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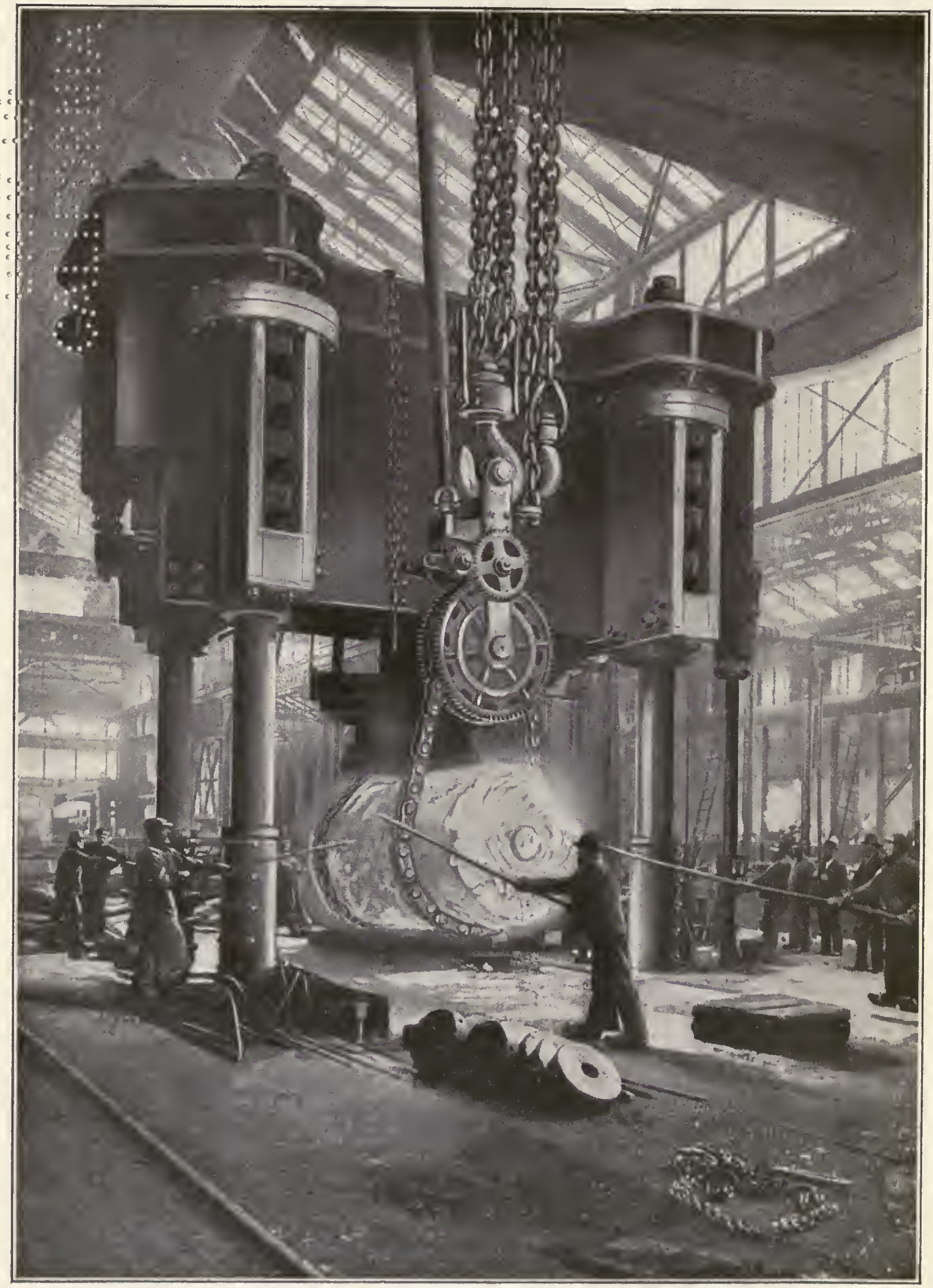

