location and defense of the mine field.

Mobile torpedoes.—The results accomplished by torpedo boats in the recent engagement at Port Arthur emphasize the important rôle that may be played in coast defense by mobile torpedoes. The destructiveness of the torpedo and its accuracy within short ranges have been clearly shown. Recent improvements point to an increased accuracy and a range of from 3000 to 4000 yards in the case of torpedoes for battleships. Shore torpedo batteries possess the advantages over those on ships of concealment, less vulnerability, greater accuracy in determining the speed and position of the enemy's ships, an increased range, and a more stable platform. As practically no limit as to size is imposed in the design of shore torpedoes, it is estimated that with these torpedoes it is possible to secure a range of 8000 yards. Such batteries would be of great assistance in closing a channel to an enemy's fleet or in rendering untenable an inner harbor. Efforts to protect the hulls of warships against torpedo attack have been unsuccessful, as shown in the case of the Tsarevitch which had 4-inch lateral bulkheads and an extension of the belt under water. An experiment with a caisson representing the same idea, applied to the Henri IV., gave very unsatisfactory results, the caisson sinking immediately. The same results were recently obtained in Russia with a barge armored to represent the Borodino, the barge being entirely destroyed by a single torpedo, a result not surprising in view of the excellent tamping afforded by water. The extreme vulnerability of ships to this form of attack can leave no doubt of the great value of shore torpedo batteries as a means of coast defense.

Defense of land fronts.—A modern coast battery differs radically from the old closed fortification. The latter was constructed to resist formal land approaches while the former is built without gorge defense. Although permanent works are unnecessary, batteries must be protected on the land side since it cannot be doubted that an attack by a landing party will be made if the attempt promises any measure of success. Battleships will not be risked if a land attack can do the work. Provision must be made to defeat such attacks by constructing field works covering all landing places and all avenues of land approach. These should be provided with entanglements, abattis, etc. These works should be defended by infantry, since the artillery personnel will be needed at the guns, as the enemy's ships may take advantage of the diversion created by the land attack, or the attack by land may be made simultaneously with one by sea. This duty, too, does not demand the services of the highly trained and technical coast artillery whose efficiency has been attained only through long training in time of peace; it may be performed by local volunteer troops with little training. To assist in the defense of these works a movable armament of automatic or machine guns which may be readily moved from place to place by hand, should be provided. This force for the defense of land fronts of a battle command should be permanently assigned to the battle command during the period of hostilities, and should be under the direct control of the battle commander. It should be entirely distinct from the field army which would be located at some central distributing point, the latter being charged with the defense of a certain extent of the coast against landing operations on a larger scale.

Submarine boats.—Submarines are valuable in harbor defense to supplement the mines, or to replace them in cases in which local conditions prohibit the use of the latter; to patrol the mine field; to repair cables, junction boxes, etc.; and to attack an enemy's squadron prior to and during the attack, or while engaged in blockading the harbor. The value of submarines for the work last mentioned was shown during recent French maneuvers when three battleships bombarding coast fortifications were attacked and declared sunk by submarines; their value in supplementing mines is generally conceded.

The following extracts from the report of the board of officers on the recent trial of the submarine boat Protector of the Lake type, indicate the rôle of these boats:

FOR DEFENSE.

"First: To take the place of fixed mines, by lying adjacent to the forts and attacking vessels attempting to reduce the works or to run past, particularly in important channels where it is impracticable to plant mines, owing to deep and rough water, extreme width, or the swiftness of currents.

Second: To supplement fixed mines, by attacking vessels approaching the mine fields or those which have crossed them.

Third: To lie outside mine fields for scouting or picket duty, keeping in telephonic communication as hereafter described.

Fourth: To pick up and to repair defective cable joints, junction boxes, etc.

FOR ATTACK.

"First: To run past the forts, and to attack vessels within the harbor.

Second: To drag for, pick up, and to cut multiple and branch cables on the bottom, or mine cables leading to buoyant mines or buoys.

Third: To sweep the channel, two submerged boats being connected by a light cable extending across all or a part of the mine field.

CONCLUSIONS AND RECOMMENDATIONS.

FOR DEFENSE.

"The board believes that this type of submarine boat is a most valuable auxiliary to the fixed mine defense, and, in cases where channels cannot be mined owing to depth, rough water, swift tides, or width of channel, it will give the nearest approach to absolute protection now known to the board. The boat can lie for an indefinite time adjacent to the point to be defended, in either cruising, awash, or submerged condition, by its anchors being upon the bottom. It is thus ready for instant use, practically independent of the state of water, and in telephonic connection with the shore. It can also patrol a mined or unmined channel, invisible to the enemy, and able to discharge its torpedoes at all times. It possesses the power of utilizing its engines in every condition except the totally submerged, and can always charge its storage batteries while so doing, necessitating its return to shore only when gasolene must be replenished. In narrow channels the boat or boats would have a fixed position, with a telephone cable buoyed or anchored at the bottom. In wide channels they would patrol or lie in midchannel, or where they could readily meet approaching vessels.

"As a picket or scout boat, outside the mine field or even at extreme range of gun fire, telephonic communication can be sustained, and information received and instructions sent for attacking approaching vessels.

"The test at Newport demonstrated the ease with which the boat can locate and pick up cables and, with minor alterations in the present model, junction boxes, etc., can be taken into the diving compartment and repaired at leisure while absolutely protected from hostile interference. The faculty possessed by the boat of maneuvering on the bottom and sending out divers, leaves little or nothing to be desired in its facilities for doing this work.

FOR ATTACK.

"The boat shows great superiority over any existing means of attacking mine fields known to the board.

"It can run by any mine field, as at present installed, with but little or no danger from the explosion of any particular mine or from gun-fire, during the few seconds it exposes the sighting-hood for observation, and can attack at its pleasure vessels in the harbor.

"The board personally witnessed the case with which cables can be grappled, raised and cut, while the boat is maneuvering on the bottom. Mine cables can be swept for, found and cut, or a diver can be sent out for that purpose.

"It should be noted that, with one exception, no seamen are needed aboard, this exception being the man who steers and handles the boat."

Torpedo boats.—Torpedo boats should be supplied to the important fortified harbors to meet and repel attacks by an enemy's torpedo boats on shipping at anchor in the harbor and to make offensive returns against an attacking or blockading fleet.

Patrol boats.—During fog or thick mist searchlights are of no value, and patrol boats are required to guard the mine fields against attack, and to patrol the approaches to the harbor with the object of preventing the torpedo boats of the enemy stealing into the harbor. On nights during which searchlights are of value these boats should constitute an additional and outer line of observation.

Searchlights.—Searchlights are necessary to discover the movements and illuminate the vessels of the enemy at night. Attacks upon mine fields or attempts by torpedo boats to steal into the harbor will probably always be made at night and such movements can be defeated by the shore batteries only with the aid of searchlights. Two general classes of lights are required: searching and illuminating. The searching lights should be sufficiently powerful to water line vessels at the effective range of the large caliber guns.

The report of the Board of Engineers upon this subject contains the following: "Illuminating lights include those used for general illumination in advanced or distant flank positions as well as mine field lights, and, in certain cases, reserve lights. The reserve lights are provided mainly from a consideration of the possibility of interruption of communication with the more advanced or distant searching and illuminating lights, and are placed upon the inner line of defense contiguous to the batteries, where communications will be least subject to interruption.

"The size of the lights employed in the maneuvers included 24-inch, 30-inch, 36-inch and 60-inch. The results led to the conclusion that the 36-inch is the smallest which can be usefully employed, and that the 60-inch is fairly efficacious for the largest size required. It may be found that 72-inch lights will be advantageous in certain places, but the 60-inch can, for the present, be regarded as the practical limit, and to exceed this will not materially increase the effective range, while disproportionately increasing the cost. The sizes recommended are two only, the 36-inch and 60-inch. The average effective range of these lights with parabolic mirror and concentrated beam, based upon all available data, is:

For the 60-inch,	6000 to 8000 yards.
For the 36-inch,	4000 to 6000 yards.

"Lights for the illumination of mine fields where the distance is not too great may be advantageously fitted for a diverging beam by using a special form of lens. The effective range is reduced one-half for a divergent beam of 20 degrees."

Marine obstructions.—These are of great value as an accessory to the defense of a fortified channel, or in closing a narrow and unfortified channel which will not be needed by our own vessels. These obstructions may consist of sunken hulks, sub-water piles, booms, and any other obstruction which would delay the passage of the enemy. No matter how good the gun defense and lighting arrangements, a boom or some similar obstruction is necessary to prevent torpedo boats getting through if they attack in sufficient numbers. Sunken hulks loaded with stone may often be advantageously used in closing narrow and unused channels.

CHAPTER III.

DISPOSITION OF ARMAMENT.

The siting of the several elements of fixed coast defenses depends upon the objects to be attained by them. These objects are: (1) To close narrow channels leading to important places; (2) to forbid the occupation of harbors useful to an enemy; (3) to protect our cities, harbors, dock yards, etc., from distant bombardment.

In the selection of a site to bar the passage of a fleet through a channel, it must be remembered that the conditions are far more favorable to the defense than in the selection of a site for encountering an army in the field. A land fortress chosen in advance may usually be passed, and the engagement forced beyond the reach of its guns. Ships can enter land-locked harbors by only a few channels, and that particular site for defense should be chosen where they can operate under the maximum disadvantages, and yet where they must certainly pass to effect their object. The harbor should be studied with a view to selecting a site combining the advantages of a wide development of fire for the defense and a contracted front for the enemy.

The batteries of the defense should be widely distributed: (1) To avoid the concentration of fire which can be brought against a contracted site; a larger target is thus offered and shots aimed at one battery may take effect upon another; (2) a widely distributed armament will permit of an effective cross-fire on an enemy's ships. If in addition, the position selected forces the enemy to make use of a contracted front, he may be prevented from developing his full power, and may be thrown into confusion should some of his vessels become unmanageable during the engagement. In the distribution of armament, batteries should not be so widely separated as to be beyond supporting range of each other, otherwise they could be attacked and overwhelmed in detail. In many cases also it may be advisable to place all of the guns on one side of the harbor entrance and thus avoid the crossing of searchlight beams and the demoralizing effect of ricochet fire from the other side, as well as simplify the land defense.

As to the position of guns with reference to the shoreline; in general, it may be said that in order to utilize all their available power, they should be pushed as far forward as possible. They should be retired from the shore line only when a wider field of fire or greater concealment can be obtained by so doing. They should be located also so that as much as possible of the course of the ships will make an angle of sixty degrees or more with the line of fire, but this consideration must not govern to such an extent as to increase greatly the distance of the guns from the channel and thus materially reduce their power with reference to the latter, since biting angles can always be obtained at the harbor entrance.

In order to reduce to a minimum the number of mortar zones which would be traversed by an enemy in entering a harbor, a mortar battery should be so located that as much as possible of the channel would lie on the arc of a circle of which the battery is the center, and the minimum distance of the battery from the channel should be that required for the perforation of armored decks. Experiments are now being conducted to determine what this distance is. At present it is generally accepted as 4500 yards.

As to the proper elevation of guns, high sites possess the following advantages over low ones: (1) They are better adapted to vertical base position-finding instruments, and, therefore, to automatic sighting. It is generally admitted that at close ranges our present range-finding system will break down either through the destruction of the base-end stations or the failure of communications, and thereafter ranges must be estimated or determined, by some method at the guns themselves. The estimation of ranges for large caliber guns will not suffice, and no strictly accurate method of determining ranges at the gun has been determined. All in all, much the best way in which this condition can be met is by the use of automatic sights. While at moderate elevation these sights are not accurate even for short ranges, yet at these ranges their error is well within the danger space. In the English service they have been found to work successfully at short ranges on sites as low as 40 feet.

(2) With high sites an enemy will find it harder to locate the guns. With a well-concealed battery of disappearing guns, which would show above the parapet for but brief periods, an enemy will probably be able to direct his fire only by locating

the openings into which the guns disappear. To deprive him of a definite target for his guns, the battery may well be placed at a sufficient elevation to hide the openings of its emplacements from view from the tops of his warships.

(3) High sites increase to some extent the protection to guns and gun detachments. The angle of fall, and hence the searching effect of a projectile will be reduced by the angular depression of the ship at the corresponding range. With a height of site of 200 feet this angular depression for a range of 2000 yards is 1 degree and 55 minutes. The angle of fall of the 12-inch B. L. R. projectile, M. V.=2250 f. s., for a range of 2000 yards is 1 degree and 16 minutes, and hence this would be the searching effect of this gun, if used on shipboard against a fort at sea level at that distance. To take away the searching effect at that range, or cause the path of the projectile to be horizontal on arrival, an elevation for the fort of 144 feet is required; to accomplish this result for a range of 3000 yards, the fort would have to be given an elevation of 322 feet.

With our disappearing system, in which the gun after recoil lies below a plane passing through the interior crest of the parapet and depressed 7 degrees below the horizontal, it is evident that comparatively little additional protection is derived from moderate elevations.

With our non-disappearing carriages the gain is still less, owing to the necessity of raising the loading platform nearer the level of the interior crest in order to obtain the greater angles of depression required to avoid dead zones.

(4) High sites also permit of greater accuracy in the observation of fire.

Certain disadvantages have been attributed to low sites as compared with high sites; as, they afford no direct fire upon a vessel's deck, her most vulnerable point; they enable ships to dispense with high angles of elevation for which their mode of mounting disqualifies them; they place the enemy's guns on shipboard on an equality with land guns as to energy of impact.

The first point is based on the consideration of the influence of height of site on the angle of fall. For a site 200 feet high the angle of fall at 8000 yards is increased by only 29 minutes; for 3000 yards by only 1 degree and 16 minutes. The angle of fall for the 12-inch B. L. R. projectile, M. V.=2250, at 8000 yards is 8 degrees and 1 minute; at 3000 yards, 2 degrees and 3 minutes. Recent experiments have shown that with service angles of fall for direct fire the perforation of a 3-inch protective deck cannot be obtained. At long ranges where the angles of fall are greatest, the increase of such angles due to height of site is negligible.

As to the second point, the additional elevation required for naval guns at 3000 yards' range, because of a 200-foot site, would be only 1 degree and 16 minutes. The angle of departure corresponding to this range is 1 degree and 50 minutes. Since the greatest practicable elevation for guns on shipboard is from 13 to 15 degrees, it appears that the attack of batteries on sites higher than we can obtain on our coast is not impracticable for naval guns at even close ranges.

As to the effect of a high site on the energy of impact of guns on land and shipboard, it is at once seen that this is negligible when we consider an example. A 12-inch thousand pound projectile fired from a height of 200 feet gains only 100 foot-tons and the projectile from the ships is handicapped only to that extent. The energy of impact of the 12-inch, model 1895, rifle at 3000 yards is 27000 foot-tons, and of the 12-inch, model 1900, at the same range, 34900 foot-tons. The gain in energy obtained by an elevation of 200 feet is, respectively, thirty-seven hundredths and twenty-nine hundredths of one per cent.

A disadvantage of high sites which must be considered whereever deep water comes in close to the shore line, is their restriction of the field of fire. With most of our carriages 5 degrees is the limit of depression; hence a site 200 feet high will result in a dead zone of 762 yards' radius and a 300-foot site in one whose radius is 1143 yards.

One of the main objects of our system of coast fortifications is the defense of our cities, dockyards and harbors of refuge against distant bombardment. The extreme range of large caliber guns on shipboard is from 16000 to 18000 yards, but it is doubtful if bombardment would ever be attempted at such ranges. Our large caliber guns and our mortars are effective up to 12000 yards, so that even if the extreme ranges mentioned are practicable, a bombardment can be prevented if the defensive works are 4 miles outside of the object to be protected. All water areas outside of the field of direct fire from which a bombardment could be conducted should be covered by mortar fire.

To forbid the occupation of a harbor to an enemy is a task for which mortars, suitably located and well protected against land-parties, are well adapted. For this purpose the mortars must be located at such a distance from the inner harbor that the latter lies beyond the inferior limit of their fire. This consideration will rarely conflict with those governing their location with reference to the defense of the channel or distant bombardment.

The small caliber guns intended for defense against torpedo boats must be placed close down to the water's edge to prevent the boats from creeping in close under the shore.

The question of concealing coast fortifications is attracting more attention than in former years. The concealment of a battery increases its protection and produces a moral effect upon the enemy who cannot determine its position or observe the effects of his fire. Our disappearing system is particularly well adapted to being rendered inconspicuous. With guns so mounted a concealment may be obtained which is impossible with those on non-disappearing mounts, and which will render the location of the battery doubtful at reconnaisance ranges, and at short ranges prevent the enemy from keeping the target constantly in view. To a certain extent the location of batteries of disappearing guns should be determined by the concealment afforded; the battery having been located, the sky line should be made a perfectly unbroken line with nothing to claim the eye, and the parapet, slopes and grounds adjacent should be so treated as to mingle as much as possible with the general features of the landscape as seen at from two to five miles. Buildings, barracks and other objects of no offensive value should be so placed as not to locate guns otherwise concealed. Rapid-fire batteries mounted in barbette particularly those having shields, are very conspicuous and should not be mounted alongside disappearing carriages if it can be avoided. The vertical D. P. F., except on a site sufficiently elevated not to require a tower, is a most tell-tale adjunct to a battery, as it is usually not only an object of prominence, but is placed so near a battery as to locate it definitely.

A mine field should be so located as to admit of being effectively covered throughout its whole extent by gun-fire and well lighted by searchlights. The mines should be distributed over a wide area, not only to prevent them from being mutually destructive, but also to render countermining more difficult. In addition to the mine field proper, mines may be planted in detached groups in waters from which a distant bombardment might be attempted. Where the channel to be defended does not exceed 30 feet in depth, ground mines should be used because of their fixity of position and greater security to friendly vessels in the passage of the mined zone; for deeper channels our service buoyant mine is used. Experience has shown that where the depth exceeds 100 feet and the velocity of current 7 feet per second, the size of the buoyant mine becomes too great to admit of successful working.

The plan of mine defense to be adopted for any particular seaport can only be decided upon after a careful study of the conditions peculiar to that port, the character of the channels, the depth of the water, strength of currents, rise and fall of the tide, etc.

The location of searchlights is one of the most important factors in a successful defense and one of the most difficult to decide upon. The proper location of the lights requires a separate study of each harbor with reference to the batteries, the observers and the general shore line. Too many lights or the faulty location of those provided will provide a decided disadvantage for the defense.

The following are extracts from the report of the Board of Engineers on this subject :

"(*a*) The searching lights should be located well in advance of the line of defense and so disposed as to cover all avenues of approach, and give the earliest possible warning. The illuminating lights should be located on the flanks of the batteries as far in advance as practicable.

(*b*) All lights should be located as near the shore line as practicable.

(*c*) During the daytime all lights should be effectually concealed from the enemy.

(*d*) During the watching period when the searching lights are in service the illuminating lights should be occulted.

(*e*) When illuminating lights are in use, searching lights should be occulted or operated so as not to interfere with them.

(*f*) While the functions of searching and illuminating lights are considered separate and distinct, these lights should, in case of necessity, be interchangeable.

"However desirable it may be for the service of the batteries to provide separate lights for each, it readily appears that the tactical control of searchlights differs essentially from that of gun-fire. With the guns it is necessary not only to cover every part of the front, but the fire of different batteries must be concentrated and cross upon the field, while with the lights, crossing of the beams creates a dark angle and the interposition of a beam between the gun and its target obscures the latter.

"The light problem is therefore practically reduced to the use of but one light at a time in any given sector of searching or illumination, or at least the beams must not be allowed to cross within the near field of fire. This consideration in general governs the number of lights that can be usefully installed and is of paramount importance. It follows from this that the night defense will be materially contracted as compared with the day defense, owing to the impracticability of illuminating all the field without serious interference. Instead of assigning separate lights to each battery or attempting to provide as many lights as possible targets, the system to be established should be one which will insure selected vessels being illuminated as long as desirable.

"The best illumination is obtained when the angle at the target between the observer and the light is made as great as possible, even up to 60 degrees as some authorities claim. When the observer is near the light, the reflected light from the target is intercepted by the beam. It is also manifestly advantageous to reduce to a minimum the distance between the light and the target and the distance between the target and the observer. These considerations are observed in the general principles already enumerated.

"It is generally conceded that a high position is the best for a searching light, but another important condition is that the light should be near the shore line. These conditions are often irreconcilable and one or the other must, as a rule, be sacrificed. The shore position is in any case considered of primary importance. The material disadvantages of placing a light back from the shore are that it illuminates the foreground and the shore line, and not only interferes with observation by reflection of the rays, but serves as a useful guide to navigation by the enemy. Nevertheless, where the light can be placed high without illuminating the fore-shore, it should be done, as by this means the diffused light from the horizontal beam over the water surface illuminates the water area below."

The best locations of marine obstructions is that within the most effective zone of fire of the defense. The obstructions in channels expected to be used by the defense should be so arranged as to permit of the free passage of vessels of the defense, the passageways being protected by judgment mines. While a boom could be most readily placed at the narrowest part of the entrance, it may be advisable to place it at another point which is better illuminated and more effectively covered by gun-fire, the channel being narrowed if necessary by the erection of dams or barricades at the shore ends. As before stated narrow and unused channels may often be effectively closed by sunken hulks loaded with stone, any attacks upon which would probably come under and be defeated by the fire of the mortars, which have been located with reference to other considerations.

CHAPTER IV.

NAVAL OPERATIONS AGAINST COASTS.

Naval operations against our coast may take one or more of the following forms depending upon the objects of the enemy:

1. Blockade.
2. Bombardment.
3. Deliberate attack.
4. Raids.

Blockade.—A blockade has for its object the isolation of a coast or a port by a fleet. It may be undertaken for the purpose of shutting up in a harbor an inferior fleet, or of interrupting and destroying the commerce of a great port. The first is called a war blockade, the second a commercial blockade. Either presupposes the superiority of the enemy at sea.

A war blockade would be instituted by an enemy to insure the safe transport of his troops, the unmolested carrying on of his commerce, and the safety of his own coast and bases. To maintain an effective war blockade, the enemy's blockading fleet will have to be considerably superior to our own, while in addition he will have to make provision for the frequent reliefs of his ships.

The blockading squadron will usually remain well out of the range of the fixed defenses, but it will make constant efforts to close in and bombard the fixed defenses and our fleet in the inner harbor. To defeat such attempts the defense will have to be constantly on the alert and prepared to open fire as soon as the enemy comes within effective range. At all times during the blockade the defense will have to be particularly on the lookout for the torpedo boats of the enemy, which will try to creep in at night to attack our vessels in the harbor. The difficulty of picking them up, the small target they offer the guns, their speed, their light draft (enabling them to run close under the cover of the shore), and the numbers in which they will probably attack, all combine to render the defeat of such an attack one of the most difficult problems confronting the coast artillery. All observers on duty must be constantly on the alert, and rapid-fire batteries must be fully manned at all times. During the day the field of observation from position-finding stations should be divided, and each station assigned to a particular sector of observation. At night each station should be assigned to a particular searching beam to supplement the watching of the search-light station for that beam. All channels not expected to be used by the defense should be closed by booms or other suitable obstructions.

In the future blockading fleets will undoubtedly make use of submarines, and their attack will probably be more difficult to defeat than that of torpedo boats. At present they are unable to dispense with periscopes, or optic tubes, and this furnishes a means of detecting them. In addition to this, Jane states: "If a submarine is in motion it disturbs the water so much that its presence is to be detected quite two miles away." At night, however, they will be very difficult to pick up, and as yet no instrument designed to indicate their presence has proved successful.

The blockading squadron may also when practicable, attempt to lay contact mines outside of the entrance, and then protect the mine field from counter-mining operations. Port Arthur furnishes an example of this use of mines. The attempts to plant the mines would probably be made beyond the range of the fixed defenses, and could be best defeated by the torpedo boats of the defense.

During the two most recent wars attempts were made to bottle up the blockading squadrons by sinking coal or stone-laden ships in the channel, but it was found that this was a very difficult operation.

The best means of offensive action against a blockading squadron is through the torpedo boats and submarines of the defense which attack the enemy at every opportunity.

The defense should, if possible, plant mines under cover of darkness in waters which may be occupied by the enemy during the day.

Bombardment.—Bombardments may be undertaken for the purpose of destroying docks, magazines and storehouses of our naval bases; or of rendering untenable to our warships a harbor in which they have taken refuge; or of inflicting damage upon our important coast batteries.

Only places of importance, commercially or militarily, need fear bombardment. The distance of our coast from the bases of possible enemies is such that a hostile squadron could not afford to fritter away any of its fighting strength on unimportant places. The bombardment of one of our great national centres, however, would affect not only the point struck but the entire country. Such a centre unprotected would lie at the mercy of the weakest attacking fleet.

Vessels in bombarding will either anchor in dead spaces out of the line of direct fire, or, if exposed to direct fire, will move back and forth over approximately the same water. If deep water out of the line of direct fire and within bombarding range does exist, it will probably be known to the enemy and would be the point he would select from which to conduct the bombardment. From this point he must be driven by mortar fire. The precaution must be taken during time of peace of providing mortar battery base-lines covering all dead spaces.

If the bombardment be attempted while the enemy's fleet is in motion, it may be difficult at first to determine whether a bombardment or a reconnaisance is aimed at. As soon as the intention to bombard has been clearly shown, fire should be opened from the mortars and from all large and medium caliber guns with the object of compelling the enemy to abandon the attempt, or, failing in this, to derange the accuracy of his fire.

The defense must be constantly on the alert, prepared to meet any change in the mode of attack of the enemy or to resist any other operations which may be made under cover of the bombardment. In all cases an attack upon one portion of the defenses should be the signal for every other portion to keep a sharp lookout to meet other attacks.

Deliberate attack.—A deliberate attack on the defense of a harbor would probably be undertaken for the purpose of seizing or holding the harbor as a base, or of destroying such ships and other property as are sheltered behind the defenses. It may take the form of a naval attack or of a land attack under the protection of a naval force.

1. A direct naval attack on fixed defenses would probably include one or more of the following phases:

a. Reconnaissance and attack of the mine field.

b. Reconnaissance of the artillery defenses.

c. Attempts to run by.

a. Reconnaissance and attack of the mine field: This would probably be the first phase of the attack, and would be carried out by small swift cruisers, torpedo boat destroyers and submarine boats; the object being to locate, and clear a passage through, the mine field.

The quickest way to put a mine field out of action would be to cut the main cables near the shore. This would only be possible at night under peculiarly favorable conditions, or in the absence of a defending force. There are three other methods that may be resorted to: creeping, sweeping and counter-mining. All are difficult and will probably be attempted only at night.