FORGING INNER TUBE FOR A GERMAN 16.8-INCH SIEGE GUN IN THE FAMOUS KRUPP WORKS AT ESSEN

The Scientific American War Book

THE MECHANISM AND TECHNIQUE OF WARFARE

COMPILED AND EDITED BY ALBERT A. HOPKINS, EDITOR OF THE SCIENTIFIC AMERICAN REFERENCE BOOK, ETC. MEMBER OF THE AMERICAN STATISTICAL ASSOCIATION

572 ILLUSTRATIONS

ARTICLES BY REAR-ADMIRAL MAHAN MAJOR A. G. PIORKOWSKI. LIEUT.-COL. L. S. ROUDIEZ, U. S. A. FRED C. HILD, THE AVIATOR. MAJOR H. BANNERMAN-PHILLIPS. CAPTAIN W. D. A. ANDERSON, U. S. A. AND MANY OTHERS

NEW YORK—1916

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PREFACE

IT is a far cry from the noble Homeric combats on the Plains of Troy to wholesale assassination with gas or hand grenades in a neighboring trench a city block away. We are so civilized that we scout with aeroplanes and drop bombs into quiet places where women and children tend their old-fashioned gardens. We come up with a torpedo under the boilers of a great passenger steamer with the aid of a submarine. We invite every force—God-created and man-created—to destroy our fellow man and his hard earned property. The glamour of war is gone, it is hard, unsentimental, unchivalrous, but not uninteresting.

This volume is not a history of the great European war, nor will it depict its horrors—there are already too many books on the war—but it does give a succinct account of what war really means, how it is carried on, how men are gotten up to position, fed, bathed, fought, imprisoned, wounded and killed. It describes how forts are built and reduced, how mines are laid and destroyed, how barbed wire entanglements are made and destroyed, how submarines carry on their audacious and successful enterprises. It is like no other book, being very largely from the pens of high army and navy officers whose names cannot be used in many cases owing to departmental orders. This book could never have been compiled except from the files of the SCIENTIFIC AMERICAN, the foremost authority on Naval and Military affairs in the United States. All matter with trifling exceptions is derived from this source which is therefore a guarantee of reliability in a sea of impossible newspaper misinformation.

A. A. Hopkins

New York, Sept. 15, 1915.

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UNIV. OF CALIFORNIA

Chapter I.

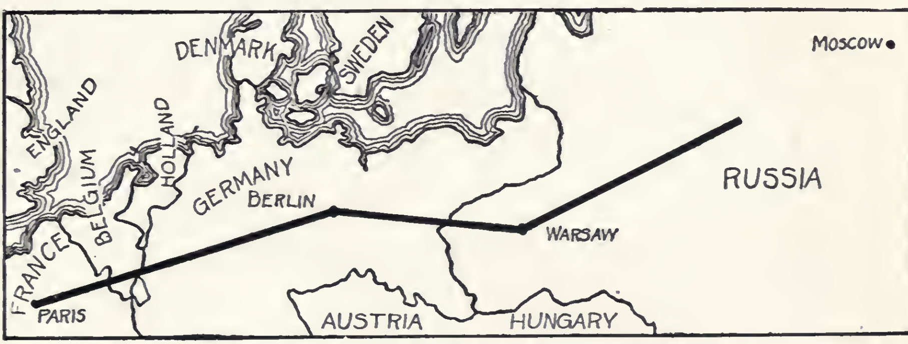
AN ARMY ON THE MARCH

Orderly Sequence in Which the Units of a Modern Army Are Brought Up to the Battle Front

ONE of the most important elements in the conduct of warfare is the rapid and orderly movement of the troops, whether in bringing them up to the front from the various mobilization centers, or in moving them from point to point, according to the exigencies of the campaign—the ever-changing fortunes of the field of battle.

To the layman, who has witnessed the gathering and dispersal of the few thousand spectators at a football or baseball game, it will be evident that the movement of bodies of men, running into the hundreds of thousands, is a matter calling for thorough forethought, method, and discipline.