Creeping consists in dragging the mine field with grapnels for cables and junction boxes. This method is used in shallow water and as near the shore as possible.

Sweeping consists in dragging a weighted rope, chain or anchor between two boats some distance apart. Grapnels and explosive charges are sometimes attached to the sweep. Cables and junction boxes brought to the surface are cut or destroyed.

Counter-mining is a more expeditious method of destroying a mine field than the two just mentioned, and will probably be the one employed by the enemy if he is not provided with submarines. This operation consists in running lines of mines across the field and then exploding them in order to destroy the connections or cause the defending mines to explode by shock. Very heavy charges are contained in counter-mines—sometimes 500 pounds of guncotton. All the mines are attached to a single cable so that they may be fired simultaneously when the last mine is dropped. Buoys are attached to the cable to mark the channel cleared by the counter-mines. The mines are placed on board of a special counter-mining boat, or, if such a boat is not provided, on a large sailing launch, which is towed at full speed through the mine field, the mines and buoys being arranged to drop automatically.

The submarine boat offers at present the best means of attacking mine fields. Such an attack could probably be defeated by the defense only by the use of the same kind of boats.

All attacks upon the mine fields must be met by the prompt use of rapid-fire batteries. Should the large vessels of the enemy cover the attack, the large caliber guns of the defense will be directed against them until the enemy draws off or the attack develops into a general engagement. During fog and thick weather the protection of the mine field must be entrusted to patrol boats. On nights when searchlights are of value these boats should remain farther out and could then give an earlier warning of an attempt on the mine field.

If the enemy succeeds in clearing a passage through any part of the mine field, this passage should at once be remined, or if this cannot be accomplished the buoys which mark the passage should be removed. A channel cleared by the enemy may readily be remined at night or in thick weather by the defense.

b. Reconnaissance of the artillery defenses: — This reconnaissance has for its object the location and estimation of the nature and strength of the guns of the defense. It is probable that our batteries of guns and mortars have been set down approximately on the enemy's charts from information obtained in time of peace, but not in a sufficiently accurate manner to permit of the assignment of targets or of determining ranges. To determine the exact location of these batteries is, then, the object of the reconnaissance.

The vessels engaged would, as a rule, be fast cruisers, although all may take part in order to take advantage of any opportunity offered to run by. In order to deceive the defense a rapid advance will be made in line directly toward the entrance.

To defeat the reconnaissance the defense should bring into action the mortars and those guns only which are clearly visible from the sea. The fire of all others should be withheld. Any of our naval vessels which are in the harbor should make every effort to defeat the reconnaissance, and thus spare the coast guns from revealing their positions. If the reconnaissance is in force, the movement may at any time develop into an attempt to run by, and batteries must be held in readiness to open fire when the enemy approaches to within effective armor perforating range when all guns should be brought into action. The change of the formation to in column will warn the defense of the change of phase.

c. Attempt to run by:—This form of attack will generally develop from some other form at any stage of the action which may present a favorable opportunity, but it may be the first and only phase of the attack. Whenever it becomes apparent that an attempt to run by is to be made, fire as rapid as in consistent with accuracy, must be opened by all guns and mortars. A fog or low lying mist which would prevent a view of the water and yet not interfere with navigation would seriously handicap the defense and would be taken advantage of by the enemy. To guard against surprise patrol boats should cover the channel beyond the limits of observation from shore. These boats should be fitted with wireless telegraphy. When possible they should work from creeks and shallows outside the defended port to avoid returning through the harbor entrance and thus being confused with hostile boats.

If the mine field is intact the enemy may run merchant vessels over it with the object of clearing a passage, the battleships following in column at full speed. The torpedo and submarine boats of the defense should remain within the entrance and attack the ships as they enter. If the fleet succeeds in entering the harbor, the batteries can, as a rule, be taken in reverse and fire will be opened to cover the attack of a landing party. If this attack is defeated, or even if successful elsewhere, if the mortar battery is not captured, the harbor can be rendered untenable to the enemy's fleet.

2. The stronger we make our defense on the sea front the greater is the likelihood that the attack will come from the land side. Ships will not be risked against strong fortifications if a land attack holds out any hope of success. In this case the ships would make a strong demonstration against the fixed defenses to cover the attack of their landing party, and at the same time stand ready to take advantage of any distraction caused by the latter. A ship can spare from one-third to two-thirds of its crew for landing operations, so that an important position must make provision against the attack of at least five thousand men. This force will be provided with a movable armament of guns running up to at least three inches in caliber, so that our lines of defense should be drawn several miles outside of the principal objects to be defended. These works should cover all landing places and all means of land approach. In addition, the gorges of our works should have strong intrenchments well back, and the flanks should be protected in the same manner, both as an inner line of defense against a large landing force and also to prevent the works from being rushed by a small force landed in rear of either flank.

Raids.—Torpedo boat raids are very likely to take place during the earliest stages of a war, perhaps before war has been officially declared. At this period our squadrons would be mobilizing and preparing for sea at the naval bases and even one torpedo boat slipping through the entrance could do irreparable injury, a result which would amply warrant the enemy in the sacrifice of a few torpedo boats. The immense damage inflicted in the war now in progress through such a raid can leave little doubt that they will be attempted in the future, and that our enemy will use every possible means, fair or unfair, to insure their success.

The first necessity in a defense against this form of attack is the establishment of an efficient service of security and information. The patrol boat system before, referred to, should be established, and at all desirable points in the vicinity of the defenses there should be stationed lookouts, with telephonic or other means of communication with district headquarters. All narrow and unused channels should be completely closed by obstructions and, if practicable, the main entrance should be partially closed by a boom. The searchlights must be active, the observers constantly on the alert, and all rapid-fire batteries must be fully manned.

Raids may also take the form of minor actions during a deliberate attack, as in the case just described of torpedo boats forcing the entrance, or in the attack of these or other small boats upon outlying searchlight or position-finding stations, which cannot be supported by the rapid-fire guns. These stations should be protected by infantry, well entrenched and provided with a movable armament.

WAR LESSONS FOR THE COAST ARTILLERY.*

By Major JOHN P. WISSER, Inspector General.

The lessons of the Russo-Japanese War, so far as the coast artillery is concerned, can now be clearly read. They are not new to military students, but a résumé of them may serve to convince those who had previously doubted the principles laid down by the writers on the subject, and no doubt will present ideas new to the general public, and may serve to teach the world at large by the citation of practical examples what no amount of theory or argument could have taught. In war, more than in aught else, the world should profit by the experience of others, because war is very expensive, and few nations can afford to learn by their own war alone, but although the *facts* lie bare, it is a question if the world's nations will draw the proper *conclusions* from them, and learn the lessons they teach in such such a way as to utilize them for the future.

The lessons to be learned relate principally to the following subjects, which will be considered in turn :

Preparedness.
Command of the sea.
Landings.
Torpedoes and submarine mines.
The *land* fortification of coast forts.
Rapid-fire guns in coast forts.
Horizontal base lines for position finding.

In each of these the war has taught interesting and valuable lessons, and some of the developments have been startling even to the military and naval experts. The Russians have been prominent in the art of fortification ever since the era preceding the Crimean War, and in their study of coast fortification they have made many valuable additions to the literature of the subject in a practical way, consequently, the war is particularly rich in lessons for the coast artillery.

*The author has taken the liberty to refer occasionally, in the course of this essay, to his work on "The Tactics of Coast Defense", not with a view to calling special attention to that work (although there is, of course, great satisfaction in finding one's statements verified in actual war) but simply because there is no other similar work in our language to refer to, and to show that the lessons are not entirely new.

PREPAREDNESS.

The importance of *preparedness* has been illustrated in many previous wars (notably the Franco-Prussian), but in none so markedly as in this. Almost before the Russians were aware that war was upon them, Japan practically obtained command of the sea, and secured the *initiative*, and she has never lost either up to the present day.

But what concerns us here more particularly, is the degree of preparedness of the coast forts and its effect on the war.

There have been ten different naval attacks on Port Arthur, and in some of them at least 2500 rounds of heavy ammunition were fired by the coast guns, consequently the latter must have been well provided in the first place.* This also indicates the immense amount of ammunition with which coast forts must be supplied at the beginning of a war. The ammunition for all forts must be on hand at the opening of a war, as it is often difficult to obtain it in any quantity after the war begins.

Search-lights appear to have been on hand and in position in adequate numbers, and these also must be provided and installed in time of peace.

The position-finding system was defective at the outset, since the Japanese ships found positions within the effective range of the coast-guns, but were not fired on by the latter in the first attack or two. Evidently these warships had found dead angles where the Russian range-finders could not pick them up. In the latter attacks, however, this defect was remedied, and evidently by means of *horizontal*-base range-finding systems.

The other elements of preparedness will be discussed under their appropriate heads.

In a general way, therefore, the coast artillery of the Russians was well prepared, and it is interesting to note the great strength of the coast artillery garrison of Port Arthur: it is variously estimated at from 5,000 to 10,000 men. An indication of the men necessary to man efficiently the forts of a single harbor.

The guns of Port Arthur alone have preserved the Russian *fleet in being* at that place up to the time of its voluntary dispersal, and this fleet was the element of greatest concern to the Japanese, and the main cause of the delays in landing the different Japanese armies. The influence of the coast forts on the

* "A total of 80,000 projectiles and nearly 4½ million pounds of powder will be required by the sea forts (of a fortified harbor), 250,000 projectiles and 2 million pounds of powder for the land forts, and 40 million rounds of small-arm ammunition for the infantry."—"Tactics of Coast Defense", Wisser, p. 97.

war has therefore been very great, but, as will appear presently, this influence was extended even farther into the war, due to the fortifications on the land side and their *infantry* garrisons, which are still holding a considerable force of Japanese troops to besiege them, a force which would be invaluable in the field army at the front.

The preparedness of the coast forts at Port Arthur in many respects, however, was not adequate, as will appear below. Had it been, it is evident now that Japan would have had far greater difficulties to contend with than she has had, and her attacks on the defenses of Port Arthur would have demanded far greater sacrifice.

The great necessity for preparedness has been set forth by writers the world over, but material becomes obsolete very fast, consequently most nations hesitate to carry the preparations very far in times of perfect peace. But when it is considered that the most peaceably disposed nation may be *forced* into a war against its will, and that events may move with surprising rapidity once war has begun, it is evident that a certain degree of preparedness should be constantly maintained.

COMMAND OF THE SEA.

The value of sea power has been brought home to every American citizen by the classical writings of Captain Mahan, and needs no comment here, nevertheless, it is interesting to note the special nature of its influence in this particular war, and the relation of the coast artillery to it.

The command of the sea, at least for a time, was essential to Japan. Her sea power, and her naval ability in general, enabled her to strike the first blow and paralyse the Russian fleet at the outset, thus giving her command of the sea sufficient to enable her to carry on the land war, and to gain all the advantages she has so skilfully utilized. Her troops have been transported by sea and landed without opposition, and by this means have been advanced rapidly in the theatre of war without much tedious marching, the Russian positions on land have been successively flanked, and abundant supplies have been brought up to the front readily and promptly.

The Russian *fleet in being* at Port Arthur, however, as weak as it was, nevertheless had considerable effect in delaying the Japanese movements, especially the landing of the Second and Third armies, and it was the coast guns at Port Arthur that protected the fleet. This crippled fleet, indeed, delayed all the Japanese movements on land from the beginning, and became more and more dangerous as the landings had to be made nearer and nearer to Port Arthur. It was to protect her transports that the Japanese made such great sacrifices in the numerous and desperate sea attacks on this point of support for the Russian fleet, and all these efforts were made to render harmless the fleet which menaced these transports or the coast defenses which protected that fleet.

Japan's invasion of Korea and Manchuria would have been impossible without the command of the sea, and should that command be lost at any time during the war, Japan's victories on land would have availed nothing and the invading army would be compelled to give up its advance and retire to its own country, or capitulate, for it would be cut off from its base and isolated in a country from which it could draw no supplies.

These principles have also been known for some time, their true development, and proper presentation to the reading world being largely due to the writings of Captain Mahan, the recognized authority on the subject.*

LANDINGS.

"Fifteen years ago landings and operations with large landing forces were regarded as minor operations in war, to-day they constitute the most important problems the army and navy staff has to deal with." (*Tactics of Coast Defense*, Wisser).

In her war with China, in 1894, Japan gave the world some interesting lessons in the transportation of large bodies of troops, in a short time, to the enemy's coast, and landing them there for service on shore, and in the present war she has added another chapter to the literature of the subject of even greater import to the military world.

The great significance of landing operations is evident when we consider that in the five most recent wars (the Chino-Japanese in 1894, the Spanish-American in 1898, the South African in 1899-1900, the Chinese Expedition in 1900, and the present Russo-Japanese war) such operations have formed a most important element of the campaigns; and there is no doubt that they will play a most vital part in all future wars between nations possessing a seacoast.

The coast artillery is mainly concerned with the *defense* of a coast line against such operations. The coast of a nation is generally fortified only at points which are either tactically or strategically important, and there the coast artillery troops are

* See also, "Tactics of Coast Defense", Wisser. 1902. pp. 200-228.

mainly located; but the unfortified coast regions between fortified harbors must also be protected, and this duty should fall to the field army (infantry, field artillery and possibly cavalry), but the coast artillery may also be charged therewith, at least in the vicinity of the fortified places.

A simple consideration of the events of the present war and a glance at the map of the theatre of operations (especially along the coast), leads to the conclusion that the coast was neither adequately fortified nor carefully guarded. The only fortified harbor was that of Port Arthur. A few guns on some of the bays of the Kwantung Peninsula, at the mouth of the Yalu, at Pietzewo, or in the port of Newchwang, would have rendered inestimable services. The proper guarding of the coast would have at least made the landings of the Japanese more difficult, and possibly confined them to Korea (which Russia could not very well fortify), thus involving long marches for the Japanese army, and consequent delays in the operations combined with difficulties of supply. As it was, the Japanese were able to effect all their landings on Russian territory practically without any opposition.

TORPEDOES AND SUBMARINE MINES.

The torpedo, whether fired from a torpedo boat or in the form of a submarine mine planted in the channel, has never before proven such a formidable weapon of offense or defense. All the principal blows, so far as the effect on warships is concerned, have been dealt by the torpedo.

This weapon, for many years the subject of contempt, and despised by the highest naval authorities (probably with good reason), has suddenly became the most effective and dangerous weapon both for offense and defense. Farragut's method of treating torpedoes is no longer applicable, and the future naval commander must recognize the changes effected by scientific improvements and practical developments.

The splendid work of the torpedo boats in this war suggests the necessity (long and strenuously advocated by the coast artillery) of attaching a number of torpedo boats permanently to all fortified harbors, liable to be used as naval bases or rendevouz.

The accidents due to unexpected explosions of mines or floating torpedoes also indicate the necessity for greater familiarity in handling these dangerous weapons, and this can only be acquired by constant practice in time of peace, and the training of a considerable personnel in submarine mine work.

The inadequacy of the defense of Port Arthur is again illustrated in respect to submarine mines. Apparently, no mines were ready, or had been laid according to any system, otherwise the Japanese warships could not have entered the roads so freely.

The great efficiency of the torpedo boats in the attack and defense of Port Arthur, also suggests the use of submarines and submersibles, especially on the defensive. That they could have rendered invaluable aid to the defense seems indisputable. Again, the close approach of the Japanese warships and the steamers designed to block the channel entrance, to the shore, also indicates the advantages to be derived from shore torpedo batteries. In this connection we desire to quote the following from an article by Lieutenant L. H. Chandler, U. S. N., one of the most prominent authorities on the practical handling of torpedo boats of our navy, published in the *Proceedings of the U. S. Naval Institute*:

"A useful field for the employment of the torpedo, which I have not as yet touched upon, is for the defense of harbors not suitable for mining, both from regular or improvised torpedo batteries on shore, or from submarine boats. It is well known that there are many harbors in which, owing to a great depth of water, rapid currents, or other causes of a like nature, it is almost impossible to establish a thoroughly reliable system of mines. Here we have a field in which the automobile torpedo is without a rival. * * *

"The advantages offered by this style of harbor defense in places where mines are not available, or even as an adjunct to mines, are so great that I am at a loss to understand why it has not yet been taken up. A more powerful torpedo could be used from permanent shore batteries than it is possible to carry aboard ship, where the confined space available for handling marks the present five-meter torpedo as about the limit in length. By increasing the dimensions of the torpedo to about double those of that now in use aboard ship, I see no reason why a range of 5000 yards with a speed for that distance of 30 knots should not be attained, by a torpedo carrying 200 pounds of explosive, and such a weapon should give a speed of over 40 knots for 1000 yards. From a shore battery where range and position of the enemy can be readily determined, such a weapon should be absolutely accurate and reliable. * * *

"I believe that, in all harbor defense work, but especially in those special harbors where the use of stationary mines is beset with unusual difficulties, the use of the automobile torpedo is an absolute necessity, and one which it is very unwise to neglect in the way in which we are now doing. Regular shore submerged batteries, with powerful torpedoes; extemporized shore batteries, submerged or otherwise, with our service weapon; and the mobile torpedo batteries furnished by the submarine boats; taken in conjunction with such stationary mines as can be used, and an outer and constantly shifting line of regular torpedo boats, will beyond question form a defensive barrier that it would be madness for a hostile fleet to attempt, and the two mobile features of such a defense would also go far to keep such a fleet at a respectful distance from the harbor mouth."*

THE LAND FORTIFICATION OF COAST FORTS.

The importance of *land* fortifications for coast forts has been thoroughly appreciated by the Russians, and the Japanese force now held before Port Arthur to reduce that place from the land side (a force that would be invaluable at the front just now) is the result. In the Chino-Japanese war in 1894, the Japanese were able to reduce this place and Wei-hei-wei by land attack without risking a direct attack by sea, but the excellent system of land forts installed by the Russians has caused the Japanese to land a considerable force for their reduction, and forced them to suffer great losses in their attack.

This is another principle which was well known to military authorities, but the value of which is only now being fully realized. Moreover, the *infantry* garrison of this fortified place (30,000 men or more) is another point requiring consideration, and one generally overlooked. Any coast fort, not on a very small island, can generally be readily captured by a land force, unless there are adequate fortifications on the land side, and this is a point that must not be forgotten in the defense of a coast. The great necessity for sufficient *mobile* armament (rapid-fire guns on wheeled carriages) is also indicated.

Had Port Arthur been without its land forts, the present Japanese force besieging it could long ago have taken the place, and the besieging force would have been available at the front in the battles now raging before Mukden. Moreover, the Russian fleet in the harbor would have been readily destroyed, and the Japanese warships observing it would have been available elsewhere.

* For the principles of laying submarine mines, and the use of torpedo boats, submarine mines, submersibles, submarines and shore torpedo batteries, see "Tactics of Coast Defense Wisser", pp. 24-29, 63-64, 71, 92, 145-146, 152-154, 172-178, 189-191.

RAPID-FIRE GUNS IN COAST FORTS.

The necessity for a great number of rapid-guns in coast forts is another point which is peculiarly emphasized in the present war. This necessity, although often insisted upon by a few, was not fully appreciated in general. But the present contest has confirmed the principle long ago established by engineers and artillerists, and now at last the military world has awakened to the necessity for installing this arm in adequate numbers.

The torpedo boat attacks on the Russian ships at Port Arthur, and the entrance of the fire ships and the steamers laden with stone for blocking the channel of the inner harbor, have called attention to the deficiency in rapid-fire guns and have indicated the importance of the latter in the defense of a fortified port.

The number of rapid-fire guns required by a coast fort is determined by the number which an attacking fleet can deploy against it, and should be at least half that number. For every mile of the line of battle in which an enemy can deploy, within 2 miles of a fortified place, about 150 rapid-fire guns will therefore be required.

Torpedo boats move rapidly and are difficult to see in foggy weather, consequently they are very difficult to hit, and a great number of shots will have to be fired to put them out of action, and that in a comparatively short time. The facility with which the Japanese torpedo boats carried on their work at Port Arthur, and the apparent impunity with which they came close in, show that the number of rapid-fire guns in the coast defense was not sufficient. In addition to that, however, the use of submarines or submersibles by the attack, would still further complicate the problem, and render a far greater number of such pieces necessary, because the times during which such boats would be exposed to fire would be very brief, and a perfect hail of projectiles would be required to destroy them.

HORIZONTAL BASE LINES FOR POSITION FINDING.

The joint navy and coast artillery maneuvers, as well as the present war, have shown the value of horizontal base lines for position finding, in contradistinction to the system of vertical base position finders, or as supplementary to the latter.

Vertical base position finders on low ground (and indeed very often on high sites) are too much exposed to the enemy's fire, and therefore too readily put out of action ; and these position finders on high sites generally leave dead angles in the field of view, or areas which cannot be seen from the position-finding stations, and cannot therefore be covered by fire.

Horizontal base systems of range finding are consequently needed to supplement the vertical base instruments.

Moreover, at the long ranges (beyond 10,000 yards) the vertical base instruments, even under the most favorable conditions, are no longer accurate in their range determinations, and yet at those ranges the mortars are particularly effective and it is specially desired to use that piece. Consequently, the horizontal base system is here again needed.

Some of the bombardments of Port Arthur took place at exceedingly long ranges (reported at 13,000 yards), which were not heretofore considered possible from aboard ship. For such ranges no vertical base instrument at present in use, unless well advanced to the front (and therefore exposed to fire), will suffice.

In the early attacks on Port Arthur the Japanese ships readily found the dead angles of the range finders, but in the later attacks the existence of these dead angles had evidently been avoided by improvising supplementary horizontal base systems of range finding, for the Japanese found that they could not safely occupy the bombarding positions they had previously taken up.

CONCLUSIONS.

In view of the facts set forth above, it is evident that the great lessons to be learned by the careful study of this war are many and important.

In the first place, a certain degree of preparedness must be attained, depending on the geographical position of the country, and the distance over sea of the possible enemy. The time that will be available, however, after war has opened, must not be overestimated, since modern wars proceed with astounding rapidity.

In the next place, command of the sea is essential for over-sea operations on land, and to enable the navy to fulfil its highest duties to attain this the home coast must be fortified to render it secure.

Again, landings of large field armies on the coast will probably be an important feature of all future wars, consequently *coast guards* must be organized to cover the unfortified coast regions between the fortified harbors.

The torpedo has become the most destructive weapon known to modern warfare, and every fortified port must have torpedo shore batteries, submarine mines (where they are practicable), torpedo boats and submarine boats or submersibles, in sufficient number to aid properly the defense.

All coast forts, exposed to attack on the land side, must be properly protected by land forts on that side, and have a proper infantry and artillery garrison to man the fortifications.

Every coast fort must have a comparatively large number of rapid-fire guns to supplement the guns of heavy caliber, and to assist in the attack of torpedo boats, submarines or submersibles, especially in the vicinity of the mine fields.

In position finding, systems with horizontal base lines must supplement the vertical base instruments, not only to replace the latter in case they are disabled, but also to cover dead angles and to attain the extreme ranges.

These are the great lessons taught by the war, and their teachings should be carefully taken to heart and utilized by the world's nations.

JAPANESE INSTRUCTIONS UPON THE EMPLOYMENT OF ARTILLERY IN BATTLE.*

TRANSLATED BY SECOND LIEUTENANT ARTHUR H. BRYANT,
ARTILLERY CORPS.

These instructions form the fifth chapter of the firing regulations (3rd edition) of the Japanese army, approved by the Japanese Minister of War, March, 20, 1902.

GENERALITIES.

In battle artillery plays an important rôle: it increases the power of the other arms and diminishes the intensity of the adversary's fire. In a general way, it is important that artillerymen should be distinguished particularly by courage, abnegation, firmness of purpose and coolness.

Artillery ought to adapt itself to the terrain.

When different units of artillery act in concert, they are placed under the orders of a higher commander from whom emanates all orders and decisions and who himself depends on the chief of the detachment. All orders of the artillery commanders should be clear, concise, and rapidly transmitted.

The artillery ought to aid the other arms from the very beginning of the battle, and it is recommended that it act at the same time with all its available forces.[1] When several detachments of artillery take part in an action it appears preferable not to spread the batteries out at great distances from each other.

Artillery in combat can be subdivided into independent fractions from a section to a brigade. Even when they operate independently of one another, these fractions owe at all times mutual support and preserve by mounted scouts a close communication among themselves as well as with the principal forces. The unit of combat is the group of three batteries.

Choice of positions is of the greatest importance.

Artillery when in position opens its fire according to the orders of the higher commander (i.e., commanding officer) of the artillery.

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* Revue d'Artillerie, August, 1904.

[1] Compare with par. 263 of the German Artillery Regulations, August 10, 1899.

Even when the artillery operates in rear of zones swept by the fire of infantry, as it does in most cases, it should not because of that fact forget its obligation to sustain that infantry. Its action is particularly important in the decisive phase of the battle and then it *should in no manner seek to avoid the fire of the enemy's infantry;* it can thus, by its own intrepid action, give a powerful material and moral support to the other arms.[1]

The replacing of missing men is done in order and with the greatest calmness, by means of the reserves.

The artillery is protected from the fire of the enemy's infantry by the infantry which marches in front of it.[2] This infantry, which should always accompany the artillery, guarantees it against all surprise. However, in case of an unexpected attack, the artillery ought to be able to defend itself.

In case of a cavalry attack the artillery shouldr emain calm, await the enemy with firmness and receive it, unflinchingly, with an opportune volley.

Neither the loss of men nor the failure of ammunition should serve as a pretext for a retreat and the abandoning of a position when once occupied; the artillery ought to remain in battery and patiently await the replenishing of men and ammunition.[3]

In time of peace, artillery should always be maneuvered against an outlined enemy.

The service of reconaissance has a very special importance and with this object in view detachments both on foot and mounted ought to be attached to large masses of artillery.

During battle, the killed and the wounded are carried to the field hospitals by means of the empty caissons, their arms having been previously taken from them.

CHOICE OF POSITIONS.

The choice of positions depends above all on the topography of the terrain. In every case a good artillery position ought to satisfy the following conditions:

- Greatest possible field of fire;
- Ground in front completely open;
- Front perpendicular to the direction of fire;
- Emplacement of the batteries extended in breadth and in depth and permitting a ready means of circulation;
- Soil of the emplacement of a resisting character;
- Easy means of replenishing ammunition;

[1] Par. 265 German Regulations 1889.
[2] Par. 266 German Regulations.
[3] Par. 267 German Regulations.

Defilement suitable to the pieces, the caissons and the other carriages.

In seeking for positions which satisfy all these conditions (a desideratum always difficult and sometimes impossible to fulfil) one should not lose sight of the fact that he may be led to fight the enemy in any position whatsoever.

The choice of positions depends, too, on general conditions, as for example : the nature and extent of the target, the disposition of friendly troops, etc. Accordingly it is of the greatest importance to make in advance a very detailed reconnaissance of the designated position.

This reconnaissance ought to be made secretly for it is important to leave the enemy in ignorance of the position which the artillery intends to occupy. It will be good to make it not only with mounted men but also with men on foot.[1]

In important detachments, part of the batteries should be placed in masked gun pits in advance of the principal position of the artillery.[2]

The gun pit reserved for a battery (6 pieces) ought to have a front of from 56 to 140 paces. The interval between batteries varies from 28 to 56 paces.

OCCUPATION OF POSITIONS.

Roads of access ought to be found in rear of the zone of the enemy's fire and sheltered from an unexpected attack. The occupation of the entire position should be effected simultaneously.

In full view of the enemy, frequent changes of position will not in general be possible. If possible the position should be occupied during the night, without the knowledge of the enemy. Fire is not opened immediately but a favorable moment in the approach of enemy is awaited.

The regimental commander after having made the reconnaissance of the position and the objective, gives his orders accordingly to the group commanders and the latter in turn give them to their batteries.

The occupation of the position and the opening of fire should be rapidly performed ; all loss of time must be avoided and the batteries must hasten to be the first to open fire.[3]

It is always dangerous to occupy a position under the enemy's fire ; it is advantageous in such cases to deploy in advance and

[1] Par. 278, German Regulations, 1899.

[2] The Japanese call this artillery *the artillery of the advance guard.*

[3] Par. 288 German Regulations, 1899.

to come into position by a rapid movement in order of battle. This is particularly important for mountain artillery. In a general way one should go into battery as close as possible to the target to be fired upon, and to diminish the losses caused by infantry fire, *the artillery must know how to construct hasty entrenchments even while under the enemy's fire.* When time permits these entrenchments are constructed by sappers.

Particular importance will be attached to the occupation of flank positions; in this case sections of artillery are habitually sent and these sections place themselves in front and on the flank to bring about the defeat of the adversary.

FIRE.

Fire is executed under the direction of the artillery commander. Artillery ought to fire up to the last minute without disquieting itself about its own losses.

The principal objective of the artillery is the artillery of the enemy for it is that which produces the greatest effect upon the opposing troops; however artillery ought also fire on the infantry and cavalry. Against a cavalry attack firing is executed by salvos; the essential conditions of success are the resolution of the battery commander, the training, calmness and sang-froid of the men. Besides, artillery can also fire on the commander of the opposing forces[1] and upon balloons.

To inflict rapidly great losses on the enemy at a determined point the fire of the greatest number of batteries should be concentrated and accelerated. In the case where the front of the enemy is very extended the target should be divided into sections and the fire of all the artillery should be concentrated upon each part in turn.

The commanders of the units which form part of the same mass of artillery have no right without authority of the commander of that artillery to turn their fire upon objectives other than those which have been assigned to them.

The group commander constantly follows the fire of his batteries and gives them, if it is necessary, directions according to circumstances. At the decisive moments of the battle he can change the objective on the condition that he report the fact immediately to the regimental commander. In critical circumstances the battery commander has the same right, immediately informing the group commander.[2]

[1] Par. 306, German Regulations, 1899.

[2] Par. 308.

The conduct of fire belongs to the battery commander, and the choice of projectiles to the group commander. Against cavalry at short ranges shrapnel with uncut fuzes are fired, aiming at about the height of the shoulders of the horses.

CHANGES OF POSITION.

Changes of position are generally made under the direction of the artillery commander; in urgent cases the battery commander can execute a like movement on condition that he report the fact immediately to the artillery commander.

The battery commander who has received an order to change position should continue to fire up to the very moment which he judges to be the most favorable for executing the prescribed movement. Movements by hand are not considered changes of position.

As a general rule changes of position are made by battery and by echelons.[1]

The coming up to a new position ought to be done, as long as it is possible, rapidly, concealed from the enemy and in deployed order without change of formation, so as to avoid too great losses from the fire of the enemy. The caissons follow and remain in rear of the zone of fire.

REPLENISHMENT OF AMMUNITION, ETC.

Artillery must of necessity dispose of a great quantity of ammunition and spare parts of harness. Ammunition is of prime necessity on the field of battle and special attention must be paid to the service of replenishing it.

In each field battery three caissons march with the firing battery. The other three caissons of each of the three batteries of the group are united and form *the reserve group* under the command of a captain; they march immediately in rear of the fighting group. In mountain batteries projectiles and charges are transported on pack saddles (6 horses to the piece).

The group commander give the necessary orders relative to the ammunition of the group reserve. At the moment of combat he fixes the emplacement of this reserve.[2] It should be found in every case in rear of the zone of the enemy's fire and about 300 meters from the fighting group.

As soon as a battery has emptied one-half of its chests the fact is reported to the group commander who gives the necessary orders for a sufficient number of the caissons to come up.

[1] Par. 317, German Regulations, 1899.

[2] Par. 296, German Regulations, 1899.

In column of march the regimental ammunition reserve follows its division. At the moment of combat the emplacement to be occupied is indicated by the regimental commander. The regimental reserve replenishes the ammunition of the group reserves.

With the ammunition columns marches the train with certain reserve articles (horse-shoes, bits, spare poles, etc.,) as well as hospital supplies.

The ammunition columns ought to maintain constant communication with their corresponding units. They are distinguished by a special numbering and announce their presence by means of signal flags.

The group and regimental reserves replenish the batteries in men, horses, and spare parts.

THE COMBAT.

In the different cases which may present themselves the artillery conforms to the following rules:

1. Offensive Combat.

The principal object of the instruction of artillery in time of peace should be the offensive combat.

This combat presents itself sometimes as an attack of position sometimes as a chance engagement.[1] In both cases the columns of march take the formation prescribed for the reserve and the artillery should enter into the struggle in the most energetic manner before the infantry comes into action. The artillery of the advance guard should occupy rapidly, and concealed from view, an advance guard position in which *it ought to fortify itself.* It should conceal with care the presence of the main body which is in rear of it. It seeks from the very first to silence the fire of an enemy.

In an unexpected action it is indispensable to get the start on the adversary in the occupation of positions and the opening of fire. The offensive commences on the order of the chief of the detachment.

In case of an attack of position it is better *to begin the deployment of forces before daybreak,* concealed from the enemy and as near as possible to him.[2] In the offensive *all of the artillery of the detachment comes into line at the same time*[3] except some batteries which remain in reserve and are carefully concealed from the

[1] Par. 318, German Regulations, 1899.

[2] Par. 320, German Regulations, 1899. It may be remarked here that the Japanese seem to make frequent use of night attacks.

[3] Par. 320, German Regulations, 1899.

enemy. It is advisable to direct against the enemy cross-fire from two different positions.

The artillery duel continues until the infantry undertakes its attack in battle formation. From this moment the artillery ought to transfer its fire to the enemy's infantry and to aid with all the means in its power the advance of its own infantry. When the latter approaches sufficiently near to the enemy's position to make firing over the heads of the troops dangerous, the artillery sweeps the ground in rear of the point of attack in a manner calculated to prevent the movement of the enemy's reserves.[1]

Finally, to facilitate the attack and the occupation of the position some batteries are sent forward to accompany the infantry; they ought to *sacrifice themselves* to give the latter the moral support which is necessary.[2]

When the position has been taken the artillery comes forward, installs itself there and fortifies.[3] In case of a repulse, it covers the retreat of the infantry,[4] firing over the latter.

II. Defensive Combat.

In the defensive the choice of position presents a very particular importance. It must be organized and fortified. The roads of access are put into condition and arrangements made for the observation of the field of fire. If there is time the ground in front is reconnoitered and distances to the points of probable entrance of the enemy on the field of battle are measured.[5]

Although on the defensive concentration of fire may also be of great importance, at first in *order not to betray the position of the artillery to the enemy*, fire must be opened only with a few pieces placed in advance or upon the flanks of the principal position, the remaining batteries occupying generally the center of the position and holding themselves in readiness to aid the foregoing.[6] It will often be of great advantage to *detach some pieces in order to have them execute an enfilading fire.*

In defensive positions suitable cover for the men, horses, ammunition and material should be provided.[7]

The commander of troops prescribes the opening of the fire; fire should not be executed at long range nor upon insignificant detachments, (scouts, connecting files, etc.).[8]

[1] Par. 322, German Regulations, 1899.
[2] Par. 323, German Regulations, 1899.
[3] Par. 324, German Regulations, 1899.
[4] Par. 325, German Regulations, 1899.
[5] Par. 326, German Regulations, 1899.
[6] Par. 327, German Regulations, 1899.
[7] Par. 327, German Regulations, 1899.
[8] Par. 328, German Regulations, 1899.

At first the enemy's artillery is fired upon.[1] The fire is not directed against the infantry except upon the order of the commander of the troops. When the enemy's infantry approaches, a rapid salvo fire is opened upon it, without however forgetting to counter-batter equally the artillery.[2]

In case of failure in the defense the artillery should distinguish itself by its hardiness and sang-froid ; at the very moment of the approaching attack, the batteries retard the movement of the assailant by remaining in position and pouring in an intense fire up to the very last moment.[3]

On the defensive, in general, fire by masses will be employed.[4]

III. Pursuit.

In case of success in the attack, the artillery of the attacking force ought to fire, as long as possible, on the enemy in retreat, directing the fire first upon the heads of column and then successively on the rest of the troops as they come in turn within the zone of action of its projectiles.

In the pursuit, changes of position are left to the initiative of battery commanders. It is well under these circumstances to resort to enfilading fire which is always the most effective.[5]

It is important in the pursuit to pay particular attention to the amount of ammunition consumed.

IV. Retreat.

In retreat the artillery is the protector of the infantry. It should pour upon the pursuing force a violent fire which it will render as effective as possible, either by a concentration of fire, or by salvo firing ; it will be necessary then for it to use a considerable number of projectiles of the reserve supply, to withdraw slowly, to choose the easiest routes for the march and above all to guard against unexpected flank attacks.[6] The position which it occupies should not hinder the retreat of the infantry. Flank positions reinforced by trenches are very useful for covering the retreat.[7] During the retreat changes of position are executed at a walk[8] ; the trot can be allowed only when the morale of the troops in retreat is good and it is necessary to occupy a temporary position as rapidly as possible.

[1] Par. 329, German Regulations, 1899.
[2] Pars. 330 and 331, German Regulations, 1899.
[3] Pars. 330 and 331, German Regulations, 1899.
[4] Par. 329, German Regulations, 1899.
[5] Par. 333, German Regulations, 1899.
[6] Par. 335, German Regulations, 1899.
[7] Par. 336, German Regulations, 1899.
[8] Par. 267, German Regulations, 1899.

THE FIELD GUN QUESTION IN FOREIGN ARMIES.*

A year ago the Scandinavian States alone, not considering France, had effectively solved the problem of field artillery re-armament. In the year which has just passed, this question, then being studied by all other Powers, has been decided nearly everywhere, if not in regard to facts and actual details, at least with respect to principles and ideas. All along the line it has been a triumph for the French doctrines and methods, and of these the Germans have been the most zealous advocates. The ready pens of German military writers have filled the magazines and reviews with articles relating to this subject. The majority of those who have some reputation have followed General Rohne in his evolution towards French ideas and those opposed have served hardly more than as foils to make the value of the arguments used against them stand out more prominently. The great German gun factories, following the example of French national industries, endeavored at the same time to imitate systems of construction formerly much deprecated by the greatest of them. This military and industrial conversion of Germany has brought about the adherence of all other Powers to the principles of construction and organization on which the present French artillery rests.

The following study will enable one to appreciate how far they have succeeded in copying their model.

The foreign states which at the present moment possess their new field artillery material are: Norway (Ehrhardt material), Sweden and Denmark (Krupp material).

Eight states, having terminated the period of experiments in 1903-1904, have definitely adopted a type of gun and have begun its construction. Switzerland and Holland after competitive tests have given preference to the Krupp material. Roumania and Turkey have chosen the same material, *a priori*, "without engaging in a bewildering series of comparative trials and without opening a fair for guns."† Portugal, at the conclusion of tests between the Creusot and Krupp works, signed a contract May 9, 1904, awarding Creusot the order for all her field artil-

* From the Revue Militaire des Armées Etrangères, September, 1904.

† Speech of the Minister of War, Roumania, November 27, 1903.

lery. Mexico has ordered part from St. Chamond, part from Creusot. England has adopted a model presented by the Technical Artillery Committee, and has confided its construction to English firms.* The United States has acted likewise, but the material will be constructed only in part by American firms.†

The two great military powers of central Europe, Germany and Austria-Hungary, appear to have also adopted a model of rapid-fire field gun after long experiments. The work of construction will probably soon begin in the government shops and those of private firms.‡

A few states are still conducting final tests or are on the point of making a decision. Belgium hesitates only between the types submitted by Krupp and Saint-Chamond. Spain, which already possesses rapid-fire field guns of French construction, Servia and Bulgaria will probably choose one of the French models.

Finally two Powers, Russia and Italy, after having renewed a part of their material, have undertaken studies and experiments again, with the object of rearming the rest of their field artillery with a more improved type.

LONG RECOIL CARRIAGE.

The necessity of using long recoil carriages in order to obtain a rapid rate of fire is to-day no longer disputed by any one. A single state, Italy, has put into execution the ideas current in Germany prior to 1902.

The 120 batteries of 75 mm. field guns with accelerated fire, mounted on rigid carriages and intended to replace the Italian 7 cm. bronze guns, were completed only at the beginning of 1904; but the hour of disillusion had struck a long time before this across the Alps. Instructed by this costly experience, Italy, like all the other Powers, has adopted the long recoil carriage, and now awaits the completion of studies undertaken for the purpose of beginning the construction of batteries destined to replace the 87 mm. guns.

BRAKE AND RECUPERATOR.

All field artillery systems adopted§ or in course of adoption have the hydraulic brake for checking recoil. Variations occur

* Twenty-one batteries intended for the Indian army are to be constructed in the fiscal year 1904-05. For the English army, the government intends to have 64 batteries constructed in the course of the fiscal year 1905-06 and 76 batteries during 1906-07 (Declaration of the Secretary of War, Arnold Foster, June 30, 1904).

† Fifty pieces have been ordered from the Ehrhardt works at Dusseldorf.

‡ Appropriations have been made in Austria-Hungary, but in Germany the budget for 1904 carries no credit intended for the rearmament of the field artillery.

§ With the exception of the Italian gun, 75 mm. A, spoken of above.

in regard to the means for returning the gun "in battery". If we except Russia, which has adopted a recuperator composed of rubber pads, Engelhardt system, for its field gun (model 1900, Poutilov type), all states have had to make a choice between spring recuperators and hydropneumatic brakes. Moreover Russia, no doubt little satisfied with the results obtained with the recuperator of rubber pads, has excluded it in the further tests that are being made for the selection of a definite type. There are, then, in reality only two systems now in vogue.

Almost all states have pronounced themselves in favor of spring recuperators up to the present time and the reason for this preference is readily understood. No foreign gun manufacturer has submitted at these various competitive trials a model of field gun provided with a hydropneumatic brake, because none of them had succeeded in designing such a brake capable of holding air at sufficient pressure. On the other hand, the hydropneumatic brakes designed by French firms had not reached, at the time when most of these trials were held, that degree of perfection which they have now attained.

The superiority of the French hydropneumatic brake is affirmed in a positive manner by the particularly careful and exhaustive trials which preceded the adoption of the Schneider-Canet material in Portugal (May, 1904). It was established "that the inferiority in efficiency of the Krupp spring recuperator was not only manifest, but that it could be considered as absolutely inherent in its nature.........."

"This recuperator consists of a long steel spring permanently subjected to considerable compression, which at the moment of fire, has to withstand an effort of more than 700 kg.; therefore it is very possible that it may break, as happened twice during the tests at the Vendas Novas polygon. Moreover, it is quite certain that this spring rapidly loses its elasticity, for the reason that at Vendas Novas dozens of times it failed to return the gun to the firing position, both in rapid-fire series and in slow, aimed fire..........

"It is said that the central counter rod of the hydropneumatic brake is apt to be broken by vibration at the moment of recoil. But this is a criticism of a type that has already been discarded by the constructors. Moreover, the counter rod is replaced in the Krupp brake by an analogous organ, the valve, which, according to the statement of the constructor, sometimes breaks and hinders the return in battery."* In so far as concerns the

* Revista Militar, Lisbon, April 15, 1904.

lack of simplicity imputed to the hydropneumatic brake, "it is sufficient to note that even the measurement of pressures, considered by their opponents as a laboratory operation, has been made at Vendas Novas by soldiers chosen at random and without preliminary instruction."*

It is well to add that even in Germany, the question of the brake and that of the recuperator are among those which do not appear to have been completely solved in the studies relative to a new rapid-fire field gun. According to reports in the German press, "the seven batteries ordered from Krupp in January, 1903, which were put in the hands of troops for test in March and participated in the Imperial maneuvers of 1903, were found very satisfactory; and the Board on artillery tests, after having subjected this material to severe endurance trials, discovered only some slight defects." But among these "slight" defects, the German papers mention precisely leakage of liquid and breakage of recuperator springs.

The German constructors have, moreover, given up denying the weakness of their spring recuperators. One of the principal arguments that they put forward in favor of this system is only that the breaking of a spring does not put the piece completely out of action and that in case of accident to the brake, accelerated fire can still be continued.

BALLISTIC QUALITIES.

The rapid-fire guns recently adopted by the various military Powers, have a caliber of from 75 mm. to 76.2 mm. and throw a projectile weighing from 6.2 kg. to 6.8 kg. with a muzzle velocity of from 480 m. to 518 m.†

If, in the rearmament of the German field artillery, "the tube and ammunition of the present gun are retained, the ballistic qualities of which are so completely at the height of the times," as General Rohne affirms, the properties of the new German field artillery, too, will not depart widely from these figures (weight of projectile, 6.8 kg.; muzzle velocity, 465 m.).

In Austria-Hungary it is likewise declared—to justify the use of bronze as the metal for guns—that a ballistic efficiency comparable to that of the French and Russian guns is not demanded in the new material, and that the Austro-Hungarian artillery will rest content with a velocity of 500 m. and weight of projectile 6.5 kg. In a memorandum addressed to the members of the Chamber, the Association of Mining and Metallurgical Industries

* Revista Militar, Lisbon, April 15, 1904.

† The muzzle velocity is much greater in Russia (589 meters).

admits that bronze answers these requirements, which are those of the present time, but takes issue on the claim put forth in the official document, "that this metal fulfils all the requirements of the future."*

"It is certain," says the memorandum, "that the German artillery will not remain inferior to others, and the possibility of an increase in its ballistic qualities is guaranteed for the future by the use of steel. The moderate requirements of Austria-Hungary, on the contrary, completely exhaust the qualities of bronze; all future improvement is excluded then, and it will no longer be possible to take into consideration the constantly increasing power of explosives."

There is, however, one exception, and it is very suggestive. It is often said: the experience of war leads to the desire for power above all else in artillery material while long periods of peace advance the qualities of lightness and mobility to the first place. Now, after the South African war, England gives this fact striking confirmation. The 1903 model adopted by this Power consists of a piece which is to fire a projectile of 8.4 kg. with a muzzle velocity very much greater than 500 m. It is indisputable that such a result can be obtained only at a sacrifice of lightness or of immobility during firing.

WEIGHT OF MATERIAL AND IMMOBILITY DURING FIRING.

Conditions imposed were everywhere very exacting at the beginning of the period of trials. In all countries it was desired to obtain from constructors the most powerful and at the same time the most mobile gun. These two contradictory requirements could very well have been realized, up to a certain point, in the former slow-fire systems of artillery. But they became very much more difficult to reconcile as soon as a third was added: the absolute immobility of the piece during firing. It then became necessary to lower the requirements and solve the problem by a combination of the three. Most nations have contented themselves with the ballistic qualities previously indicated (weight of projectile, 6.5 kg., muzzle velocity, 500 m. at a maximum), and in this way have been able to obtain a piece weighing about 1750 kg. limbered and 1000 kg. in battery. The increase in muzzle velocity of the Russian gun, model 1900, (velocity of 589 m.) has caused a marked increase in the weight of the piece (1884 kg.) even though the carriage is not provided with shields; yet its immobility during firing is insufficient to permit of truly rapid fire.

* The Field Gun Question in Austria-Hungary. Parliamentary document.

General Rohne declares that "the German gun C/96 when transformed will possess the advantage of remaining stationary during fire without the necessity of lowering brakes, an operation which would delay the opening of fire, but this is an advantage that should be given up if the high ballistic qualities of the French gun are demanded."*

England hopes to obtain a ballistic power superior to that of all other field artillery of the world (weight of projectile, 8.4 kg., muzzle velocity, much greater than 500 m.) in a rapid-fire field gun the weight of which limbered is not to exceed 1900 kg. It is readily conceived that these figures, may have been received with some skepticism. Experience alone will show the degree of immobility of the new English piece when firing.

SHIELDS ON THE CARRIAGE.

The subject of shields is still one of the most controverted questions at the present time, but we are far from the time when a German journal declared that "the adoption of a shield would be a disgrace to the arm." The fact is that all field guns recently adopted carry shields about 4.75 mm., 5 mm., and even 6 mm. thick.

In Norway, where the Ehrhardt material has been in use since 1902, the necessity for shields was recognized at a later date. The problem was a difficult one to solve on account of the weight of the piece, which was already great. A detachable shield, 3.5 mm. thick, had to be adopted. This is fastened on top of the axle and on the march is carried by the caisson. This arrangement is not altogether satisfactory, because the shield has to be attached to the piece before firing, which requires a certain amount of time, and moreover the legs of the cannoneers are not protected. Denmark has had to grant extension of time to Krupp for the delivery of its field artillery material "in order to enable him to take under consideration recent experiments relative to the use of shields."† The shield, 5 mm. thick, adopted by the United States is composed of three parts which are hinged and fold upon one another on the march.

In Germany certain authors have fought "this disease of modern artillery" with weapons of irony, "this epidemic, the period of incubation of which has lasted ten years, which will inevitably lead to a fatal issue unless some decisive medical intervention does not apply at the proper moment an appropriate

* Zur Artilleriefrage, by Rohne, Lieutenant-General z.D. (Jahrbuecher, February, 1904).

† Internationale Revue.

prophylactic treatment." They have affirmed "the possibility of making war on this bacillus by the simple healing processes of nature, which must not be confounded with empiricism." But up to the present time, their remedies do not appear to have acted with any great degree of efficacy. General Rohne has always been in favor "of a shield 3 mm. thick, offering protection from infantry fire up to a range of about 400 m. and from shrapnel fire at all ranges. Whatever may be the methods of fire used, the number of hits obtained will always be proportional to the vulnerable surfaces of objectives. With the same expenditure of ammunition and in the same length of time, there will never be obtained the same result against a battery with shields as against one without them. The latter will be put hors de combat while the former will be hardly touched. In addition, every process (for example, a different construction of the projectile) by means of which the effect on batteries with shields would be increased, would also lead to the disadvantage of diminishing by that much the efficiency against living targets." This opinion may be considered official in Germany since the Minister of War has declared, before the budget commission, February 16, 1904, "that the German field artillery must adopt shields because the French have them."

A single Power, Russia, has up to the present time been decidedly opposed to the shield. An opponent of the armored gun carriage, who believes in seeing before believing, says on this subject: "If the Japanese have armored their guns—perhaps afterwards, as the Norwegians have done—events in the Far East could be a fertile source of practical experiences in the battle of batteries with shields against batteries without them."*

BATTLE FORMATION.

The principle of the shield for the carriage being admitted, the necessity of protecting equally the larger part of the personnel ought to lead to the adoption of the armored caisson. These caissons are generally such that they can be tilted up to the rear, and have a plate on the bottom 5 mm. in thickness (Danish model), or else, as in Sweden, are armored on the front face so that without being upturned they can be placed beside the gun during firing.

This formation has raised numerous objections in Germany. General Rohne is in favor of it "because it is the only disposition of the caisson that ensures promptness of ammunition supply. Other measures that have been proposed are too delicate

* Schilde fur Feldartillerie, by Wille, Major-General z.D.

to be employed on the field of battle,—as is the case in regard to the endless chain,—or rather they would lead to the purveyors of ammunition being rapidly put hors de combat. The danger of a caisson exploding, in consequence of a shot hitting and penetrating it, and causing disorder in the battery is undeniable; but the difference is hardly appreciable if the caisson, instead of being on the firing line, is some paces in rear."*

ORGANIZATION.

Reorganization of field artillery has everywhere been considered as a corollary of rearmament. All the Powers that are putting rapid-fire field guns in service are at the same time reducing their batteries to four guns, with the exception of Russia who has retained eight guns to a battery. Military writers in Germany have taken up this question also. General Rohne expresses himself as follows: "The great rapidity of fire of the gun with long recoil on the carriage enables us to reduce the number of pieces of each battery to four. A battery of four guns will have a greater efficiency than a battery of six because in the latter: 1, the rapidity of fire of each piece could not be utilized; 2, it would be less under the control of its commander; 3, troops in times of peace would be relatively less in number. Rapidity would lead accordingly to 'recklessness of fire' and waste of ammunition. In a battery of four guns, each piece, forming with its caisson a platoon, can be commanded by an officer."

In the great military Powers, notably in Germany, the closely related question of the number of batteries to be attached to an army corps has been discussed. Some officers do not look without regret upon diminishing the number of guns that can be put in the firing line and, having admitted the principle of batteries of four guns, demand 36 batteries for an army corps, in order to maintain the 144 guns of the present organization. General Hoffbauer, adopting an intermediate position, wants 30 batteries of 4 guns each for the army corps. But the greater number are satisfied with the present 24 batteries of rapid-fire guns each of four pieces.

"A corresponding increase in the number of batteries (36 batteries of four guns each for an army corps, or even 30) is not necessary and would cause numerous inconveniences; notably, a more restricted supply of ammunition and the impossibility of deployment of such a mass of artillery. There are needed, then, for an army corps 24 four-gun batteries, the two pieces

* Zur Artilleriefrage, by Rohne (Jahrbuecher, January, 1904).

taken away being replaced by two caissons. Well trained batteries, plentifully supplied with ammunition, that will surely find the space necessary for their deployment, will be of much more value than numerous batteries scantily supplied with ammunition, that will not be thoroughly trained due to the more reduced strength of personnel in times of peàce, and that could never all enter into action because ground will be lacking for their deployment."

General von Blume considers that even if the French return to 144 or 120 guns for an army corps, Germany should not, in a spirit of imitation, go beyond having 96 guns as the required number. "The prime question is to determine the maximum amount of artillery that can be advantageously employed in battle, for everywhere else this arm is only an encumbrance for the command." The same author shows that on August 18th, 1870, "there could never have been found along the front of attack of the German army the necessary space in order to have the artillery of five army corps brought into action simultaneously, if each of these corps had had 144 guns." From this study he draws the conclusion that "not only the employment of artillery on the field of battle has its limits, but that even within these limits the support given the infantry by the artillery does not increase proportionally with the number of guns."*

METHODS OF FIRE.

Everywhere there has been appreciated the necessity of doing away with the former methods of ranging and of adopting a method of progressive fire with a large fork, based more or less on the French method and "assuring the complete utilization of the properties of the new guns."

An article published in the Artilleri-Tidsskrift, by Colonel Wennenberg of the Swedish army, gives the results of experiments made in Sweden with the new gun, model 1902, in firing under battle conditions. "The method of fire is not yet elaborated in all its details to such a point that it may be said we have obtained from the new material all that might be required of it. This could be attained only after a certain length of time of actual use of the guns. But the experiments have already been so extended that from now on we can work along independently and according to our own ideas, although the principles in force in France with the exception of a few minor changes, have been also followed by us up to the present time."

* Der Bedarf an Artillerie fuer die Schlacht, by v. Blume (Jahrbuecher, April, 1904).

Though excusing himself for being an admirer of foreign ideas, General Rohne recognizes that in this important question he is obliged to borrow his arguments from the French artillery drill regulations which permit of passing to effective fire so very rapidly. He therefore approves of the necessity of changing the methods of fire in order to obtain all the advantages inherent in rapid fire, by seeking "not the greatest possible efficiency, but a sufficient effectiveness in the shortest possible time; for the important point is by far the utilization of time rather than that of ammunition."

From this rapid review it is a legitimate conclusion to hold that foreign systems of field artillery have been inspired to a very great degree by the material, organization and tactics of the French artillery. But with the exception of the English gun, on which an opinion cannot be passed at the present time, no foreign rapid-fire field material possesses the marked ballistic qualities of the French field gun. The heavy financial sacrifices made by the Powers for there armament of their artillery can not be frequently repeated. The guns now in course of construction and those which will be shortly adopted abroad will without doubt remain, then, in service for a long time. From this fact the advance made by France in 1897 appears in a way firmly established.

PROFESSIONAL NOTES.

Artillery Material, U. S. Service.

Service guns and mortars.—These have been maintained in a satisfactory state of efficiency. New firing mechanisms are now being assembled, and this work will continue in the different armament districts as rapidly as possible. Efforts to improve the rapidity of fire of seacoast and other guns have not been relaxed. The direction of such efforts during the year has principally been confined to mechanical rammers, automatic breech openers and desirable changes in details of existing mechanism.

An experimental mechanical rammer was designed and tested with a 12-inch B.L. rifle on a 12-inch disappearing carriage, L.F. model of 1901. The object of this device is to decrease the time and labor required to seat the projectile and powder charge in the chamber of the gun. It consists of a car, travelling on a circular track on the loading platform of the emplacement, and carrying separate loading trays and rammers for the projectile and powder charge. The force required for seating the projectile in the bore is obtained from springs compressed by hand power between shots. The powder is seated by a rammer actuated by hand power only. The results of the tests of the device showed (*a*) the projectile was discharged into the gun at such high velocity that hardened-steel projectiles would injure the rifling and parts of the bore about the entrance to the projectile seat; (*b*) with the present form of powder grain and quantity required for full charge, that all sections of the charge can not be inserted simultaneously. The device will be altered so as to insert and seat the projectile at a lower velocity, and subjected to further tests. The difficulty of inserting the powder charge in one operation would, it is believed, be overcome by the substitution of rods for the present grains of powder.

An experimental mechanical breech opening and closing device has also been designed and made. It is now being tested on a 12-inch B.L. rifle mounted on a disappearing carriage.

Seacoast carriages.—The 6-inch disappearing carriage, L.F., model of 1903, is essentially a rapid-fire mount. The time required for the gun to rise into battery has been reduced to about three seconds. In the shop tests of several carriages this operation required only two and three-fifths seconds. A sighting platform and 3-inch objective telescopic sight are provided on each side of the carriage. On the left platform are handwheels for traversing and for elevating, and on the right a handwheel for traversing only. This enables each of these operations to be performed by a separate gunner when direct fire is used. Springs, which the upper ends of the gun levers compress during the last part of their rotation in recoil, accelerate the beginning of the return of the gun into battery.

As much time is consumed in applying a quadrant to a mortar each time it is laid in elevation, several different designs of fixed quadrants and elevating devices have been made and tested. The design submitted by Capt. E. P. O'Hern, Ordnance Department, was found to be most satisfactory, and a

Correction.

Following page 291, the pages now numbered 300, 301, 302, should be 292, 293 and 294, respectively.

Page 289: 6th line from bottom, for "there armament" read "the rearmament".

Supplement: Index to Current Military Literature, Exchange and Book Notices.

Authors alone are responsible for opinions expressed.

number are being made for practical test during next year's army and navy maneuvers. The design of the safety firing switch for mortar carriages has been completed and the switches ordered applied to all carriages in service. The switch positively breaks the firing circuit until the mortar is elevated to 45°, the lowest elevation at which mortar fire is had.

All of the 12-inch disappearing carriages, L.F., model of 1897, will be provided during the coming year with complete electric traversing, retracting, elevating and depressing equipments; 3-inch objective telescopic sights, sighting platforms, counterbalance devices, etc., which will make them in all material respects the same as the 12-inch disappearing carriages, L.F., model of 1901. All 12-inch disappearing carriages, L F., model of 1896, in service, are being equipped with electric retracting equipment. The retracting gears of the 8-inch and 10-inch disappearing carriages, L.F., model of 1894, are being redesigned and will be provided with wire retraction ropes. The only means provided on the 15-pounder barbette carriages, procured from the Driggs-Seabury Company, for moving the gun in azimuth, was the shoulder bar, which experience shows is not satisfactory. A system of gearing for this purpose has been designed and will be applied to all carriages in service when funds permit. A multiple scale for range drums and pointer has been designed and a number will be issued for trial. The design allows the effect upon the range of all variations in the muzzle velocity from the standard to be corrected for by data obtained from a trial shot.

The investigations for verifying the accuracy of the formula heretofore used in the calculation of the throttling openings of the hydraulic recoil system of gun carriages, have been continued A formula has been experimentally determined which, with those formerly used, allows for the contraction of the liquid vein, and has been practically tried in different carriages with excellent results. It is found that the flow of oil through the orifice varies materially with the form of piston used.

Smokeless powder.—This Department has continued its investigation of smokeless powders with a view to improving their qualities to enable them to be fired under pressures of from 40,000 to 45,000 pounds per square inch for the purpose of utilizing the strength of our service guns. It has been noted that some powders when fired at high pressures develop critical points in their pressure curves, or points at which the rate of evolution of gases suddenly increases for an increase of charge, resulting in excessive pressures, often exceeding the elastic strength of the guns. Early examination of some such powders indicated them to be normal, except that the material of the grains appeared to be more brittle than those of other lots. When struck by hammer on an anvil or when compressed longitudinally in a vise, pieces would break away from the grain with more or less violence, while grains from other lots of powder without critical points would be compressed to flat disks without breaking into separate and detached pieces. This quality of brittleness is considered to be a source of danger, and the experiments in regard to it have resulted in the introduction into the specifications for smokeless powders of a test to determine the toughness of the colloid. This test is as follows: Take 10 powder grains representing a lot of powder to be examined and cut off both ends of each grain at right angles to the length of the grain until the length equals the diameter = 1. Compress these slowly between parallel surfaces until the first crack appears. The decrease in length necessary to crack the grain is calculated as a percentage of the original length, and the average must not show less than 45 per cent. A very good powder should show over 50 per cent.

When attention was first invited to the effect of brittleness it was suggested as being important that the relation between brittleness and percentage of volatiles be determined and three samples of powders having percentages of volatiles of 4.33, 3.73, and 3.33, respectively, were selected for test. When fired no critical points were obtained in any of the pressure curves. One of the samples was placed in the heating chamber and the temperature regulated at 120°, which was subsequently raised to 150° and then to 180° F. The heating was continued at intervals for about six months. The test indicated that under continued drying at high temperatures a maximum of quickness is reached after which, for some reason, the powder becomes either slower or weaker. An important deduction is that as long as powders retain their normal percentages of volatiles from which they are with difficulty deprived, they should not give dangerous pressures in firings with service charges, and the toughness of the powders was found not to be materially affected by considerable variations in the normal percentages of solvents. The Department has now under consideration a possible change in the form of the grain to increase the progressiveness of the powder, and the necessary investigations may even lead to a change in the composition.

The reserve supply of powder issued to posts is stored in hermetically sealed galvanized cases. These cases are effective, can be repeatedly used, and have sufficient strength to permit of their being piled on their sides in tiers as high as the head room of magazines will permit. Some of the early forms of cases were sealed by balata washers which were found to be unsatisfactory. Means have been found by which these can be converted at a very slight expense into those of later model in which the sealing is done by a soldering strip, and the changes are being made as rapidly as possible.

Capped and uncapped projectiles.—Under allotments from the Board of Ordnance and Fortification this Department has been conducting experiments upon deck armor of 3½ inches and 4½ inches thickness, with 8-inch, 10-inch and 12-inch armor-piercing shell, capped and uncapped, at varying angles of impact, to determine the effect upon the armor, and also the relative value of the capped and uncapped shell in mortar firing. In these experiments the plates were required to fulfil the requirements of protective deck plates prescribed by the Navy Department. The plates were mounted on a strong oak frame and backing with the face of the plate in a vertical plane, making the desired angle with the direction of the axis of the bore of the gun, and at a suitable distance from the muzzle to interpose screens for measuring the velocity at each round. The charges used were determined to make the striking velocity in each case the same as the remaining velocity for an angle of fall equal to the angle of impact. With the 8-inch capped shell and a 3-inch plate, perforation was secured with an angle of impact of 25°. The 10-inch capped shell at 20° and the 12-inch at 15° both seriously cracked a 4½-inch plate. The results of these firings lead to the conclusion that, for relatively thin plates at least, the capped is markedly superior to the uncapped shell, even for very oblique angles of impact and relatively low velocities.

In connection with this test one 12-inch armor-piercing capped shell, charged with high explosive and detonating fuse, was fired against a 4½-inch plate, the angle of impact being 15°. The percussion part of the detonating fuse was arranged without the delay-action feature, so that it would operate with as little delay as practicable following the impact of the projectile on the plate.

The effect of the shell on first striking the plate was to make a glancing indent; the projectile then moved until its base was about 12 inches from the middle of the indent, and exploded in contact with or in close proximity to the face of the plate. The explosion was a high order of detonation, and the plate was completely wrecked, the backing was nearly destroyed and moved 6 feet from its initial position, and swung round about 45°.

—*Report Chief of Ordnance*, 1904.

Range Firing With Mortars.

The present scheme of range firing from seacoast mortars contemplates the sweeping of the field of fire from a range of 3000 yards to the maximum range of the mortars. The field between these limits is divided into ten zones, requiring ten different powder charges. At present the maximum range obtainable is 10,800 yards, due to the inability to fire the mortars with sufficiently large charges to give the requisite muzzle velocity for longer ranges, owing to weaknesses which have developed in certain parts of the mount. To remedy this and also increase the angle of elevation to 70°, parts of the mount have been redesigned. The principal changes consist in placing on each side of the mortar opening in the racer a girder on which the recoil cylinders are trunnioned and in replacing the five throttling holes with continuous throttling grooves cut in the walls of the recoil cylinders. When these alterations have been made it will be possible to sweep the field of fire from ranges of about 2000 to 11,400 yards, and the number of zones required can be reduced to six, or possibly to five. This is particularly advantageous on account of the reduction in the large number of powder charges required by the existing scheme. Under the proposed plan 1000-pound projectiles will be used with five different charges of powder from the shortest to a maximum range, the angles of elevation varying between 45° and 70°, except that with full charges the highest angle of elevation will be limited to 65°. On account of this limitation it may be found possible to omit the girders, which it has been proposed to add to the carriages. Eight-hundred-pound projectiles will be used for the outer zone only, to extend the ranges requiring full charges and velocities of 1325 f.s., with elevations between 45° and 65°.

Recent firings with these mortars indicate very clearly that the drift of mortar shell is to the left for angles of elevation between 60° and 70°. The point of crossing from left to right of the plane of fire seems to vary somewhat with different projectiles, but all of the curves cross before the elevation drops much below 60°. The drift to the right seems to be a maximum for an elevation of about 55° and then to decrease, showing a marked tendency to recross the plane of fire for an angle less than 45°. In order to investigate this tendency more fully and at less expense than that which would result from firings from 12-inch mortars, a series of firings was made from the 75-millimeter subcaliber tube in the 12-inch mortar to include all angles of elevation between 5° and 70°. These latter firings indicate that for the atmospheric conditions existing at the time of the test, the 75-millimeter projectiles did not at high angles of elevation show a drift to the left of the plane of fire; a tendency of the projectiles to go to the left was, however, apparent.

Deflection of 12-inch torpedo shell.—In order to determine whether 12-inch torpedo shell on striking water are deflected toward the surface at an angle of fall, a series of experiments have been inaugurated to embrace the action of projectiles on water impact from the .30-caliber bullet to the largest projectile the trajectory of which under water can be recorded. The firings from a .30-caliber rifle were made from a rest, the inclination to the surface of the water being varied; for each inclination a charge was used to give initial velocities to projectiles of 500, 700, 900 and 1100 f.s. Thin vertical screens of suitable material were placed near each other and under the water, and the holes made by the bullets passing through enabled the trajectory to be plotted. The results indicate that the small-arms bullet is first deflected downward toward the normal and then shows a tendency to move away from it. In several cases the trajectory, due to this movement, passed the prolongation of the axis of the piece. The energy of the bullet is so rapidly dissipated it is difficult to say how much this movement toward the surface of the water might amount to in a projectile weighing 1000 pounds. It was observed, however, that the tendency of the bullet to rise to the surface of the water increases as the angle between the line of fire and the surface of the water decreases. It is apparent that for some angles less than 15° the bullet will enter and emerge after travelling some distance under the water. For an angle of fall of 15° the .30-caliber bullet, with a striking velocity of 500 f.s., travels horizontally about 100 calibers after penetrating to a depth of about 23 calibers. These figures are not materially changed by increasing the striking velocity to 1100 f.s.

If the 12-inch armor-piercing shell loaded with high explosives and fired at extreme range, at which it would have an angle of fall of approximately 15°, should travel 100 calibers and penetrate not more than 23 calibers below the surface of the water, it is evident that the probable damage to a battleship would be much greater for the shell striking 100 feet short than for the shell striking the ship, assuming, of course, that the percussion fuze in the shell is adjusted not to act on water impact, which is practically the case with service fuzes which will be used. It will be borne in mind that any departure of the seacoast projectiles from the tangency to the trajectory will increase the chances for reaching the hull of a battleship by striking the water short of the battleship, since the increased surface of the shell striking the water would give a stronger tendency to upward deflection. It having been correctly assumed that the dimensions of the target for a mortar shell are increased by twice the effective radius of the shell when exploded under water, the principal lessons from these experiments is that with shell fired from high-power guns the dimensions of the horizontal target may be increased 100 calibers by the shell striking short of the target. The results of the experiments with the .30-caliber bullet have in general been confirmed by firings made from the 6-pounder gun, and firings from guns of larger caliber are in progress.

—*Report Chief of Ordnance*, 1904.

Field Artillery Material, U. S.

The manufacture of the 3-inch field artillery material has progressed satisfactorily during the year. The difficulty of obtaining the superior quality of materials required in its construction has been overcome with the exception of the counter-recoil springs and panorama sights. All of the material except these two articles is being procured in this country. Repeated efforts have been made to interest American manufacturers in the making of the two excepted articles and, it is believed, with success. Appropriations have so far been made for 26 complete 3-inch field batteries for the Regular Army and 26 batteries for the Militia, all of which are now under manufacture, except 6 guns, carriages and limbers, which have been completed and issued. The remainder should be finished by October 1, 1906. The pilot 3-inch carriage was completed and proof-fired at Rock Island Arsenal last December, and was then sent to the Sandy Hook Proving Ground for further test. There have been fired from it 787 rounds. As the margin of stability of the carriage for horizontal fire was found to be greater than necessary, the length of recoil of the gun on the carriage was reduced from 48 to 45 inches. The action of the carriage with the 45 inches of recoil was highly satisfactory.

The design of the sights for this carriage was completed after much study, and sights are now being made at Frankford Arsenal for all carriages under manufacture. The sighting apparatus differs materially in design and operation from that previously used in our service ; the principal difference consists in the provisions made for indirect laying of the gun and for setting it in elevation from either side of the piece. This latter provision enables the piece to be kept constantly on the target, and results in an increased rate of fire. On the left side of the carriage there are an open front sight, with cross wires, and a rear sight, the shank of which carries a peep and a panorama sight. The latter sight has a 1-inch objective, a field of view of about 10°, a magnifying power of 4 diameters, and forms the image erect. The axis of the objective is 5.6 inches above that of the eyepiece, and by means of worm gearing can be rotated through any angle about the vertical axis of the telescope. A glass reticule is provided with horizontal and vertical cross lines, and two additional horizontal lines, 3 and 6 millièmes, respectively, above the horizontal line. The rotating part carries a disc graduated to 64 points, each point being 100 millièmes. The rotation of the eyepiece is effected by means of a worm provided with a micrometer giving a least reading of 1 millième or one one-thousandth of the range. The shank can be swung laterally to correct for differences in level of the wheels ; it has an elevation scale graduated in yards, and a deflection scale graduated in points.

The range quadrant on the right side of the piece has adjustments for correcting for differences in level of the wheels and for the angle of site. It is graduated in yards. A battery commander's telescope is now undergoing trial ; its telescope is similar to that of the panorama sight and has vertical and horizontal scales graduated to the same unit as the panorama sight.

Upon its completion the automobile forge and battery wagon was successfully run from Jersey City, its place of manufacture, to Washington under adverse conditions of roads, and was further tested on the various roads in the vicinity. During the summer it was issued to the battalion of field artillery at Fort Myer, Va., for further tests during practice marches and the Manassas maneuvers. The wagon when fully equipped for the field weighed about 12,000 pounds, which was too great for the bridges and culverts found on the average country road. Much valuable information and data were obtained from the building and operation of this wagon, which are being utilized in a new design under preparation in this office. The new wagon will carry complete machinist's, carpenter's, saddler's and farrier's tools, and a limited quantity of supplies, but no spare parts, etc., for the battery. This will enable the weight of the loaded vehicle to be reduced to less than 8000 pounds. The motive power will be supplied by four cycle gasolene engines, as in the earlier model.

Small-caliber field gun.—Claims having been made that a field gun of about 2 inches in caliber, mounted upon a long recoil carriage and firing high explosive shell weighing about 5 pounds, would in a given interval be more effective than a 3-inch field gun firing shrapnel, tests were made during the year for the purpose of securing information and arriving at an opinion in regard to the relative value and serviceability of such material. These tests have not sustained the claims above mentioned. On the contrary, the rapidity of aimed fire from these two guns not being very different, the relative value of their fire is to be regarded as more nearly proportioned to the weights of their respective projectiles, especially when it is considered that the 3-inch gun will fire both a 15-pound high explosive shell and 15-pound shrapnel. The usefulness of the small-caliber explosive shell is apparently restricted to destructive effect by direct projectile hits upon exposed material, such as field guns, caissons, houses, etc., since its explosive charge is not sufficiently powerful to be of much value in breaching effect.

The pattern of such small-caliber shell exploded in flight is similar to that of the 15-pound shrapnel—i.e., the fragments are projected forward in a similar cone of dispersion. The shell was, however, of slight value in its effects against troops in the open, since the action of its percussion fuze was such that the burst occurred frequently on impact with the ground or after ricochet on a rise of a few feet only. Its value in this respect would probably have been improved by having a longer delay action in the fuze. The form of the cone of dispersion due to the small bursting charge was such that the shell could not be used for searching effect on troops in ditches or behind parapet. Capacity for accomplishing this purpose is generally regarded as the chief reason for employing high explosive shell with field guns. It may be remarked that the plans of this Department contemplate the use for field purposes of a lighter gun than the 3-inch gun now under manufacture, and it is proposed to make the caliber of this gun 2.38 inches, the projectile for which will weigh 7½ pounds, this being considered the smallest caliber which can employ an efficient shrapnel.—*Report Chief of Ordnance*, 1904.

French Mountain Artillery.

In France, a 68 mm. mountain gun designed by a certain Captain Ducrest has been tested with satisfactory results. The drill regulations for mountain artillery, approved September 4, 1902, are arranged in a manner similar to that of the regulations for field artillery, and conform to the latter in so far as they are adapted to the guns in question.

The piece consists of the gun, the carriage, composed of the front carriage and trail, the wheels and the shafts, all of which parts are detachable. The piece can be either drawn on wheels or carried on pack animals. In the latter case three animals are required, one for the gun, one for the carriage, and one for the trail, the wheels and shafts.

The gun is of steel of the built-up type, with a DeBange breech block with plastic gas check, and the sight is mounted on the side. It is 50 calibers in length and weighs 150 kg. The carriage is of sheet steel. The front carriage weighs 112 kg., the trail 34 kg., the wheels 54 kg., and the shafts 19 kg.

The ammunition is carried in chests which are packed on mules, as is also the mountain forge. The batteries are also provided with wagons for transporting forage for the animals and the packs and supplies of the personnel. The projectiles supplied are shrapnel with combination fuze, weight 6.3 and 6.5 kg., long shell with percussion fuze, and canister. The pointing devices include the quadrant, the azimuth circle, the direction scale and battery telescope. Each piece is equipped with a fuze punching machine similar to that of the field gun. Recoil is checked by a friction brake bearing on the hub of the wheel.

The piece is served by four cannoneers: one gun pointer, one assistant pointer, one firing number and one ammunition server. At the ammunition chest are one fuze setter and one ammunition server.

Against a stationary target it is prescribed that progressive fire with time and percussion fuze shall be employed. Salvo fire is to be employed under certain circumstances and the "rafale", in which the fire is brought to the ultimate limit of rapidity. Owing to the absence of a traversing mechanism on the gun, sweeping is impossible.

On the march and in action the battery is subdivided in the same manner as field batteries; the personnel of the battery, on a war footing, is divided into 6 sections, each in charge of a chief of section and one or two sergeants.

Great importance is attached to the reconnaissance of the position before occupation. Until superiority of fire has been obtained, the pack mules are to be held in a sheltered position, but not further than 3 minutes from the battery. As a rule the battery will be transported on pack animals.

—*von Lobell's Jahresberichte*, 1903.

Japanese Field and Mountain Artillery.

Recently published descriptions of this material enable us to complete the short notes previously given[1]. The following, with the plate, is taken from the Mitteilungen uber Gegenstande des Artillerie- und Geniewesens, 8 and 9 Heft, 1904.

FIELD GUN.

The gun (fig. 1) consists of the tube *A*, the jacket *B*, the trunnion band *C*, carrying the trunnions which are lengthened out on either side and thus serve also as the axle of the piece, the locking ring *D*, and the front ring *E*, which locks the jacket to the tube. The gun is of forged steel and is painted a snuff-color.

At the breech end (fig. 2) on the under side are two projections *H* between which the arms *J* of the carrier fit and are held by the pin *G*. On top of the breech is the seat *K* for the pointing arc, and on the right side is a tubular projection *F*, perpendicular to the axis of the piece, which holds the sight in direct fire or the direction plate in indirect fire.

The breech mechanism is of the interrupted-screw type and opens downwards. It consists of the carrier *L*, the breech block with its threaded sectors *M'*, the angular operating lever *MNQ*, the extractor and firing mechanism. The carrier, as above stated, is hinged to the breech of the gun on the lower side. The cylindrical breech block has its threads cut away over ¼ of the circumferenee in two places, likewise the breech housing of the tube, so that when the breech block is shoved in, a quarter turn locks it. The breech block is screwed in the carrier and can be rotated in the latter one-quarter of a revolution. It is bored out axially to receive the firing mechanism. Towards

[1] JOURNAL U. S. ARTILLERY, September-October, 1904, p. 193.

the top of the carrier is the operating lever MNQ, which turns about M. It has a horizontal arm NM and a short vertical arm MQ; the short arm carries a stud which engages in the slot Q in the breech block, and in opening and closing the breech serves to rotate the breech block the required amount. The operation of opening the breech is then evident. The operating lever is raised until the arm NM is vertical, whereby the short arm becomes horizontal and the breech block is turned through ¼ a revolution. The slot Q is then in the dotted position Q' (fig. 2), the screw threads of the block are disengaged from the female threads of the breech housing, and the block is locked to the carrier by means of the locking bolt R. The carrier, together with the block, is then pulled down to the rear until it comes into the horizontal position, in which it is held by a suitable support (dotted lines, fig. 3). Closing the breech is performed in the inverse order.

The firing mechanism consists of the firing pin with its striker, the main spring, another small spring, and the trigger S. The two springs are assembled one behind the other; the main spring is compressed and the firing pin armed by closing the breech. If the breeck block is not fully closed a safety device prevents the piece from being fired. The normal position of the striker is regulated by the small spring, whereby the cap of the cartridge is protected from accidental blows of the striker. The details of the firing mechanism and the trigger device are shown in figs. 2 and 3.

The extractor T lies in the lower part of the breech recess and is operated by an arm U. This arm is mounted on the same pin V that serves as hinge-pin for the carrier, and in its recess has a motion to the front and rear about this axis. On the lower side is a stud W against which the carrier strikes when the breech is opened; the arm U rotates to the rear actuating the extractor T, which ejects the cartridge case.

CARRIAGE.

The trail consists of two pressed steel flasks with curved edges, suitably tied together by transoms. The front end of the trail is reinforced by stiffening plates A, bolted on and so constructed as to form the trunnion beds of the gun. The trunnions extend through them and carry the wheels of the carriage at their outer ends. Near the middle of the flasks of the trail the road brakes are hung by tie rods B. The recoil brake lies at the lower end of the trail between the flasks. At the end of the trail are the trail shoe C, the pintle ring D, two trail handles E, and the folding trail-handspike F. The carriage also has axle stay-rods H and two axle seats.

The elevating mechanism is on the right cheek of the trail and consists of the worm N, with handwheel M, the worm-wheel L, and the pinion O, the teeth of which engage in those of the elevating rack on the gun.

For checking recoil and returning the piece to battery use is made of the recoil brake and wheel-shoes which replace a trail spade. The recoil brake is arranged as follows: On the inner side of the nave of each wheel is a grooved rim in which a traction rope runs (fig. 5). The ends of these ropes are fastened one end to the wheel-shoe and the other to the cross-head P (fig. 3) of the piston rod, (dotted lines, fig. 5, side elevation). In the flasks of the trail there are grooves in which this cross-head slides. When the cross-head is pulled forward by means of the ropes the cup-shaped springs (Belleville) of the brake are compressed. The wheel-shoes are hung from the axle by chains and have spade-like projections on the under side, which sink into the ground when the wheels on recoil force them down. In firing, at the beginning of

recoil, the wheels turn and run up on the wheel-shoes, whereby further motion is stopped. At the same time the ropes wind on the naves and draw the cross-head forward, compressing the springs and thus checking the recoil. The wheel-shoes firmly embedded in the ground, prevent the carriage from sliding to the rear. When the pull on the ropes stops, the springs run the whole system forward, the wheels rolling off the shoes. The average length of recoil is 0.5m. Although the piece is thus run forward after fire, it does not always happen that it comes into exactly its original position; it has to be relaid after each round, which diminishes its rate of fire.[1]

On account of this recoil and the operation of the breech mechanism, which requires two motions in either opening or closing the breech, the Japanese field gun cannot be included in the class of true rapid-fire guns, but only in that of guns with accelerated fire, as for example, the German field gun, model 1896.

The road brake *T* is so arranged that it can be placed lower, as is necessary when the gun must fire at great angles of elevation. This brake is operated by the crank handle *V* on the left side of the carriage. The wheels have 16 spokes and a metal nave. Their diameter is 1.4m., so that the height of the line of fire is 0.7m.

MOUNTAIN GUN.

The mountain gun differs from the field gun only in a few details. The carriage consists of two parts which are held together by a pin. The Belleville springs of the recoil brake are replaced by a spiral spring. The wheels have only 14 spokes, and are 1m. high so that the height of the line of fire is 0.5m. The carriage has no road brakes. The material is carried on four pack animals, two of which carry the carriage. A fifth pack animal is provided for each piece for carrying ammunition and equipment.

POINTING APPARATUS.

The sight for the field gun is the usual form of open cross-sight, consisting of the sight standard and head with deflection scale. The head has a stud for the first rough laying and a peep for accurate aiming. The front sight is on the right trunnion of the gun. On the sight standard there is a range scale graduated from 200 to 6200m. (below 1000m., marked every 50m. and above, every 25.), and also a scale graduated in degrees from 0° to 20°. Each degree is divided into 16 parts and $\frac{1}{16}$° corresponds approximately to $\frac{1}{1000}$ of the range. The sight is held in the seat *F* on the right side of the gun, can be left in its seat during firing, and is raised and lowered by a spiral-screw gear. Allowance for drift must be made on the deflection scale. The length of the line of sight is 700mm.

On the sight for the mountain gun, the range scale is graduated from 0 to 4300m., and the scale of degrees from 0° to 30°, each division being subdivided into 16 parts. The length of the line of sight is 400mm.

For indirect fire the pointing arc (quadrant) and direction plate are used. The pointing arc consists of a rather flat arc (not a full quadrant) of copper with the same scales on it as on the sight. The level and index travel along the upper side of the arc, being moved by a translating screw engaging in a rack on the arc. The level has also on one side a scale for angle of site. The index can be set for this independently of its movement along the arc.

The direction plate for azimuths consists of a vertical standard, which fits in the seat for the sight, a horizontal drum attached to the standard, and an

[1] The Japanese drill regulations prescribe the following rate of fire: Four to five rounds per minute for a single gun, 15 to 20 rounds per minute for a battery of six guns.

alidade fitting over this drum and revolving about it. The standard is hinged to the drum so that whatever may be the elevation of the gun, the flat plate of the alidade can always be made horizontal. The drum can not be turned horizontally about the standard, and its circumference is divided into 144 equal parts, each equal to 2½° ($\frac{360}{2.5}=144$). The plate of the alidade revolves about a vertical axis passing through the center of the drum. It has an index pointer on the under side which can thus be brought opposite any division of the drum, and the plate can be clamped in that position by a set screw. The alidade plate is graduated on the near end to read 10 minutes, 15 divisions each side of the 0, so that each interval on the drum is thereby divided into 15 parts ($\frac{2.5°}{15}=\frac{150'}{15}=10'$). An angular change of 10′ corresponds to $\frac{3}{1000}$ of the range. The ruler of the alidade has an index that moves along this scale and is clamped at any point by a set screw. A given setting having been made, the gun is laid on the auxiliary aiming point by sighting along two sight vanes along the longer axis of the ruler. These vanes are painted red.

AMMUNITION.

Two kinds of projectiles are provided for both field and mountain guns: Shrapnel with combination fuze and high explosive shell with base percussion fuze.

The shrapnel (painted black) has a base charge of 75 grams of black powder above which is a diaphragm and above this are 234 bullets which are regularly packed in 13 layers (each of 18 bullets) around the central communicating tube filled with 17 grams of compressed meal powder. The bullets are of hard lead, are 12½mm. in diameter, weigh each 10.7 grams and do not appear to be set in any matrix. The finished shrapnel is 3.35 cal. long (about 25cm.) and weighs 6 kg. The fuze is screwed in the head. The combination fuze has two rings, the upper fixed and the lower movable by means of which the time of burning is set. In general its principles of construction are the same as those usually followed, but in the percussion part it is centrifugal acting. The firing pin is fixed in position. Below it the plunger is held firmly in place at the base of the fuze by six clips about 1½cm. long which engage over the upper edge of the plunger. During flight of the projectile, due to its rotation,[1] these clips separate and fly back against the walls of the chamber, leaving the plunger free, which then acts on impact.

The explosive shell is made of steel and has a very fine pointed, hard steel head screwed on. In the base is an opening for the base fuze. The shell weighs 6.1 kg. and is 4.47 cal. long (about 33⅓cm). The charge consists of 800 grams of yellow powder (probably melinite). The base percussion fuze for this shell is similar in principle to the percussion part of the combination fuze. The plunger has near its lower end a projecting ring which rests on the base of the fuze chamber. The plunger also carries the firing pin. Eight clips surround the plunger, their upper ends being pivoted above it and their lower ends resting on the projecting ring. Due to the rotation of the projectile during flight, they fly back and release the plunger. The detonator consists of 2.5 grams of a very powerful high explosive; above this an upper chamber of the fuze is filled with 60 grams of fine yellow powder.

The cartridges are put up in brass cases, and are separate from the pro-

[1] The velocity of rotation must not be less than 6000 revolutions per minute.

jectile. According to all accounts up to the present time, they are not united before use. There is no "fixed" ammunition.

The limber carries 40 rounds (5 of which are explosive shell) packed in compartments, the cartridges on the upper tier and the projectiles below. Those for the explosive shell are marked in red. The limbers for the guns and for the caissons are the same in construction and carry the same number of rounds. The chests of the caissons carry 50 rounds, 5 of which are explosive shell. The caisson differs from the limber in having a road brake of the usual construction. The limbers and caissons have no springs. A characteristic of both is that the axle is not continuous from wheel to wheel, but consists of two short pieces fastened on each side under the chest. This construction is evidently for the purpose of saving weight.

The following table gives the ammunition supply of a battery: *

	SHRAPNEL.	EXPLOSIVE SHELL.
6 guns (limbers)	6 × 35 = 210	6 × 5 = 30
3 caissons of the fighting battery (limbers and bodies)	3 × (35 + 45) = 240	3 × (5 + 5) = 30
3 caissons of the group reserve	3 × (35 + 45) = 240	3 × (5 + 5) = 30
Total	690	90

* According to the Militaer-Wochenblatt of October 18, 1904, the ammunition supply of a battery at present consists of 6 gun limbers with 40 rounds each, and 6 caissons (with their limbers) containing 40 + 50 = 90 rounds each. In addition, one ammunition column is attached to each artillery regiment, and three to each division, each column consisting of 27 caissons. For each battery therefore there are 24 wagons at 90 rounds each, a total of 2160 rounds. This gives for one gun 360 rounds which, with the 40 in the limber, makes a total of 400 rounds per gun that are immediately available. Of these, 355 are shrapnel and 45 explosive shell. For the mountain batteries 16 projectile chests take the place of each caisson. These are carried on pack animals.—ED.

NUMERICAL DATA.

	FIELD GUN.	MOUNTAIN GUN.
Caliber	75 mm	75 mm
Length of gun	2.2 m	1 m
Length of bore	1.86 m	0.8 m
Number of grooves	28	28
Twist	7°	7°
Depth of grooves	0.75 m	0.75 mm
Diameter of wheels	1.4 m	1.0 m
Height of axle	0.7 m	0.5 m
Height of line of sight	90 cm	70 cm
Length of line of sight	70 cm	40 cm
Value of a division on the sight and pointing arc	1/1000 R	1/1000 R
Value of a division on the direction plate	3/1000 R	3/1000 R
Shrapnel, weight	6 kg	same as for field gun
bursting charge	92 gm	
number of bullets	234	
weight of a bullet	10.7 gm	
diameter of a bullet	12.5 mm	
Explosive shell, weight	6.1 kg	
bursting charge	800 gm	
Muzzle velocity	1500 f.s.	900 f.s.
Track	1.2 to 1.3 m	0.7 m
Weight of gun	316 kg	100 kg
of breech block	16 kg	——
of gun with carriage	846 kg	290 kg
Limits of elevation	— 11° to + 19°	— 10° to + 30°
Weight of powder charge	450 gm	——

The Present Status of the Edison Storage Battery.*

Type E is the cell now manufactured and placed on the market in three sizes, which differ only in the number of assembled plates. The full capacity of the cell is found to be about 140 ampere-hours, which makes the total output at 30 amperes, 173 watt-hours, and at 120 amperes, 145 watt-hours; or the specific output 13.7 watt-hours per pound (30.2 watt-hours per kilo) and 11.5 watt-hours per pound (25.4 watt-hours per kilo) at the two rates, respectively,

The containing cell, as also the grids and pockets, are made of thin sheet steel plated by a special process. The jar completely encloses the element and the lid is soldered permanently in place. There are four openings in the steel top. Two of these are insulated by rubber bushings, through which the terminal posts project. The third opening is a filler hole with gas-tight hinge-stopper. The fourth opening is a gas vent provided with a valve and gauze screen, to prevent escape of entrained liquid.

The insulation between the walls of the can and the enclosed element is all of hard rubber. On the bottom is a four-barred grating, 0.4 inch deep. On the ends are ladder-like frames, giving about 0.11 inch clearance and grooved to hold the edges of the plates. On the sides are solid sheets 0.014 inch thick. It has been found necessary to subject all the rubber insulation to a special chemical treatment to prevent a foaming action of the alkaline electrolyte.

Between the plates are threaded four-cornered rods of rubber about 0.1 inch thick and spaced 0.57 inch apart. The distance between opposed plate surfaces is about 0.04 inch. Plates of like polarity are bolted to a horizontal bar at the top, provided with spacing washers and joined to the vertical terminal post.

The grid itself and the pockets containing the active materials are identical for both positive and negative electrodes. The grid is 9.25 inches high—excluding the lug—4.75 inches wide and 0.015 inch thick. It contains 24 rectangular holes, each 2.95 inches high and 0.5 inch wide. Into these holes are fitted pockets. These are made up of strips of 0.003-inch steel, having flanged edges that telescope together to form the pocket or container of the active material. These pockets have each about 5,000 perforations.

The active material of the positive plate is an oxide of nickel in finely divided form commingled with a conducting substance, such as flake graphite, in order to improve the conductivity of the mass. The active material of the negative plate is finely divided iron similarly commingled with a conducting substance. The electrolyte is a 20 per cent. aqueous solution of potassium hydrate.

In assembling, the pockets are filled with active material, closed and inserted in the holes of the grid. The plate is then subjected to a pressure of 150 tons, for the purpose, first, of flanging the pockets over the holes in the grid, in order to lock them firmly in position, and, second, of corrugating the surface of the pocket in such a manner as to provide adequate elastic movement of the envelope, in view of the contraction and expansion of the contents. The weight of the active material in its initial condition, and including the conducting material, is about 3.2 grams per pocket for the nickel and 4.6 grams for the iron plate. This represents a total quantity of 922 grams positive active material, and 662 grams of negative active material in an

* Abstract of a paper presented before Section C of the International Electrical Congress of St. Louis, September 15, 1904, by Dr. A. E. Kennelly, professor and Mr. S. E. Whiting, instructor of electrical engineering at Harvard University.

E-18 cell. The weight of electrolyte per cell is 3.1 pounds (1.40 kilos) at a normal density of 1.190, which represents about 25 per cent. of the total weight of the cell.

The Edison cell is of the oxygen-lift type. That is to say, the process of charging consists in driving oxygen electrolytically from the negative to the positive plate. During discharge the oxygen leaves the positive plate and enters the negative plate. The chemical actions in the cell have not, as yet, been completely investigated. The following conditions may, however, be accepted provisionally as forming a working theory:

CONDITION.	POSITIVE PLATE.	ELECTROLYTE.	NEGATIVE PLATE.
Charged..............	NiO_2 NiO_2	KOH H_2O KOH	Fe
Discharging	$\overset{+}{K}$ NiO_2K $+$ NiO_2K	H_2O	$-$ HO $-\ Fe$ HO
Discharging	$+Ni_2O_3KOH$ KOH	H_2O	$FeO-$
Discharged..	Ni_2O_3	KOH H_2O KOH	FeO

The cycle represented in the above table shows that during discharge the electrolyte divides into potassium cations and hydroxyl anions, the former being directed toward the positive plate and the latter toward the negative plate. On arriving at these plates the ions give up their respective charges. At the positive plate, the potassium robs the nickel oxide of a portion of its oxygen and, in combination with the water present, forms new molecules of potassium hydrate, the original electrolyte. At the negative plate the hydroxyl ions deliver oxygen to the ion and form water. Thus the electrolyte tends to become concentrated in the pores of the positive plate and attenuated in the pores of the negative plate. Diffusion ultimately destroys this difference of concentration and leaves the electrolyte in its original condition, since at any instant the total quantity of water and of potassium hydroxide (including the pores of both plates), remains the same.

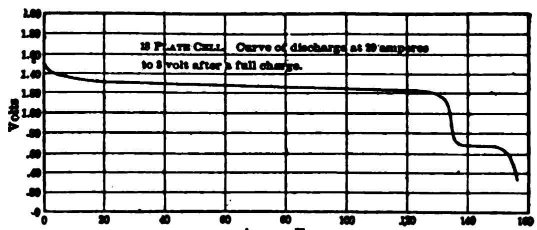

Fig. 1.

It would appear from the form of electromotive-force curve (fig. 1) during complete discharge, that after the cell has become almost entirely discharged other stages of oxidization develop, and further investigation may show that the outline of the chemical cycle above presented is very incomplete. Whatever the complete cycle may be, it is, in all probability, however, of the type indicated.

Various observations show that the discharge curve of electromotive force of the type-E cell possesses the following peculiarities:

(1) An initial period of rapid descent occupying about 10 per cent. of the delivery period.

(2) A nearly steady gradient of gradual descent continuing until within about 10 per cent. of the end of the whole delivery period.

(3) A final period of rapid descent occupying the last 10 per cent. of the delivery period (assumed as stopping at a potential difference of 0.75 volt).

A fair sample of this curve is represented by the heavy line in fig. 1. The initial electromotive force is influenced by the previous history of the cell, more particularly by the time which has elapsed since the close of the preceding charge. The range of electromotive force is between 1.35 and 1.65 volts. It would seem that this electromotive force depends upon the amount of gases remaining after the charge, occluded in the pores of the cell.

The electromotive force at and near the end of the discharge is also somewhat variable, depending in some measure upon the rate and nature of the discharge. It clearly accompanies the exhaustion of the active materials.

It has been observed that the internal resistance of an Edison type-E cell is substantially constant during the main working portion of the discharge corresponding to (bc) in fig. 2. Thus, in the E-18 cell, the internal resistance at

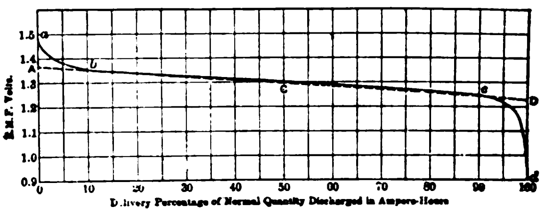

Fig. 2.

ordinary temperature is about 0.0022 ohm. The internal resistance is slightly less at the beginning of the discharge, but becomes considerably greater near the end of the discharge. Since, however, this rise in resistance occurs only during a small portion near the end of the delivery, its effect in the total discharge may be neglected for most practical purposes.

The internal resistance does not vary greatly with the discharge rate within the usual working limits of 0 to 150 amperes. In other words, the drop of pressure in the cell is approximately proportional to the discharging current strength.

The energy liberated in an Edison E-18 cell is 1.3 volts $\times$ 141 ampere-hours $=$ 183.3 watt-hours $=$ 14.48 watt-hours per pound (31.9 watt-hours per kilo), and this liberation of energy is constant to a first approximation for all rates of discharge within the working limits. The amount of this liberated energy which is delivered in the external circuit depends only on the electrical efficiency of the circuit, or on the drop of pressure in the cell. Thus, at 90 per cent. electrical efficiency, or 10 per cent. internal drop (corresponding to about 60 amperes in the E-18 cell), the externally delivered energy would be 183.3 $\times$ 0.9 $=$ 165 watt-hours.

The charging electromotive force of an Edison cell is approximately 1.6 volts (somewhat greater at the outset) until 60 per cent. of the charge has been stored, when it rises to about 1.75 volts, simultaneously with increased evolution of gases. This rise is, therefore, apparently connected with gaseous polarization. To the electromotive force of the cell must be added the drop in internal resistance, in order to find the potential difference at charging terminals. The mean electromotive force of the cell during charge may, therefore, be taken as roughly $1\frac{2}{3}$ volts. The resistance of the cell during charge is approximately the same as during discharge, being greater at the outset of the charge, corresponding to the condition of resistance at the end of the discharge.

During the charge of Edison cells, bubbles of gas are liberated at both plates, oxygen at the anode or positive plate, and hydrogen at the cathode or negative plate. The collected gases form an explosive mixture.

Since the mean electromotive force of discharge is approximately 1.3 volts, and the mean electromotive force of charge approximately 1.67 volts, it follows that the superior limit of watt-hour efficiency in an Edison cell is $\frac{1.3}{1.67}$, or 78 per cent. In practice it is always less than this, due to internal drop.

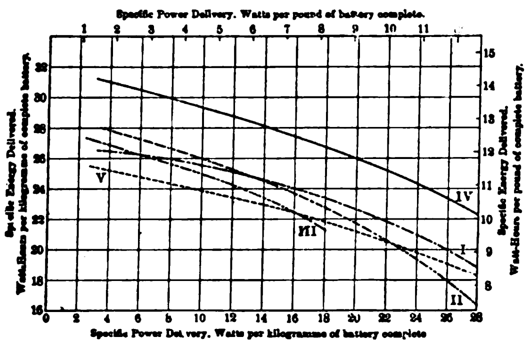

Fig. 3.

The Edison cell would manifestly possess an ampere-hour efficiency of 100 per cent. if no gases or irreversible substances were generated in the cycle of chemical action. Thus, if a certain number of grams of iron were reduced and a certain number of grams of nickel were oxidized by one ampere-hour of charging current, and no other action took place, then, on discharge, the reconversion of these masses of active material would develop the complete ampere-hour of electricity. On the other hand, every gram of hydrogen (or the equivalent mass of oxygen) liberated and discharged from the negative plate during charge absorbs 26.8 ampere-hours of electricity, which is not returned to the circuit during discharge. The ampere-hour efficiency of the Edison cell is, therefore, determined by the amount of gas escaping during the charge. This in turn depends upon the rate of charge, or charging-current strength, since the greater this strength the greater the drop in internal resistance, and the sooner the plates are brought to that difference of potential at which the water is rapidly decomposed.

The essential results of various tests are represented in fig. 3. This chart gives the output of the Edison cell (per unit mass) at varying power rates of discharge. Curves I., II. and III. represent the laboratory tests obtained for type D by the Laboratoire Central d'Electricité, Mr. Hibbert and M. Hospitalier, respectively. Curve V represents the corresponding values for the E-18 cell on normal-rated capacity and delivery. Curve IV. represents, on the other hand, the corresponding values for the E-18 cell, when operated under laboratory conditions of maximum capacity and delivery. In practice, the output may be expected to fall between these two curves, IV. and V.

It would seem that the Edison cell is so durable that no electrical depreciation is discernible in the cells during the three years' total experience of the practical construction of the battery. No mechanical corrosion of the plates or pockets has been discernible during that time, and no depreciation seems to have yet occurred in the active material, judging from the capacity tests of cells, which are stated to be as great at the present time as they were when the cells were first constructed. The capacity of some type-D cells that had run nearly 3000 miles in an automobile was found to be equal to that of new cells of the same type. Two of these cells were opened for examination and the sediment in them collected and dried. The dry sediment weighed 3.9 and 7.1 grams, respectively, probably less than one-third of one per cent. of the active material in the grids. In fact, a new cell, freshly set up will show about this quantity of material washed by the solution from the external surface of the plates. No signs of depreciation or corrosion appeared on any of the plates or connections.

According to observations at the factory, Edison cells lose 15 per cent. of the ampere-hour charge in eight weeks of idleness. Another test showed 11 per cent. of loss by standing one week. Hibbert's tests on type D showed nine per cent. loss in 48 hours and 27 per cent. in 26 days. Hospitalier's tests on type D showed less than 10 per cent. loss after 24 days. A test of the authors on four type E-18 cells gave, after 26 days idleness, 100 ampere-hours per cell. This represents a loss of nine per cent. of the normal rated capacity of the cells, or 28.6 per cent. of the maximum rated capacity. At a corresponding charge, the delivery within 24 hours would have been about 140 ampere-hours.

All of the tests show that the cells are remarkably immune from deleterious effects due to careless treatment. Cells have been allowed to dry out, have been permanently short-circuited, or even charged in the wrong direction. These cells have shown a full restoration of their capacity after a prolonged restoring normal charge.

The Edison nickel-steel alkaline storage cell, in its large output at heavy discharge rates, its low depreciation in capacity and its durability under severe and adverse treatment, approaches the capabilities of a piece of mechanical apparatus more nearly than is ordinarily credited to electrolytic structures. For this reason it is specially adapted to automobile service, where the treatment is abnormally arduous and severe.

—*Western Electrician*, October 1, 1904.

* * *

ADAPTABILITY TO TELEPHONE USE.

There are several characteristics of the Edison cell that commend its application in telephone service. Its durability, small demands for attention and general operating flexibility are much in its favor. On the other hand its normal voltage is low and is subject to a large per cent. of variation. Its first cost is high and its actual life has not yet been determined. These qualities may be listed as follows:

THE EDISON CELL AND ITS QUALIFICATIONS FOR TELEPHONE SERVICE.

Superior Qualities.	Inferior Qualities.
Construction durable.	Voltage low.
Attendance small.	Voltage variation great.
Maintenance slight.	First cost high.
Internal resistance low.	Electrical efficiency low.
Corrosiveness slight.	
Volume small.	

As the lead cells and the nickel-iron, or Edison cells, constitute the only storage batteries of any considerable importance, only these two types will be compared.

Owing to the very thorough construction and special processes involved in its manufacture, the present cost of the Edison cell is high. In fact the present prices prohibit the general adoption of this cell for the great majority of storage battery applications. It may reasonably be expected, however, that the cost of the nickel-iron type of cell will soon be reduced to figures comparing favorably with the cost of lead cells, as methods of manufacture become more developed and improved.

The Edison battery equipment, on account of its greater voltage range must include certain accessories including counter E. M. F. cells with suitable switching and wiring equipment for regulating purposes. It may be noted that the initial cost of the Edison battery equipment is about twice as great as for a similar lead battery. It does not necessarily follow from this, however, that the lead battery is any cheaper for maintaining service an indefinitely long time as its maintenance expense is relatively high.

The continued maintenance of a battery for a long period of time involves two factors, personal attendance and renewal of parts. The former may said to comprise general care and repair while the latter relates to the renewal of worn out or defective parts such as would be covered by bills for material.

The lead cells must require a greater amount of attention in their normal working than the Edison cells for there are more points demanding attention. Moreover, the danger from neglect is much less for the Edison cell than the lead cell. This means less expense for attendance in favor of the Edison cell.

Storage battery practice in the past has pretty thoroughly demonstrated that the average life of an ordinary lead battery, under usual conditions, is from five to fifteen years, or say ten years. There are many obvious and well known reasons why the life of a lead cell is thus limited; e.g., gradual loss of the active material, sulphating, etc. On the other hand, there appears to be practically no chance for deterioration in the Edison cell, so long as pure water is used to replace evaporation and gassing and so long as the electrolyte is kept well above the plates. The question of renewals, therefore, is also evidently in favor of the Edison cell.

The results of this investigation may be briefly summarized as follows:

1st. The Edison cell is entirely practical in its three chief physical aspects —mechanical, chemical and electrical.

2d. Owing to its low ampere-hour and watt-hour efficiencies, its power consumption is large for a given output. This considerably increases its operating expense where the power rates are high.

3d. Its present relatively high initial cost must limit its general adoption only to uses for which it is especially adapted.

4th. Its application in telephone service would appear to be advantageous in small common battery exchanges because of its small demands for attention and maintenance, doubtless more than sufficient to offset the difference in initial cost.

5th. It is especially adapted to the requirements for automobile service.

—*Journal of the Western Society of Engineers*, October, 1904.

Wireless Telegraphy in Russian Military Field Operations.

The accompanying illustrations, figs. 1 and 2, show the power car and wireless telegraph transmitting and receiving car in use by the Russian army in the East, the system used being that of the Gesellschaft für Drahtlose Telegraphie, of Berlin, designed by Messrs. Braun, Slaby and Arco.

There are in operation at the present time about 40 transportable military wireless telegraph stations in the armies of the various countries of Europe using the apparatus shown in the accompanying illustration, which includes a power car, an apparatus car and an implement car, equipped for transmitting news from land to ship or from one army to another at distances of several hundred kilometers. These transportable stations are fitted with wireless telegraph apparatus for two wave lengths, a short wave of 350 meters and a

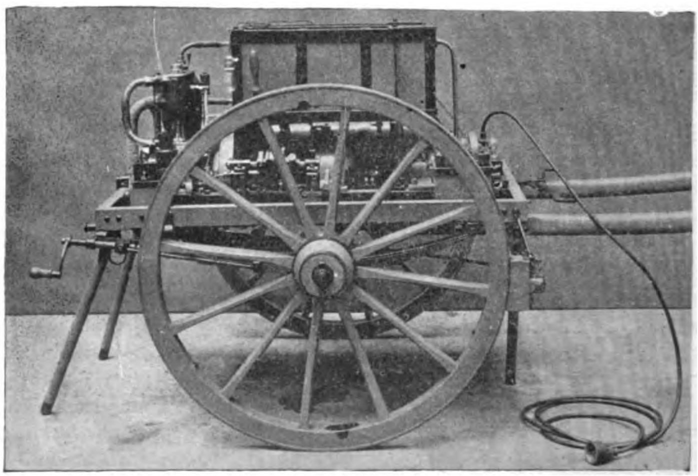

FIG. 1.—POWER CAR FOR RUSSIAN MILITARY WIRELESS TELEGRAPH SERVICE.

long wave of 1050 meters. The outward balancing of the aerial wire is accomplished in the first case by a compensator of about 8 square meters of copper gauze, and 24 square meters to the second case, stretched out at a height of about one meter from the earth.

In some cases linen kites are employed and in others balloons are used to carry the aerial wire, the latter having a capacity of 10 cubic meters. The kite is employed with a light wind to economize the use of gas and has a useful wind surface of 1.1 square meter. The cart which carries the balloon and kite is a two-wheeled affair similar to those shown in the illustration, which latter carry the power generating apparatus and the receiving and sending electrical equipment. The implement car is provided with a gas reservoir and the necessary tools, as well as a reserve benzine reservoir for supplying fuel to the power car. The gas reservoirs are built directly in the car and hold about 5 cubic meters each at a gas pressure of 120 atmospheres, being tested according to legal requirements at 200 atmospheres. Two receptacles are sufficient for filling a balloon.

The power car which supplies the necessary current is equipped with an alternating-current dynamo having a capacity of one kw. and a direct-current exciting dynamo directly coupled to a 4-hp. benzine motor noted at the left in the illustration of the power car. This small engine is cooled by a circulation of water forced from a reservoir around the cylinder of the engine and through a ribbed pipe-cooling system by a small cog-wheeled pump, a ventilator or fan being utilized for cooling. The benzine tank is located near the water reservoir and has a capacity sufficient for a continuous telegraph service of 30 hours.

The engine is provided with electric ignition apparatus. Storage batteries are automatically charged by the continuous-current dynamo which supplies the exciting current for the alternating-current generator. The power car is also provided with a cable drum controlled by a conical friction clutch coupling to haul in the balloon. The engine has a maximum speed of 1000 r.p.m., controlled by the igniting lever and the air and gas-mixing lever.

The apparatus car equipped with the transmitting and receiving devices is separated into two parts by a frame, one part containing the receiving apparatus and the other the transmitting apparatus. The high-tension equipment, the inductor, spark-gap and high-tension transformer are located in the forward part, while in the back part are installed a Morse register, two sets of receiving apparatus, a Morse key and a small receiving transformer below. Above on the frame is installed a large receiving transformer, the receiving plug and a counterbalance commutator with two levers.

On one of the doors, as shown in the illustration of the apparatus car, there is a sound-receiving device, with an electrolytic detector and telephone, while on the other door there is a testing set, which can easily be removed. A storage battery is provided for lighting and an automatic switchboard for cutting in and out the current for charging the batteries. A plug box is arranged on the outside of the apparatus car with a connection for a conductor cable coming from the power car. There are also two cable drums provided on the sides, to one of which the stronger balloon is attached and to the other the lighter kite cable. The aerial wires are 200 meters long and cannot be varied in length for either the balloon or the kite, as the proper lengths are determined by the system. For replacing the earth connections in the usual system of wireless telegraphy, a balancing conductor is provided, consisting of an insulated metal plate or the copper gauze above referred to.

When transmitting with the long wave all of the transformer windings are switched in. In order to prevent the receiving apparatus being connected up by mistake while transmitting, the switch box of the receiving apparatus is so arranged that the wrong connections are impossible. It is very important that the intensity be regulated according to the distance between stations. For if the intensity is too strong the coherer might be injured. The intensity can be reduced by short-circuiting one or two of the three spark-gaps at the transmitter. The intensity in the coherer circuit may be reduced in several ways; the coherer possesses a wedge cleft, so that it is in its most sensitive position when the smallest opening is downward and vice versa. The receiving transformer may be regulated, the intensity being lessened by moving the outward or primary coil upwards, so that the secondary coil embraces it to a less extent. With distances of from two to ten kilometers the copper

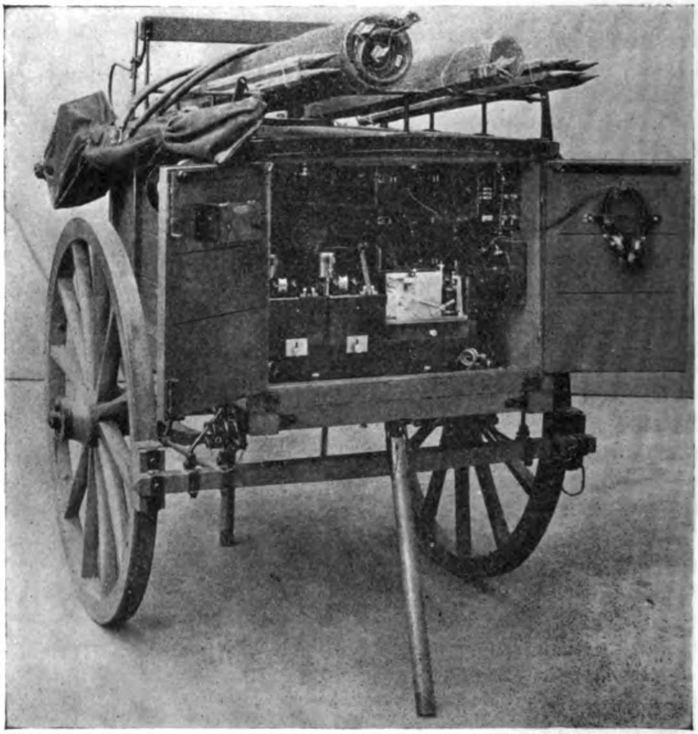

FIG. 2.—APPARATUS CAR FOR RUSSIAN MILITARY WIRELESS TELEGRAPH SERVICE.

gauze compensator is not used, while with distances of from .5 to 2 kilometers the aerial wire is not plugged into the receiving apparatus and under a distance of .5 kilometer the receiving apparatus is not switched in while transmitting.

By the use of the kite under favorable conditions or by means of the small balloon held captive by a fine steel wire, the Russian portable stations are able to communicate to one another with certainty over distances of 100 kilometers or more.

This system as employed in Germany is in charge of the balloon section of the German army and is said to have given excellent satisfaction during the last German maneuvers. It has also been adopted by Austria and, it is stated, is about to be introduced by Spain and Sweden.

—*Electrical World and Engineer*, October 15, 1904.

Notes on the Russo-Japanese War.

M. Eletz, a military correspondent of the Novoe Vremya in Manchuria, gives some extremely interesting particulars of Japanese tactical methods, which are very instructive. According to his account the Japanese, in their marches, have avoided the valleys as much as possible, and have chosen to to move by paths in the mountains, thus often avoiding the passage of rivers, incurring little danger of being taken on the flank, and being able to hide their movements from the Russians. They march slowly, a chief object being to save the men. Chinese are always scouting in advance of the columns. Behind them come cavalry patrols, accompanied always by infantry. Next follows the advance guard, and then the troops in small columns at considerable intervals. In a general way the cavalry comes behind the infantry serving as an immediate support for the artillery. Pauses are frequent on the march, but short, and as often as possible in heavy rain or great heat. Bivouacs are preferred to regular camps, and towns or villages are rarely occupied. The bivouacs are rarely upon the main roads, but often apart in the mountains, the only exception being in the case of passes. Positions are not occupied until the general is assured of security, and, as soon as the Japanese are established in a place, they immediately entrench themselves. It is their practice to make maps of the districts in which they operate, marking the ranges from the positions occupied, and these maps are placed in the shelters for the men, where the officers explain the positions.

In regard to the combat, the Japanese always bring superior forces into action, and never fight without artillery. The certain sign of an approaching attack is the appearance of the Chinese spies, the flight of the villagers from their farms and houses, and the establishment of signalling stations on the hills. The attack begins with long artillery preparation, progressive fire being used, and the guns being well concealed. The first object is to silence the Russian guns, but the correspondent does not give a very favorable account of the effects of the firing, which he says is very rapid, though often stopped owing to failure of ammunition supply. He seems to think that the Japanese ammunition is wasted for insignificant objects, and says that in the attack the Japanese advance only when the Russians, under the pressure of the Japanese artillery, begin to retire. Chinese once more are in the van of the attack, followed by skirmishing lines and then the reserves. They make ideal use of the ground, their reserves and even skirmishing lines being scarcely visible, and they seem to spring from the soil. When they advance the greatest care is taken in the protection of the flanks where considerable reserves are massed. The Japanese do not willingly retreat, because they are always imbued with the idea of their superiority over the adversary. The correspondent discovers one defect in Japanese tactics. He points out that they always act upon the same formal plan, and that any operation which would derange their habitual tactics, and which they had not foreseen, would disconcert them altogether.—*A. & N. Gazette.*

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It was assumed that the new Japanese gun, which is of very light character, was giving excellent results in the war, but some recent accounts of the fighting would seem to show that these remarkable results have been due rather to the skill of the gunners than to the quality of the arm. The Times' correspondent, describing the battle of Ta-wan or Tien-su-tien, in which General Keller was killed, says it was essentially an artillery engagement, and that the Japanese guns were clearly demonstrated to be inferior alike in respect to range, weight of projectile, velocity, and rapidity of fire. We confess to being surprised at hearing that the Russians have the advantage in the two latter qualities. The correspondent says that the Japanese guns suffered in comparison with those of the Russians, but that superior numbers compensated for other deficiencies, the Russians opposing at most thirty guns to at least double that number. The Japanese seem to have shown surprising skill in nearly every action in bringing their guns into play from commanding positions, and pouring a tremendous fire upon the points to be attacked. In other words, they have used their great tactical mobility to the best advantage, and have perhaps thus given a somewhat exaggerated idea of the mechanical and ballistic qualities of their guns.—*A. & N. Gazette.*

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According to accounts of several correspondents, the Japanese field artillery is in many respects inferior to the Russian although a great deal has been written about its superiority. Like the infantry, the Japanese artillery is more mobile than the Russian, and hence has been more effective, but the Russian guns have a greater range, fire a heavier projectile and have a greater muzzle velocity (1950 f.s. as against 1500 f.s.). It is said that the Russian gun can fire 16 rounds a minute. In one respect the Japanese artillery is superior to its adversary's: its high explosive shell are charged with a more powerful explosive. The Japanese often make use of explosive shell in cases in which other artilleries would employ shrapnel. The reason is that, first, the Japanese fuze is graduated only up to 4800 m. and secondly the high explosive shell on account of the great power of its bursting charge has a large radius of action which almost permits of its replacing the shrapnel. (The reports of the Russian medical officers, however, show that the wounds made by the fragments of explosive shell, which are usually very small, are in the majority of cases not serious.) The Japanese would obtain remarkable results by a combination of the use of high explosive shell fire and shrapnel fire. Although the field and mountain guns have the same caliber and fire the same projectiles, their range is very different as they differ in weight of piece, in length, and in the weight of charge. One of the lessons of Liaoyang appears to be that about three miles is the utmost effective range. The Japanese had that with the lightest gun that would give it. The Russians had a longer range with guns whose weight was a handicap to them. What the Russians gained in rapidity of fire, greater caliber and longer range, they lost in not being able to move their guns so quickly. The Japanese artillery practice and the timing of their shrapnel were distinctly superior to the Russian, and they carried out the scheme of focussing a concentrated fire simultaneously which was very effective. With all its mobility, however, the horses of the Japanese artillery are small in size, not very strong and not well trained. It was for this reason that on the 18th of July, for example, in one Japanese division only 13 field guns could be brought up on the battle field even after having had the teams doubled. This defect is always very noticeable and at times is not counterbalanced by the remarkable qualities of the personnel, the skill with which the pieces are served, and the expertness of the gunners, which are above all praise.

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The artillery of both sides played a leading rôle in the fight around Dachitchao towards the end of July, while the infantry was in general less deeply engaged than in other battles of the present war. It is not without interest, accordingly, to note a day's work of a particular battery. The *Russkii Invalid* gives an account of the action of the 2d battery (of 8 guns) of the 9th East Siberian Brigade. This battery remained under fire for 15 hours without interruption, having opposed to it six Japanese batteries (of 6 guns each), and its fire could not be silenced during all that time.

The battery opened fire on the enemy's artillery at 6:30 a. m. At 10 o'clock it had located the emplacements occupied by the Japanese batteries which were on the slopes of hills at very long range (6 versts, 7000 yards, says the Russian journal). The Russian battery was excellently well masked and made use of indirect fire exclusively, laying the guns by means of the level. Up to 5 o'clock p. m., that is to say for ten and a half hours, the Japanese were unable to distinguish its emplacement and answer it, while its fire changing frequently from objective to objective, forced the enemy's batteries to change their positions several times and successively silenced them. At 5 o'clock p. m. a second battery came up to reinforce the 2d battery of the 9th Brigade. Its movements were seen and in an instant it suffered considerable losses. The 2d battery also received a certain number of hits intended for its neighbor. But these were chance shots and the Japanese could never discover its exact position as is shown by its relatively small losses for such a long fight: 2 men killed, 7 seriously wounded, 5 slightly wounded, 26 suffered minor injuries; 6 horses killed, and 3 wounded.

The battery remained in action until night had completely fallen. Its 8 pieces had fired 4178 rounds or 522 rounds per piece, truly an excessive expenditure of ammunition.

The following deductions can be made: The first is the difficulty the enemy has in registering a well-masked battery whose coming into position has escaped his notice, and consequently the relative security which results therefrom for a battery firing under such conditions. Then, the possibility of frequent and rapid changes of objective while employing exclusively indirect fire, and finally the imprudence that always exists in bringing a reinforcing battery too near batteries already engaged and under fire. Most of the losses of the 2d battery were caused only after the enemy's attention and his fire were directed on the insufficiently masked movement of the reinforcing battery coming into battery at 5 p. m.

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The *Russkii Invalid* relates some suggestive incidents from the experiences of the artillery in the war. On August 30th, a battery of the 6th East Siberian Artillery Brigade happened to be placed in a low position amid standing crops of "gaolain" which extended a little distance before its front, the men being seated and lying down near their guns. The Japanese infantry stealing through the tall growth opened fire at short range. The battery commander was killed, all his officers wounded, and almost the whole personnel put hors de combat in an instant. Fortunately a chief of piece succeeded in continuing fire against the border of the gaolain field whence the Japanese had debouched, neighboring supports came up, and the Japanese were driven off. This incident indicates the great vulnerability of a battery not provided with shields, even in the firing position, when infantry might open fire against it at short range. A French battery under these circumstances would have been able to resist such an attack with success. In another case two batteries of the 10th Corps were in a perfectly protected position behind a rocky ledge to the south of the village of Suitshan. Only the battery commander kept observation from the crest itself, with signallers transmitting his orders by means of flags. Four Japanese batteries were at the time inflicting serious damage upon the 3rd East Siberian Artillery Brigade. In a moment the range was determined by the Russians, and the four Japanese batteries, evidently taken by surprise, were silenced. Whenever they tried to reopen fire, a rafale (two rounds per piece) reduced them to silence again. Shortly afterwards the battery commander noticed that the Japanese with difficulty were dragging another battery up a height to enfilade the Russian position. He opened fire on it, and the enemy's battery caught in the movement was unable even to open fire. A little later a movement of troops was observed who were massing in a fold of the ground. The range was known. A salvo of control to verify the elevation and then a rafale of three rounds per piece for the whole group were fired; the troops massing there were seen dispersing in all directions. For two whole days the Japanese could not get the exact range of these two batteries because they were so well defiladed. In two days of uninterrupted fighting they lost only: in the first battery, 2 men wounded and 2 killed; in the 2d battery, 2 horses killed. The action of these two batteries is manifest proof,—of the difficulty of determining the range of well concealed artillery, which is for that reason almost invulnerable; of the possibility of the commander of a group thus defiladed and occupying a broad front (16 pieces), directing the fire by means of signallers; of the possibility of two batteries reducing four to silence and preventing them from reopening fire, when the former have determined the range of the line of the enemy's artillery; of the rapidity with which a battery caught in movement is put out of action even when it has not yet come into battery; of the possibility of firing with effect on troops completely concealed by a fold of the ground, when their position has been suitably determined.

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Effect of Torpedo Explosions.

It will be remembered how, on June 12 last, the Russian cruisers Rossia, Gromoboi, and Rurik, unexpectedly emerged from the harbor at Vladivostock, and took the offensive against Japanese shipping. On the third day out they fell in with the steamers Sado Maru and Hitachi Maru, both of 6000 tons, in the Tsushima Straits, transporting soldiers and military stores from Shimonoseki to the mainland. The Hitachi Maru, commanded by Captain Campbell, refused to stop, and was sunk by the guns of the Gromoboi; but the other vessel, disabled by gun-fire, hove to, and such of the non-combatants as desired were allowed to leave in boats. She was then torpedoed on both sides by the Rossia, and the squadron hurried northward again, leaving her apparently sinking. She remained afloat, however, and was towed home by the Hino Maru. From the appearance of the vessel after being towed into port, one would hardly suppose her to have suffered very serious injuries, whereas below the water-line such huge holes had been torn in her sides that it is almost incredible how she could remain afloat at all. The first torpedo struck the vessel on the starboard side opposite the engine room leaving a hole, as shown by figure 1, 16 feet by 17 feet in the outside shell, through which, in the original photograph, the machinery in the engine-room is visible. The main condenser, the high-pressure front column, the sole-plate, the air, feed, and bilge-pumps of the main starboard engines, were smashed, the starboard pocket-bunker entirely blown up, and the ballast-pump, donkey-pump, and spare crank-shaft carried away to the other side of the ship. The screen bulkhead between the engines and boilers was also partly destroyed, and the starboard double-ended boiler was bodily shifted a few inches for-

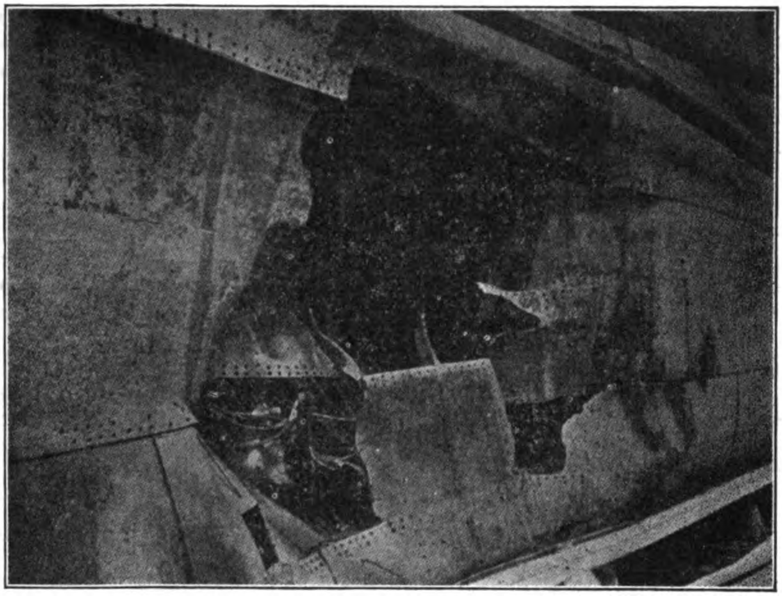

FIG. 1.

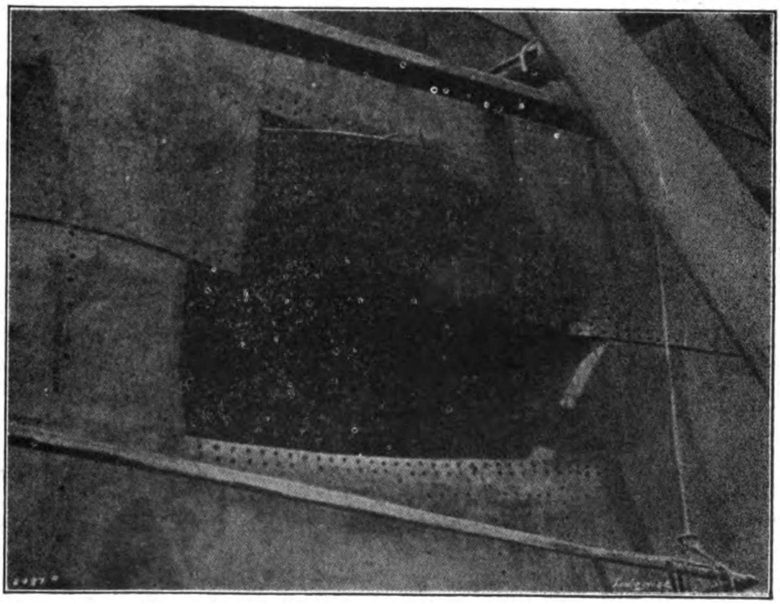

FIG. 2.

ward. Figure 2 shows the effect of the second torpedo on the port side. It exploded in the cross-bunker forward of the boiler space on that side, leaving a hole 7 feet by 13 feet in the outside shell, smashed the bunker bulkheads, and carried the port double-ended boiler some inches aft. About 150 shells

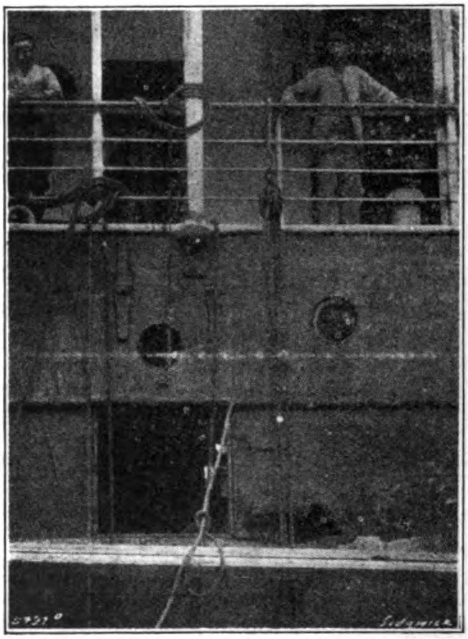

FIG. 3.

are reported to have struck the vessel before she was disabled by two of them bursting in the engine room. The damage caused by the entrance of a shell is seen by figure 3, which shows the hole which a shell pierced in the upper deck sheerstrake on the starboard side.

—*Engineering*, October 7, 1904.

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Injuries to the Askold.

On the 10th of August two distinct fights occurred. The first took place at 11:30 a.m. and lasted about an hour and a half. The Russian fleet came forth from Port Arthur, battleships in front, and deployed at first in line ahead, bearing to the west in order to escape to the open sea. Fire was opened against the Japanese ships at 8000 meters. A series of evolutions changed the line of battle four times, the range at times being 5000 meters. The cruisers were engaged for some minutes during which they happened to be at the head of the column. Finally the Japanese withdrew to the southwest, the Russian fleet standing east. The injuries on both sides appear to have been slight. The Askold was hit twice :

Hit No. 1. (fig. 1.) A 12-inch projectile from the Shikishima killed the officer at the range finder on the starboard bridge, traversed the spar deck without exploding and detonated at the base of the forward funnel. The steps leading to the bridge, the wireless telegraphy house, and the chart house were practically wrecked by its splinters; the plates of the funnel base were

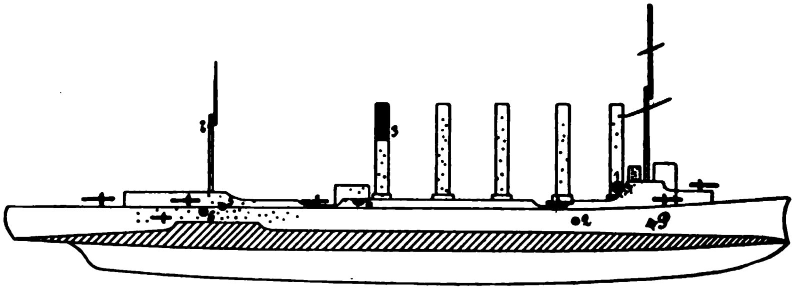
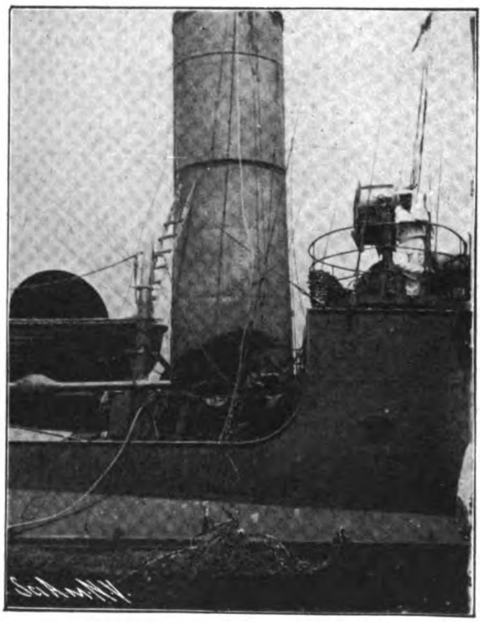


Fig 1. Starboard Side.

very much torn and bent, and the fragments passing out through the opposite side of the funnel wrecked it. Parts of the projectile also struck the two boilers beneath the funnel, puncturing about 16 water tubes.

Hit P. (fig. 1.) A ricochet hit, apparently from a 15-cm. gun, penetrated the upper works under the starboard bow gun and about 1.5 m. above the waterline; it set fire to a supply of 7.5 cm. ammunition that was under the starboard bridge. This burnt without causing any great damage.



Hit 1.

The battle began again sometime between 3:30 and 4:00 p.m. and continued until night fell. The ranges decreased to about 3700 meters. Towards 6:00 p.m. the Cesarevitch had her rudder damaged by a shot and suddenly turned out of line. This caused the disorderly change of front of the Russians, and the energetic intervention of the Retvisan, which went at full speed straight for the head of the Japanese, and for about a quarter of an hour at 1500 meters drew their whole fire in order to allow the Russian line to reform. An opening was seen in the line of the enemy and the Askold took advantage of it in the endeavor to get through. But the Asama advanced to cut off her retreat. The Askold advanced upon the latter with the intention of torpedoing or ramming the Asama, but was prevented by the Kasagi, the Takasago and another cruiser, which came up and overwhelmed the Askold from both sides with a violent shell fire. With full speed at 23 knots the Askold, passing at about 2800 meters from her nearest opponent, succeeded in getting away from them. But she was hit 12 times and the rear funnel was so badly damaged that her speed fell to 20 knots. The Japanese cruisers, however, could not continue the chase. The Asama was burning. This artillery duel had lasted about an hour and a half. Thereupon four torpedo boats rushed forward in the wake of the Askold: an 152 mm. projectile stopped one of them, the others drew off; but some torpedoes passed by the stern of the Russian ship. At 11:00 p.m. the Askold was out of reach of the enemy. The ship had fired 200 projectiles cal. 152 mm. and 300, cal. 75 mm. She was struck altogether by 1 ricochet, 14 large caliber and numberless small caliber projectiles and explosive shell fragments, particularly towards the stern.

Smokestack Wrecked by Shell Fire. Effect of Fragments as they Passed Out of the Stack.

In the afternoon's fight she received the following hits:

Hit 2. (fig. 1.) Probably by a 15 cm. projectile, struck the waterline: slight injuries, armored deck intact. A ricochet hit struck the forward torpedo-net spar and bent the end at right angles.

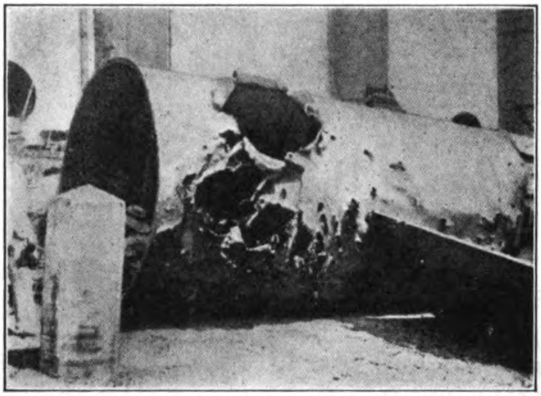
Hit 3. (fig. 1.) Tore off the upper third of the rear funnel; fragments damaged the last boiler aft, breaking seven water tubes.

Hit 4. (fig. 1.) Projectile of large caliber tore out a large piece of the bulwark, 1 square meter; explosive effect small, damage otherwise slight.

Hit 5. (fig. 1.) Projectile of about 80 mm. cal., penetrated the spar deck, exploded in an officer's cabin; some fragments penetrated the rear wall of the cabin.

Hit 6. (fig. 1.) 20.3 cm. shell went through the side plating, exploded in the cabin of the navigating officer, completely demolishing it; some large fragments made a large hole, about ½ sq. m., in the rear wall. Cabin furniture burnt in some places.

Hit 7. (fig. 1.) Struck the rear part of the top of the main mast. Apparently a 12 cm. projectile.



Hit 3.

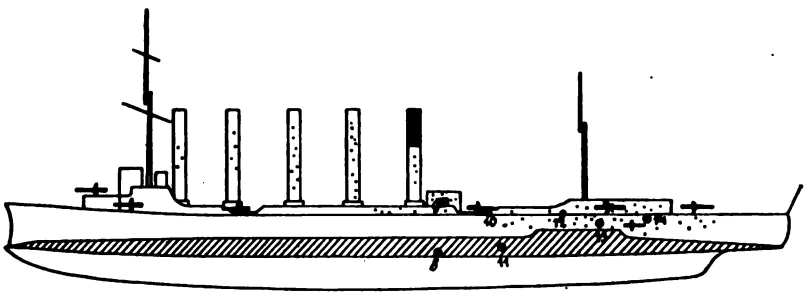


Fig. 2. Port Side.

Hit 8. (fig. 2.) 20.3 cm. shell struck the hull at about 0.5 m. below the waterline, exploded in the coffer-dam; the armored deck showed no sign of damage, made a hole of about ¾ sq. m. in the plating.

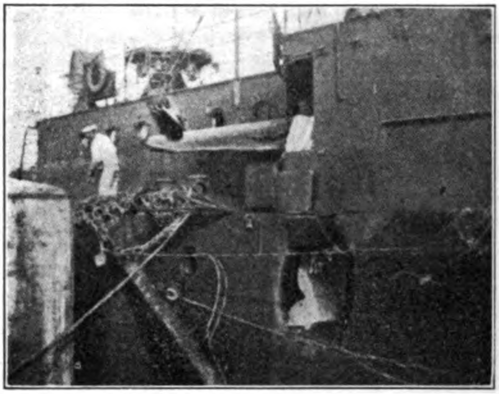
Hit 9. (fig. 2.) Small caliber; put an ammunition hoist out of action; exploded on the outside.

Hit 10. (fig. 2.) 15 cm. shell went through the gunwale, exploded without serious consequences.

Hit 11. (fig. 2.) 20.3 cm. shell hit the ship exactly on the waterline, making a hole of about ¾ sq. m., and exploded in the coffer-dam without any further effect.

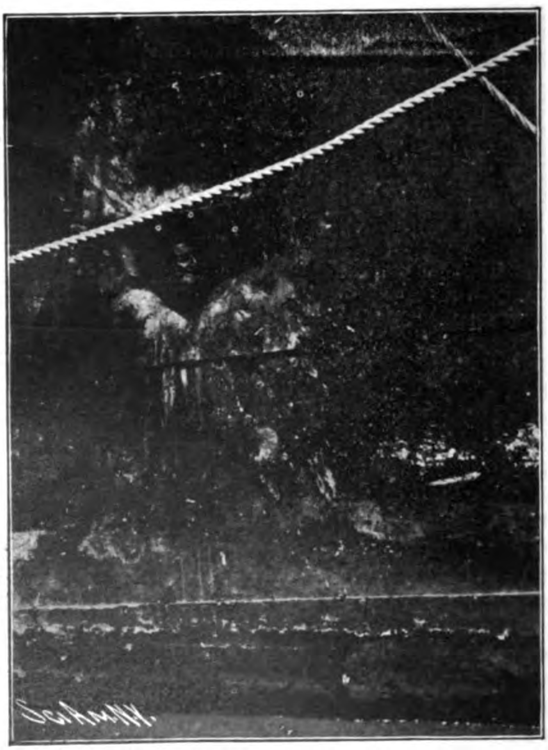
Hit 12. (fig. 2.) 15 cm. shell went through the spar deck near the side plating, and made a hole of about ¼ sq. m.

Hit 13. (fig. 2.) 20.3 cm. shell penetrated the side plating and the side wall of an officer's cabin, exploded in the adjoining cabin, tore a hole the size of a man in the midship wall, completely demolished the two cabins, caused a fire of not much moment however, and killed two men at the 7.5 cm. gun aft on the port side. The gases from the explosion of this projectile were of a yellowish green.



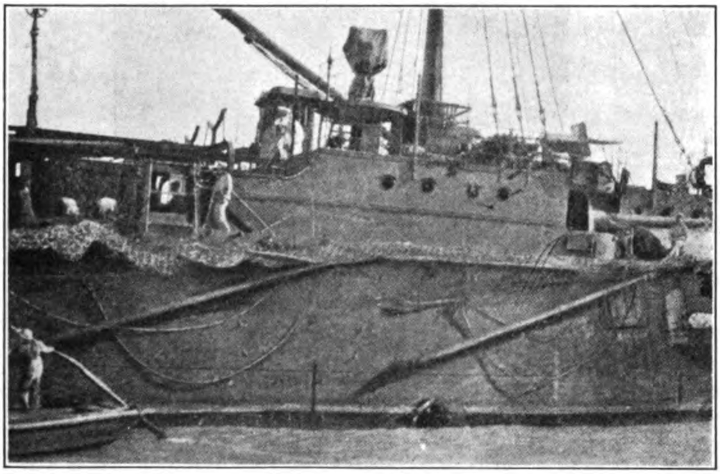
Hit 6.

Hit 14. (fig. 2.) 20.3 cm. shell made a hole about ¼ sq. m. in the side plating and destroyed an officer's cabin.



Hit 8.

After hit 11 the Askold took in water in rather large quanties so that her captain had to have the speed reduced from 20 knots to 12; at Woosung on the 13th this quantity was estimated at 100 tons, but it did not have any appreciable effect and from the exterior the difference was not noticeable, the ship drawing about the same amount as when the bunkers were filled with coal. It was due more especially to the small caliber projectiles and shell fragments that the vessel was put hors de combat. The guns and their shields remained intact although the latter bore traces of numerous impacts. These shields were too narrow, however, to protect fully the piece and personnel. In the rapid-fire guns the recoil cylinders were often struck by shell fragments. Another serious defect of the Russian artillery was that the elevating mechanism was not strong enough; the teeth of the toothed sectors often broke off.



Hit 11.

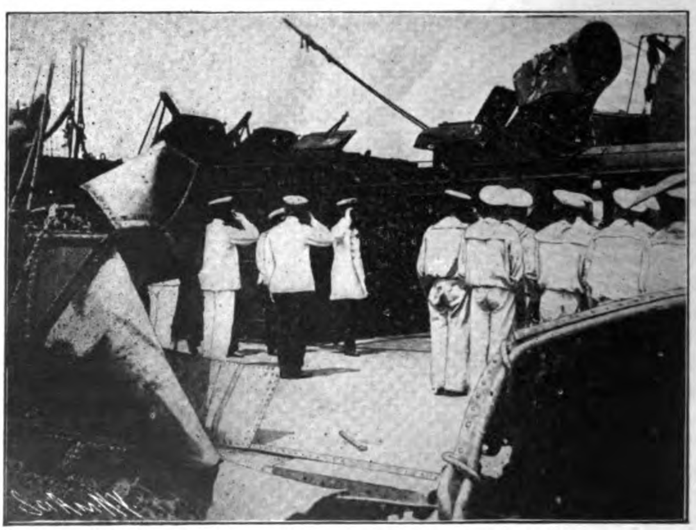
The Japanese seem to have concentrated their fire on the rear of the Askold or else they fired with too little elevation. Especially striking is the absolutely local effect of the artillery fire. After penetration of the side plating, a thin steel partition sufficed generally to isolate the explosive effect. The large and medium sized Japanese projectiles appear to be about 4¾ calibers long; the bursting charge consists of either ordinary black powder (hit 1) or a chemical compound which on explosion produces black or yellowish green gases. Even those of large caliber fired at ranges of 2700 meters do not open up the large holes or cause the destruction that would be made by melinite shells, for example. They often explode immediately on contact with the first obstacle, thin plates, and many even on impact with the water and therefore work little destruction within the ship. This would indicate either very low velocities of impact or extreme sensitiveness in the fuzes. Their great fragmentation, however, is something remarkable.

That no fire of any consequence broke out in the ship is explained by the fact that the use of wood in construction was limited to the utmost extent. Even the ship's boats were of iron or steel. The deck was covered with linoleum which fulfilled its purpose excellently well.

In addition to the injuries mentioned, all the searchlights and ship's boats were damaged, the three middle funnels, upper works, etc., were riddled by

Hit 13.

shell fragments, and the outer plating showed numerous marks where it had been thus struck.



The Admiral Complimenting the Crew on their Bravery.

The Askold had taken part in five fights before the one of August 10th, and had received several injuries which had been temporarily repaired at Port Arthur. The main mast had been struck and cut off at three-fourths of its height. The rear funnel had also once before been completely shattered. A large projectile had struck and exploded at the waterline on the port side and broke three frames (just forward of hit 8). This hit was received February 9th and had been repaired at Port Arthur without docking. A large plate about 6 to 8 sq. m. covered the hole made by this projectile. A 15 cm. shell had put the two waist guns out of action. These guns were to have been replaced at Port Arthur, but there were no guns in either of these positions during the fight of August 10th. It is said they had been taken out again for defense purposes on land at Port Arthur.

—*Mitteilungen aus dem Gebiete des Seewesens*, xi, 1904; *Marine Rundschau*, October, 1904.

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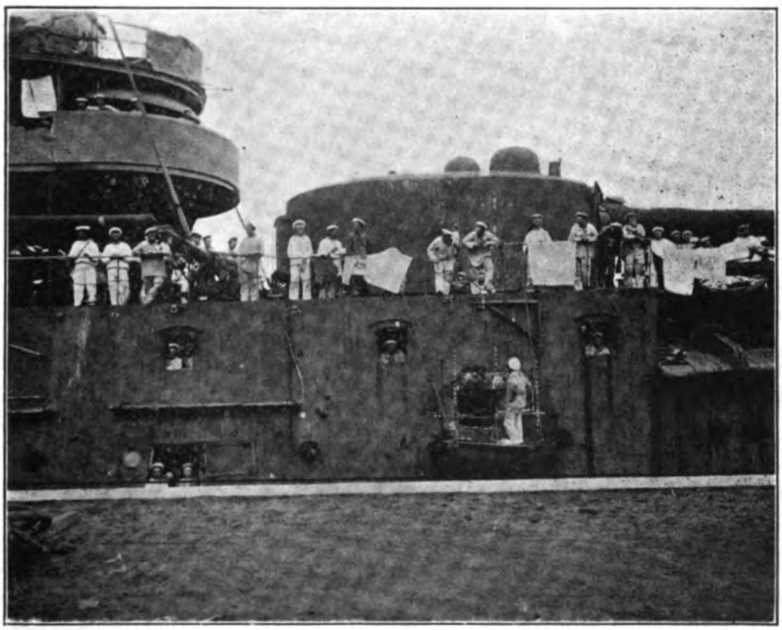
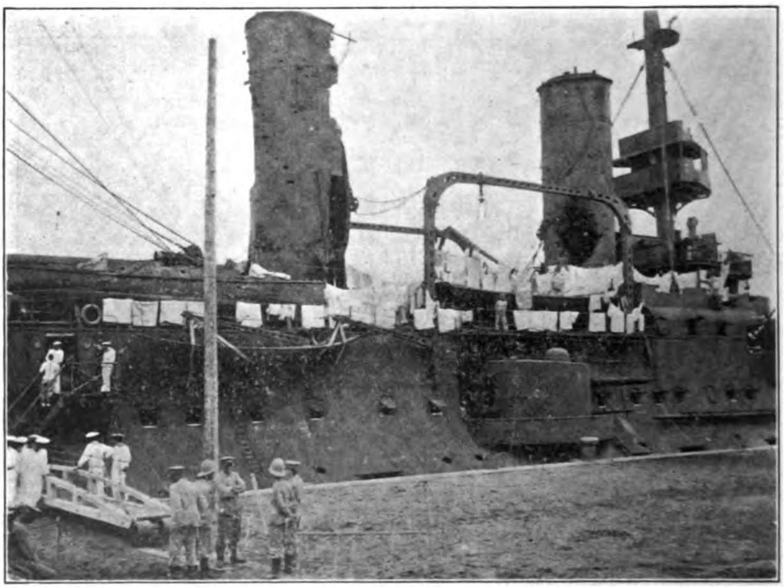
The Cesarevitch after the Naval Battle of August 10th.

The Cesarevitch was hit by fifteen 12-inch projectiles, some above and some below the water line. One projectile which struck the unarmored portion of the bow tore off an anchor on the starboard side and carried it into the



Hole being patched up under forward turret of Cesarevitch, made by a 12-inch Japanese projectile. At left hand upper corner broken place in bridge shows where Admiral Witsoeft was killed. (*Photograph by courtesy New York Tribune.*)

interior of the ship, making a hole in the side a meter and a half wide. The bow was also penetrated by another projectile which exploded in the interior. The forward armored turret containing two 12-inch guns was hit by quite a number of projectiles and shell fragments, but they could not penetrate the armor and rebounded, causing only cracks in the turret armor. The points most seriously damaged were the forward bridge, the chart house and the military mast forward. One projectile fell in the compass room, traversed it, made a hole at the base of the military mast forward, and then exploded. Its fragments flew in all directions, sweeping the bridge, killing the Admiral and four of his officers and wounding all his staff. There was not a single person present who was not wounded more or less seriously. This same projectile caused further damage to the ship. The military mast in which was the stairway leading to the military top, was bent and twisted, and at any moment seemed likely to fall, being supported only by some debris of metal. This mast was also hit by a projectile above the military top. The conning-tower also was struck several times but remained intact. Three projectiles struck the funnels and put them out of service. The after one was split open almost from top to bottom. Another projectile hit the rear turret at an angle on the port side but could not penetrate the armor, was deflected, and continuing its course struck the military mast and bent it. All the boats of the battleship were destroyed by projectiles of small caliber. Many other injuries of a more or less severe nature could be cited.



The Cesarevitch at Tsingtao wharf three days after sortie from Port Arthur.
(*Photograph by courtesy New York Tribune.*)

In a general way, all the unarmored parts of the Cesarevitch were punctured in many places by fragments, small projectiles, and machine gun bullets. On the starboard side there were two holes below the water line, and one above under the forward turret. One of those below was about 2 meters long; water entered through this opening and filled two compartments. The port side was hit by three projectiles; the first destroyed a boat on the deck and made a hole in the latter about 2½ meters in diameter; the second struck the base of one of the turrets and the third broke the rudder shaft.

The destruction of the Rurik and the serious injuries inflicted on the two other cruisers of the Vladivostok squadron, also the condition of the Askold after the battle of August 10, show how vulnerable unarmored ships are to large and medium caliber projectiles and their fragments. The Cesarevitch, in which only the heavily armored parts resisted large caliber projectiles that caused great damage in the less thoroughly protected portions of the vessel, shows how necessary it is to avoid diminishing the amount of armor and thereby the protection it affords. The large units, the *battleships*, are the ones that have stood the hammering, and their armor, in spite of other injuries received, has enabled them to continue fighting.—*La France Militaire.*

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The present range of the Whitehead torpedo would appear to handicap considerably that weapon in what appears to be the distance at which future naval actions may be fought, says the *Naval and Military Record.* In the present war opposing battleships and belted cruisers have never had much less than 5000 yards between them in their general engagements. This is nearly double the effective range of the Whitehead torpedoes carried in the ships of the British fleets, and 2000 yards outside the new Austrian-Whitehead, which is said to be safe for an accurate run of 3000 yards. No torpedo appears to have been fired from any of the battleships or cruisers engaged in the naval battle off Port Arthur, when the Cesarevitch, the Pobieda, and the Retvisan appear to have received all their damage from the gun-fire of their opponents.

Submarines.

The *Armee et Marine* states that the French submarine Alose, which was built at the Mourillon Arsenal, was launched with success on October 12th. She is the last of the series of ten boats, constructed for the mobile defenses of Corsica, Algeria, and Tunisia. The other nine are the Perle, Esturgeon, Souffler, Dorade, Bonita, Thon, Grondin, Anguille, and Oursin. The length is 78.74 ft.; beam, 7.45 ft.; displacement, 68 tons; motive power, entirely electric; speed, 8 knots; and complement five men.

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According to the *Liberté*, trials have been in progress for several months past with a new type of accumulator for submarines. The accumulators actually in use in the French navy in the submarines last completed yield 250 horse-power, giving the boat a speed of 11 knots. The submarines of the Emeraude type which are still building are to be fitted with accumulators yielding 600 horse-power, and giving a speed of 12 knots. But the accumulators of the newest type of the same weight as those in the Emeraude boat will yield 1000 horse-power, and give a speed of 16 knots.

* * *

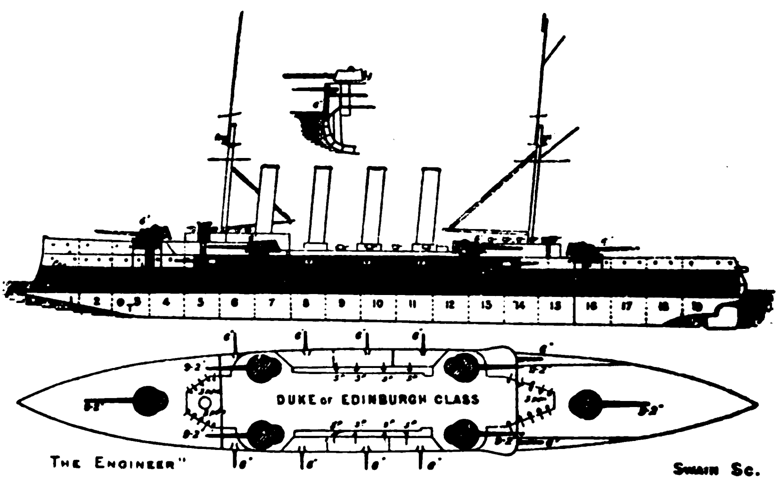
The French naval authorities do not seem yet to have reached a solution of the problem whether the submarine or submersible boat should be preferred; and there seems a doubt whether the Commission appointed to answer the question will be able to satisfy expectations, as their tests were made in too calm water to settle sea-going difficulties. It is now urged that exhaustive trials should be made with the latest and best representatives of the two classes—the Aigrette, a submersible designed by M. Laubeuf, a naval engineer, against the improved Gustave Zede, known officially as Z., designed by another engineer, M. Maugas. The particulars of these two boats are of interest. The Aigrette, now being completed is of 172 tons displacement, being 117 ft. 7 in. long and 12 ft. 9 in. broad and she has a Diesel motor of 185 h.p. for propulsion on the surface and for charging the electric accumulators. The speed on the surface is 8½ knots with the motor indicating 174 brake horse-power, and under the surface 6.1 knots with the electric motor giving 147 h.p. The Z, on the other hand, is of 202 tons displacement, the length being 135 ft. 8 in. and breadth 9 ft. 10 in. But when submerged a speed of 11 knots is claimed for her when the motor is developing 190 h.p. The dimensions indicate a very different form, which may enable the greater speed to be achieved with this relatively small increase of power; but there are those who doubt whether 11 knots can be maintained. The time taken in immersing the Z. will be very much less than the four minutes required for the Aigrette; but against this it is claimed that the vessel is less stable, less habitable, more complicated in its mechanism, and more costly. The consumption of oil of the motors for such boats is put at 8 lb. per horse-power per hour, which seems high. —*Armée et Marine.*

* * *

Messrs. Vickers, Sons and Maxim are at present engaged in the construction of seven new submarines for the British Admiralty, 100 ft. in length, and they are also building an eighth submarine 120 ft. in length, a new class. This craft is being proceeded with as quickly as possible, as in the event of this submarine proving the success she is expected to be, others of the same class will be ordered.

H. M. S. Black Prince.

Special interest attaches to the Black Prince, launched from the yard of the Thames Ironworks and Shipbuilding Co., Ltd., and her sister the Duke of Edinburgh, as these are the first ships designed by Mr. Philip Watts.



"The Engineer" Swain Sc.

H.M.S. BLACK PRINCE

Below are particulars of the Black Prince compared with the French Renan and the U. S. A. California, which are of practically the same displacement, also with the British Drake class. It is interesting to note that while we have decreased in size the Americans have made a corresponding increase.

Name	Black Prince.	Drake.	Renan	California.	Washington.
Nationality	British.	British.	French.	U.S.A.	U.S.A.
Displacement, tons	13,500	14,100	13,500	13,400	14,500
Length, ft	480	500	515	502	502
Beam, ft	73½	71	72	70	73
Draught (mean), ft	27½	26	27	26½	26½
Main armament	Six 9.2-in.	Two 9.2-in.	Two 9.4-in.	Four 8-in.	Four 10-in.
Secondary armament	Ten 6-in.	Sixteen 6-in.	Twelve 6.4-in.	Fourteen 6-in.	Sixteen 6-in.
Tertiary armament	Twenty 3-pdrs. Eight pom-poms	Ten 12-pdrs. Three 3-pdrs. Two Maxims.	Twenty-two 3-pdrs. Two 1-pdrs.	Eighteen 12-pdrs. Twelve 3-pdrs. Sixteen smaller	Twenty-three 12-pdrs. Twelve smaller
Submerged tubes	Three	Two	Two	Four	Four
Belt	6-in.—3-in.	6-in.—3-in.	6-in.—4-in.	6-in.—3½-in.	5-in.—3-in.
Armor deck	¾-in.	4-in.	2½-in.	4-in.	3-in.
Side above belt	6-in.	6-in.	5-in.	5-in.	5-in.
On big guns	6-in.	5-in.—6-in.	6-in.—8-in.	6-in.	9-in.—5-in.
On secondary guns	6-in.	6-in.	5-in.—6-in.	5-in.	5-in.
Horse-power	23,500	30,000	38,000	23,000	?
Designed speed, knots	22	23	23.5	23	22
Boilers	Babcock & cylindrical	Belleville	Niclausse	Babcock	Babcock
Coal (normal), tons	1000	1250	1400	900	900
Coal (maximum), tons	2000	2500	2300	2000	2000
Weight of armor, tons	—	2700	3400	2219	—
Weight of machinery, &., tons	2250	2500	—	2100	—

Owing to the different systems employed in mounting the big guns, comparisons of the total armaments are a trifle misleading. The broadsides are:

Black Prince.	Drake.
Four 9.2-inch.	Two 9.2-inch.
Five 6-inch.	Eight 6-inch.
Renan.	**California.**
Two 9.4-inch.	Four 8-inch.
Six 6-inch.	Seven 6-inch.

Washington.
Four 10-inch.
Eight 6-inch.

So that the Washington is much the more serious opponent on paper. In actual practice the Black Prince has a reserve of guns, as the plan indicates, though there is reason to doubt whether this has all the value that was assigned to it a year ago. The Far East fighting seems to indicate that very few guns will be disabled in battle. Should this prove to be a general truth, then the Black Prince class will always be in the position of having two useless guns. Since, however, each of the four big guns in this type is mounted singly, the "survival chances" of each are considerably greater than those of the usual twin turret armed ship. With single turrets, also, a greater rate of fire is to be maintained, so that, despite the two idle guns, the four single pieces undoubtedly represent more fire than would the same guns in a pair of turrets.

The Black Prince and her sister the Duke of Edinburgh are usually described as the first completely belted British ships of modern times. This, how-

ever, is not a feature of very much importance because they only carry 3-inch aft, and double skins, and so forth, give most of our recent ships about 2-inch. The one thickness is probably of little more use than the other under modern battle conditions. A more real advantage is that the usual 6-inch amidships belt is continued to the bow at 4-inch; 4-inch is the thinnest armor for which the Krupp process can advantageously be used, so that there is more than 2-inch value for the 2-inch difference between the bows of the Black Prince and the Drake.

Against this, however, is to be set the fact that the vessels of the Black Prince class are practically without armor decks. A skin deck of two thicknesses exists, but its stopping power is probably insignificant. Viewed in connection with the very great advances recently made in capped projectiles, this virtual abandonment of the armor deck's extra resistance does not please the average naval officer, though possibly the greatly increased offensive power of the Black Prince may be counted by some as a considerable makeweight, offense being from some points of view the best defense that can exist. This, however, is still an obscure point, since it is involved by the fact that the first shot or so of the enemy may do enough damage to render the originally powerful attack equal or inferior to his own, while he himself, being better defended, suffers nothing from that demoralization which hits are almost bound to produce to a greater or less extent.

The Black Prince, like the Duke of Edinburgh, will be among the last of ships with the 6-inch guns—abolished for their later sisters. These 6-inch will be 50 calibers long, and, therefore, considerably more powerful than previous guns of this size, but whether they will ever fire in battle is another matter. There is little to indicate at present that ranges at which the 6-inch gun will be any good will obtain.

It is worthy of note that there is no ahead fire for the forward 6-inch guns—a good thing. Sponsons and recessed ports forward are pretty on paper; in fact, they merely serve to check speed and make the ships wet.

The Black Prince carries no 12-pounders. Presumably she relies upon her 6-inch guns to check torpedo attack, for 3-pounders are useless for this. It may be added that 12-pounders appear to be little more useful.

In speed the Black Prince is below the Drake class, which reach 24 knots with a very economical coal expenditure. This speed reduction is viewed with disfavor, despite the theory that a certain 22 knots is better than a problematical 23. The Drakes do a certain 24, and the Black Prince class, it is hoped, will also exceed the contract speed by a knot. The steam generators to be fitted are of the Babcock and Wilcox type, of the latest improved pattern.

To sum up, the Black Prince type is better armed than the Drake class by at least 33 per cent. In defense it is about 20 per cent. less efficient, but it is also smaller than the Drake type. In speed and coal endurance there is an inferiority of approximately 8 per cent. The armament gain is so great that it more than balances any loss, and the advance is certainly commensurate with the times. —*The Engineer*, October 14, 1904.

Japan's *Sea* Power.

Correspondence is now going on in the Japanese newspapers as to whether or no the Japanese fleet was built upon the best principle. Stated concisely, the arguments put forward are as follows: Japan in building up her navy has followed the British fleet, and adopted a few monster battleships, on the "quality before quantity" principle. The question is, "Would she not have done better had she proceeded upon less imitative lines, or rather upon the German system of 'quantity first,' preferring four relatively weak vessels to three more powerful ships?" Incidentally the questions of distribution of guns and armor, the type of artillery, coal stowage, boiler types, and torpedo armament have all come under discussion, the whole being raised by the fact that Admiral Togo never had under his command a force sufficiently strong to make victory quite certain. It is recognized in Japan that had Russia been less unlucky upon the water, had her fleets been led by better admirals, the struggle upon the water might have been both desperate and inconclusive. Luck, and a superior organization of *personnel*, have stood Japan in good stead. Neither of these matters is our concern here, but an examination of the question as concerns *matériel* may be of interest.

Japanese naval policy has produced its fruits in the fleet with which she started the campaign—six battleships, each at the time of its creation the best to be had for the money; six armored cruisers, superior to any other armored cruisers at their inception; and a due proportion of smaller cruisers and torpedo craft. The Nisshin and Kassuga we omit, as they were not originally intended for the Japanese fleet, and their purchase was simply due to the prospects of war. The loss of the Hatsuse is the peg upon which those who ask whether a better policy was possible hang their arguments. The sinking of that ship reduced the Japanese battle-fleet by one-sixth at a single stroke: had the battle units consisted of vessels like the German Wittelsbach, the loss, supposing the same expenditure, would have been but one-ninth or thereabouts—say, 11 per cent., instead of nearly 17 per cent. Taken by itself, this is a strong enough argument—till it is carried a little further. Had the French Henry IV. been the selected type, the percentage of loss would have been but 9 per cent. or so; had the German Ægir type been selected, it would have been less than 5 per cent. Thence we may argue down through protected cruisers to destroyers, and even to picket boats, with a loss represented by some minute fraction, or we may proceed in the other direction with bigger and bigger fancy ships, till we arrive at a solitary unit, whose loss would mean a loss of 100 per cent. The selected unit, whatever it may be, is therefore purely relative, and the most that can be said is that it is quite true that the smaller the unit the less the percentage of loss. But that is and always has been obvious. It was certainly obvious to those who directed Japanese naval policy.

The dread of a repetition of the Hatsuse disaster, very strongly anticipated in Japan, is at the root of the present discussion. In thinking of the Hatsuse foundering off Shantung, people forget the big ships off Port Arthur and at the battle of Round Island. Here, if anywhere, the advantage of big units was apparent. The heavy casualties of the Mikasa show how frequently she was hit; quite as often, perhaps, as was the smaller Cesarevitch. Yet the Mikasa kept the sea, while the Cesarevitch, disabled, crept into Kiao Chau. The moral is obvious—the bigger the ship the more hammering she will stand. Had the Mikasa been a Wittelsbach it is improbable that she could have remained at sea, with the result that instead of remaining intact the Japanese fleet would have lacked an important unit. Whatever risks big units may entail, they confer a staying power not to be secured by other means, for a ship away repairing is, for the time being, as bad as a ship sunk, whereas one that can remain with the fleet is a loss merely to the extent of her disablement.

The 10-in. gun has found some partisans in Japan amongst those who think that smaller battle units might have been desirable. The Russians in the Pobeida and Peresviet carry good 10-in. pieces, equal, indeed, to their old 12-in. in the Poltava class, but far inferior to the 12-in. guns carried by the Japanese. No 10-in. can have the power of a 12-in. of equal date; and it is hard to argue that five 10-in. blows will do as much harm as four 12-in. In certain circumstances they might; in many others they are likely to do nothing where the 12-in. will do much. Powerful big guns have always been in favor with the Japanese, who put them in the Matsushima class against all advice. Time has shown that whether or no they were correct in this particular case, they were very right in general principle, for the big gun is everything in these days of long range fighting, and probably no sacrifice is too great for the gain that the most powerful gun afloat conveys. Besides the merely physical effect of the powerful blows, there is the important though little considered "moral effect." The moral effect of the powerful guns is probably very great indeed. Though the physical effect of the big Canet pieces of the Matsushima class at Yalu was nil, their moral effect counted for a good deal. There is no question also but that the big guns of the Chinese battleships worried the Japanese, not by what they did so much as by what they might have done. The mere threat of the American 13-in. guns at Santiago prevented Cervera's fleet from attempting any fight worthy of the name; and had the Japanese big guns at the battle of Round Island been medium pieces, it is hard to believe that the Russians would have been beaten back to Port Arthur. On the whole, therefore, there is little to favor the theory that in following the British navy the Japanese naval policy might have been better where guns are concerned.

In armor dispositions there is perhaps some room for criticism on the grounds that the duties of British and Japanese warships are so very different. British ships that must be prepared to fight away from bases need more armor, perhaps, than Japanese vessels which are nearer their bases. At least, it may be argued that a saving here, expended in gun power, would have been an advantage that during the war could have been appreciated. Ton for ton, Japanese vessels are less heavily armed than the Russian ships which they were presumably built to fight.

In matters connected with the engine-room a mild "battle of the boilers" exists. Japan was one of the first nations to see the war advantages of water-tube boilers, and adopted the Belleville variety about the same time as we did. Unlike the British Navy, however, the Japanese seem to have found no difficulty in assimilating the new type—principally because they trained their stokers better, and avoided the British naval error of introducing "improvements" of the unsuccessful sort. None the less, however, British condemnation in this matter was followed; and the "slavish imitation," as it is called, is finding critics amongst Japanese engineers, who claim that actual service results which they can watch in their own waters are of far more value to them than "distant experiments which for Japanese purposes are artificial."

This question, however, is rather one of the future than the present. The question of the day is rather, "Would the Japanese fleet have been better had the general policy of its units, armament, equipment, machinery, boilers, and so forth, been different?" The general answer of the Japanese appears to be in the negative; and in the hour of a life-and-death struggle the consensus of opinion is altogether in favor of those who were responsible for the Japanese fleet as it is. Whatever academical criticisms of Japanese naval policy may be brought forward, the fleet of Togo triumphantly riding the seas is a practical answer, to which its creators may point with justifiable pride.

—*The Engineer*, Sept. 23, 1904.

BOOK REVIEWS.

History of Andrew Jackson. By Augustus C. Buell. In two volumes. New York: Charles Scribner's Sons. 1904. $4.00 per set.

These two interesting volumes constitute an important addition to American history, and furnish a most entertaining life of a great American, written in a pure American spirit. The only other life of Jackson of any importance is the very complete one of Parton, published seventeen years ago, and written in a different spirit.

Mr. Buell, the author of the present work, feeling that Parton's life did not fully reflect the age in which Jackson lived, or the Jacksonian spirit, as it has been called, determined to present a new history of the great American, more in accord with that spirit. Jackson had been a life study with him: he had read every book relating to him, beginning in his seventh year, and had had personal interviews with many eminent men and women who passed their prime of life with Jackson, in his endeavor to become thoroughly familiar with his subject, and in order to fill out important details in the portrait he had determined to paint.

The spirit of Jackson's day was intensely American, and Jackson was a typical American of his day. The present work is written in the spirit of those times, into which the author, by his devotion to his work, had faithfully worked himself.

Mr. Buell is well known as an author, his most important work, aside from this, being his *Life of Paul Jones*, portrayed in a very similar spirit. Moreover, his service in the Army of the Potomac (1863-65) enabled him to arrive at a fair judgment of the military elements in the life of his present subject, and to furnish intelligent descriptions of the various engagements in which his hero figured, especially of his most important military action, the battle of New Orleans.

Jackson is presented to us in these volumes in his various careers, as pioneer, patriot, soldier, politician and president, and the picture is true to life in each and all; when we close the book we *know* Jackson very intimately. Every page of the book is interesting; his Irish ancestry gives us a clue to some of his characteristics, while the account of his early childhood and youth, and of his beginnings as a frontier lawyer in Tennessee, prepares us for his energy and strength of character; his life as a representative, senator, judge, planter, merchant, governor and president, is full of important events and teems with strenuous activity; his duels and quarrels are all characteristic of the man, and the accounts of them are most entertaining, while his Indian campaigns and the defense of New Orleans against the British attack show him to have been a commander of remarkable ability. Throughout the history the reader is in sympathy with the subject, whether he agrees with his principles or not. Jackson is by nature a hero, and the world worships him as such. In spite of all his peculiarities and faults, his character has the ring of true metal always, hence he is to be admired and honored, and he is essentially *human* in all his actions, consequently he has our sympathy too.

On the whole, the portrait of General Jackson (so he preferred to be called) as presented by Mr. Buell, is intensely interesting, entertaining and instructive, and constitutes a stirring picture of an energetic American, framed in a setting of the spirit of the times. The work is appropriately dedicated "*To the Embodiment in our Times of the Jacksonian Spirit*, THEODORE ROOSEVELT."

Since completing the manuscript, the author suddenly and unexpectedly passed away, leaving the work without a preface, but his letters enabled the publishers to indicate the purpose of the work and the reason for its production.

We will conclude this brief notice by quoting a portion of the text, not only to illustrate the interest of the narrative and the style of the author, but also to indicate the value of the work as a contribution to American history :

"In conclusion of the last chapter we said that General Jackson's army of New Orleans 'saved the Louisiana Purchase.' Few people of the millions who in this year of grace, 1904, celebrate the centenary of that colossal transaction between Napoleon Bonaparte and Thomas Jefferson, realize the significance of those words. To most people in the twentieth century the memory of New Orleans is that of a glorious misfortune ; a great victory gained after peace had been made ; a brilliant page of history stained with blood shed in vain. Common—almost universal—as that view may be, there never was a more perfect fallacy. Viewed in the light of its actual influence upon the map of North America and the fortunes of this Republic, it was the most important battle ever fought between Great Britain and the United States. It was, indeed, fought after the war of 1812 was over. On the face of things, that fact had the aspect of a misfortune. But that was really a minor consideration.

"The real, vast, enduring value of the battle of New Orleans lay in the fact that it prevented another war.

"In foregoing pages we have from time to time mentioned the Louisiana campaign of 1814-15 as an attempt at territorial conquest with a view to permament occupation by the forces of Great Britain. But thus far we have adduced no positive evidence. Here we shall endeavor to establish the fact.

"At the outset it is of official history (See Bathurst Papers, State Paper Office, London) that the concentration of land and naval forces at Negril Bay, Jamaica, was not ordered until after the peace commissioners had assembled at Ghent. The War Office minute embodying the order to General Pakenham 'to proceed to Plymouth and embark there for Louisiana to assume command of the Forces operating for the reduction of that *Province*,' was dated November 4, 1814. The peace commission had then assembled at Ghent. Why did the British Cabinet, in its order to General Pakenham, describe Louisiana as a 'Province'? The fact that it was a State of the American Union was as well known to the British Government as to our own.

* * *

"Twenty-two days after the date of Pakenham's orders the combined armament set sail for the coast of Louisiana. The fleet carried more than an army. The narratives of *The Subaltern* and *Captain Cooke*, reputable officers of the Eighty-fifth and Forty-third Light Infantry respectively, tell us that there was on board the fleet 'a complete government staff' to be installed in place of the State government of Louisiana at the moment of occupation. * * *

"The 'civil government staff' for the 'Province of Louisiana' which Admiral Cochrane's fleet brought along consisted of a lieutenant-governor, the Hon. Mr. Elwood, transferred from Trinidad; a collector of customs, already mentioned, from Barbadoes; an attorney general, an admiralty judge and a secretary for the colony sent from England direct; with a 'superintendent of Indian affairs,' Mr. Dockstadter, transferred from Upper Canada.

"The British Government had also arranged with Spain for free trade with the Indians in all Spanish possessions north of the Rio Grande! Spain, of course, was then completely under the feet of England, in the southwest as well as in Florida.

"Besides his general orders at Plymouth, Pakenham brought with him a proclamation approved by the Home Government or Colonial Office. This proclamation was to be published as soon as the British army should occupy New Orleans. It promised protection to everybody, general amnesty to all previously engaged in hostilities, and proclaimed the sovereignty of England, in behalf of Spain, over 'all the territory fraudulently conveyed by Bonaparte to the United States.'

"It denied the validity of the secret treaty by which Spain receded Louisana to France in 1800. It denied Bonaparte's right to act for France in 1803. And finally, it 'denounced the pretentions of the United States to sovereignty under the alleged purchase from Bonaparte.' "

This extract is sufficient to indicate the value of the work historically, and also shows the interest attached to the narrative.

The work is printed in large clear type on heavy paper and is substantially and attractively bound.

The United States. A History of Three Centuries. 1607-1904. Population, Politics, War, Industry, Civilization. By William Estabrook Chancellor and Fletcher Willis Hewes. In ten parts. New York: G. P. Putnams Sons. **Part I.: Colonization, 1607-1697.** Pp. 533.

This comprehensive work, of which the opening volume has just appeared, promises to be one of the most complete and satisfactory histories of the United States, for the general reader, that has yet appeared. No other single work covers the ground from so many different points of view: industry, commerce, civilization, war, conquest, population, education, literature, religion, social life and politics; no other history of our country has been planned with a view to presenting *all* the different phases of its development, and tracing the evolution of all our distinctive national qualities and institutions; none has so fully utilized all the available material, since many of the historical records (often in the form of monographs accessible to but a few), presenting the results of the latest investigations by trained scholars, are of more recent date than the histories now before the public; and finally, no other history of importance covers the *entire* period from 1492 to 1904.

The authors came to their task particularly well equipped for the work in hand. Mr. Fletcher W. Hewes has for many years been recognized as the leading authority in the department of statistical and economic history, and his part of the work is not only a distinctive contribution to American history, but also an element of exceptional value and novel interest to all readers, from the school boy to the practical business man. It presents to the young student in particular a picture that is quite unique in an historical work, which will therefore be of infinite importance to the younger generation.

Mr. Wm. E. Chancellor, for many years a careful student of American History, with a wide experience as teacher and lecturer, confers fresh interest on the narrative by his vigorous and dramatic style, his picturesque presentation of events, and his critical and discriminating characterization of the great men who have made American history. The story is told in so fascinating a way, in such clear-cut sentences, with new ideas on every page and new ways of presenting the subject-matter, that the reader is carried along, absorbed in the development of the picture, interested in the growth of the nation, entertained by the philosophy of history as it is presented, and satisfied with the amount of information conveyed. The deep significance of the important events is brought out in an impressive and novel way, and the fearlessness of the authors in stating their views on all points is pleasing and attractive to the fair-minded reader. It is not a mere record of events, with a simple statement of their causes and effects, but a truly philosophical study of the history of our country, tracing the origin and development of the movements and influences which have shaped the history of the nation, and considering "the varied causes that led to what may be called the final Americanizing of the varied national elements from which were made up the people of the American continent from the Atlantic to the Pacific and from the Lakes to the Gulf."

Part I. (the first volume of the work) comprises the period of *Colonization*, 1607-1697, and is a record of the twelve English Colonies of the Seventeenth Century, preceded by a brief review of the period of discovery and settlement.

Each volume discusses its subject-matter from four points of view, viz:

Population and politics. War. Industry. Civilization.

The present volume, under the first of these, opens with an outline of the beginnings of new Spain, the rise of England as a Sea Power and the founding of Jamestown, and the first half-century of Virginia; then follows the beginnings of New Netherlands, the Pilgrims at Plymouth, the Carolinas, the Quakers, the beginnings of new Sweden and the beginnings of new France.

Under the second section, the wars with the Indians, from 1622 to 1697, are discussed, including, besides the minor wars, the Pequot, King Philip's and King William's wars.

Under section three are presented essays on early colonial agriculture, manufacture, and shipbuilding, on iron and steel, textiles and minor manufactures, and on trade, transportation and finance.

Section four contains articles on Religion and Morality, Education, Literature and Social Life.

This analysis of the subject-matter gives some idea of the variety of subjects treated, but a very inadequate one. This first volume contains eighteen larger maps and diagrams, and 132 smaller maps throughout the text. The larger maps include several very interesting ones, such as the route of Columbus in 1492, a map to explain the error of Columbus, one of the important Indian tribes in 1600, Smith's map of the New England Coast, and a map showing the claims of European countries, 1600-1650. The diagrams are historical perspectives of various kinds, showing graphically, increase in population, and enumerating the successive events of importance, in Civilization, Industry, War or Politics, with curves of population, education and wealth, etc. They are very interesting and instructive, and serve to complete the picture of the growth and development of the country. The smaller maps are a novel feature, and serve a very useful purpose, illustrating the text without confusing or distracting the mind of the reader. They are, in general, simple outlines of a region, with only such points marked as are of interest in the description which the map illustrates.

To illustrate the author's style, as well as the general character of the work a few extracts are here given, selected at random :

"The most astonishing personal achievement of all the sixteenth century was that of a Portuguese mariner in the service of Spain. Ferdinand Magellan, the Marco Polo of the world's wide waters, was able to prove, what Columbus failed to prove, that the world is round. Setting out from Spain with five ships, only two remained with him when he passed beyond the straits that now bear his name. Unterrified by desertions and mutinies, he sailed out upon the Pacific, so calling it for its calm after the frightful storms of the Atlantic. Latitude he could measure with the astrolabe; but chronometers were yet unknown, and longitude none could measure accurately. He would go round the world! Was it round? And how far around was it? He did not know; his crews knew that he did not know. They could not go back, and they must go forward and up to the Moluccas, which Magellan sailing westward had reached a dozen years before. Months went by in heat and calm. They drifted on. They endured starvation and thirst, quarrel and terror, the nameless, indescribable terror of the lost. They found the Philippines, nearly in the latitude of the Moluccas; and there Magellan, the first circumnavigator of the globe, was killed. Del Caño, commanding the *Victoria*, well named for this supreme adventure, completed the voyage eastward. To Marco Polo we, the sons of Europe, owe Asia; to Columbus we owe America; but to Magellan, as stout a heart as ever sailed a ship upon the seas, we owe the knowledge of the round earth.

"This, the crowning achievement of all sea-voyages, was of geographic importance, enlarging the horizon of human life, and revolutionizing the business and politics of the world. Men at once increased their efforts to find a more direct route from Europe through America to Asia. The 'Northeast Passage' became the dream of navigators. It was not until 1852 that McClure completed the knowledge of a route through the Arctic Ocean, and won the prize of £5,000, offered by the British Parliament for the achievement. The easier passage is now being constructed by man at the Isthmus of Darien."

"The century closed with general religious toleration of all Protestant Christians, not excepting Hugenots, with all political and economic democracy throughout North Carolina, and with political democracy and economic aristocracy entrenched at Charleston, in South Carolina. Here, upon a new site, in 1680, was established a community of wealthy traders, who by 1700 were living in town, but owned great slave-worked plantations, located inland. The destiny of South Carolina by this time was already indicated. It remained for the next two hundred years to disclose that destiny, upon the vast and crowded stage of American history." * * *

"Ship-Building. That this industry was particularly beneficial appears from the comment of one Captain Johnson: 'Our maritime towns began to increase roundly, especially Boston . . . the which of a poor country village, in twice seven years, it is become like unto a small city.'

"Nor was ship-building confined wholly to mercantile craft. As the sea success of the colonists increased, competition threatened; and in those years competition meant guns, powder and shot. The Dutch, with their Amsterdam craft, were not loath to compel the New England ships to do their bidding, so the United Colonies of New Haven and Hartford fitted out a cruiser of ten guns and forty men for serious war service on Long Island

Sound. Massachusetts fitted the ship *Anthony* for the same sort of service. New Hampshire built the *Faukland*, 54 guns, and a galley of thirty-two guns for the protection of its sailormen. * * *

"An Age of Ignorance. Astrology was only beginning to pass away. Comets were still supposed to be 'the threats of God in the sky.' Insects of all kinds were believed to be the products of animal and vegetable putrefaction—a belief endorsed by Bacon himself, as astrology was by Kepler . . . Aristotle, the ancient, had not affirmed that the blood circulates; therefore, thought the seventeenth-century multitude, Harvey was wrong. Even Harvard College did not accept the idea of the circulation of the blood until 1699. The human body supposedly consisted of earth, air, fire, and water, and manifested four humors, melancholy of earth, blood of air, daughter of fire, and phlegm of water. Blood-letting was the commonest remedy for all manner of diseases." * * *

These extracts must suffice to indicate the scope of this work and its philosophic character. To the intelligent reader it is a rich storehouse of information, presented in a new form, and furnishing much food for thought in all the great domains of human endeavor.

Every American citizen should be familiar with the contents of this great work, for it portrays the life-history of the nation in all its spheres of action. Therefore, we cordially and sincerely recommend it for our army libraries, official and personal, and for the Post Libraries for the enlisted men, together with the other publications of the same firm of publishers, which had been planned with express reference to the requirements of post libraries, namely:

Heroes of the Nations. *Story of the Nations*. *Heroes of the Reformation*. *Civil War:* Ropes. *American Men of Energy*. *The Winning of the West:* Roosevelt.

These, together with the work before us, would constitute an educational series for the young American, which could hardly be surpassed, and could not fail to make better soldiers and citizens of our enlisted men.

Guerilla or Partisan Warfare. By T. Miller Maguire, M. A., LL.D. 112 p. O. London: Hugh Rees, Ltd. 124, Pall Mall, S. W. 1904.

In this book the author has brought together many interesting and instructive examples of the operations of guerillas in campaign in almost all countries,—in fact there is hardly anything in connection with guerilla or partisan warfare that occurred in the last century that has not at least some reference to it. The subject is of importance to the British officer because so many of the British campaigns, from the very nature of the Empire, are and have been what be called guerilla wars—small wars, irregular, savage wars. But it should appeal with perhaps equal force to the American officer also. Our Civil War and Indian wars furnish numerous examples of such operations, and conditions in the Philippines demanded the very qualities that are the secret of success in wars of this nature.

The book is not merely a collection of historical examples. The subject is divided into various heads, and each is treated separately and in detail. Explanatory matter is added and many useful comments are made, so that it not only covers a very wide field of historical research, but is full of valuable information, and contains many useful lessons. Guerillas in Spain, Russian partisans, Pindharees, the celebrated system of raids in the American Civil War, as exemplified by the skilful enterprises of Mosby, Stuart, Ashby, Grierson and others, Guerillas in France, Franc-Tireurs, La Vendee, Cossacks, Banditti, Guerilla operations in South Africa, and in many other countries, tactics, treatment, discipline, and the difference between regular and guerilla warfare,—to mention a few of the topics that are so instructively treated by the author,—gives some idea of the scope of the work. As illustrative of the extent and frequency of occurrence of these "small wars," it is interesting to note the two tables at the end of the book : one showing the theatre of operations of the principal foreign guerilla wars in modern times, and the other the principal operations of the British army and navy in the reign of Queen Victoria, "more numerous than the operations of all the other armies of Europe put together," the British army alone being engaged in no fewer than eighty-two distinct campaigns.

Dr. Maguire writes entertainingly, and in clear, forcible language impresses on the reader many practical truths in regard to the conduct of wars of this nature. Those who read the book will gather many suggestive hints in this respect, and can scarcely fail to be interested in the historical examples so fully quoted.

Tactics for Beginners. By Major C. M. DeGruyther. Ed. 3. 8+360 p. pl. D. London: Gale & Polden, Ltd. 1904. Six shillings.

This is the third edition of this excellent manual,—a fact that is, in itself, sufficient evidence of the value of the book and of the appreciation with which it has heretofore been received. Revised and in some parts rewritten in 1902 in consequence of the lessons learned in the South African war, it has been further improved and a new chapter has been added, "The Evolution of Tactics since 1866." which is very interesting and instructive.

The author says his book is simply intended as a groundwork for future study, as a thorough knowledge of the subject of Tactics can only be acquired by studying past campaigns; nevertheless the work is none the less valuable because unpretentious. It is a well-written precis, containing much useful information on practical tactics, and fulfils its purpose admirably by making clear to the student the things he ought to know, the principles involved and the reasons therefor.

Messrs. Gale & Polden have brought out a Fourth Edition of Major Banning's **Organization and Equipment made Easy,** the third having been exhausted in a little over a year. The new edition is revised to date, noting those contemplated alterations which appear likely to be ultimately introduced in British army organization, and will be found the same useful manual, well-prepared and concise book of reference as was the former edition.

A Series of Five Lectures on the Russo-Japanese War, 1904, is a little book of 41 pages consisting of lectures originally delivered to the men of "The Queen's Regiment," by its author Lieut.-Colonel H. D. Robson. It constitutes a concise narrative of the events of the war, with critical comments on the battles and operations down to the middle of August, and will prove of assistance to those who wise to learn a little about the war. Several maps accompany the text and assist one in following the actions described. It is published by Messrs. Gale & Polden, Ltd., 2, Amen Corner, E. C., London, price ninepence, post free.

The same publishers also send us **The Scout's "Aide Memoire" in Rhyme,** a convenient little number of their Military Series, in which the duty of a scout is succinctly expressed in the form of catchy and easily remembered rhyme. Price threepence, post free.

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