As far as possible and almost invariably the march of armies, especially in settled countries, such as form the theater of the European war, is carried out upon the highways. The order of march, the sequence of the various units, has been determined by long experience, and the diagram which incloses three sides of page four and represents a division of about 20,000 men, when on the march in the presence of the enemy, may be taken as broadly representative of a similar unit in any of the first-class armies engaged in the present conflict. Two such divisions constitute an army corps of 40,000 men, and three army corps make up a field army of 120,000 men.



THE FIRST GERMAN ARMY OF INVASION OF FRANCE (1,200,000 MEN), IF MARCHING ON A SINGLE ROAD, WOULD HAVE STRETCHED FROM PARIS 1,200 MILES, TO WITHIN 400 MILES OF MOSCOW

Now the first thing, probably, that will surprise the layman in looking at this diagram, is the extraordinary length of road that is covered by 20,000 troops on the march. The distance from the head of the advance cavalry to the last wagon of the supply train is 21½ miles. This means that if it were advancing by a single road and were covered by a single body of advance cavalry serving

Photo by Branger

FRENCH SOLDIERS ENCAMPED IN A PUBLIC PARK WAITING THE ORDER TO MARCH

COMMANDEERED PARIS AUTOBUSSES PASSING THROUGH THE COMPIEGNE FOREST

BATTERY OF FRENCH FIELD ARTILLERY

FRENCH CUIRASSIERS ON THE MARCH

for all the troops that followed, an army corps would reach 41 miles and a field army for a distance of 120 miles.

Photo by Branger

A COMPANY OF FRENCH ALPINE CHASSEURS ON THE MARCH IN THE VOSGES MOUNTAINS. ALPINE STOCKS ARE A PART OF THEIR MILITARY EQUIPMENT

It has been estimated by some of the military critics that the German army of invasion of France was composed of 1,200,000 men. If so, and the Germans could have marched unopposed into Paris, and if we imagine that army marching by a single road, stretching from west to east, at the time when the advance cavalry reached the Arc de Triomphe, Paris, the tail of the German host would be 1,200 miles distant. The column would reach through France, Belgium, across

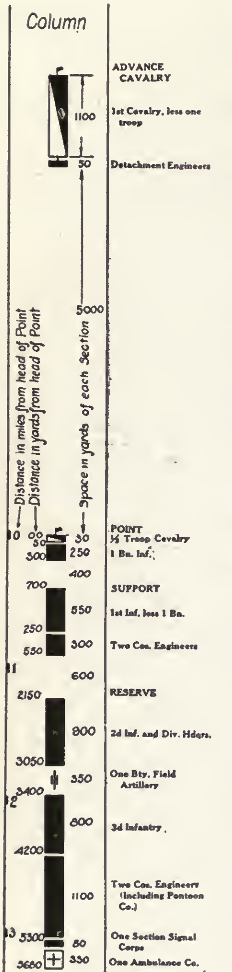
Germany and some 500 miles beyond the Prusso-Russian boundary to within 400 miles of the city of Moscow.

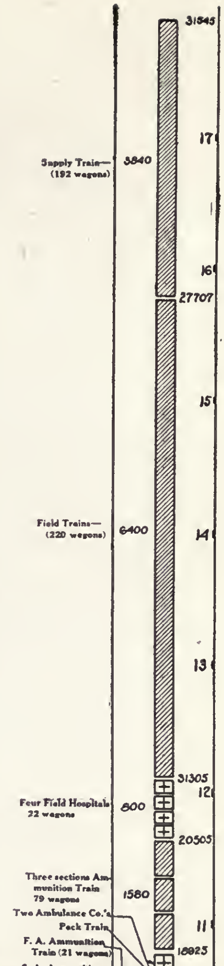
The enormous size of modern armies necessitates advance upon a wide front and upon parallel roads, the separate lines of advance keeping in close touch with each other to maintain cohesion and insure a properly coordinated arrival on the battle field.

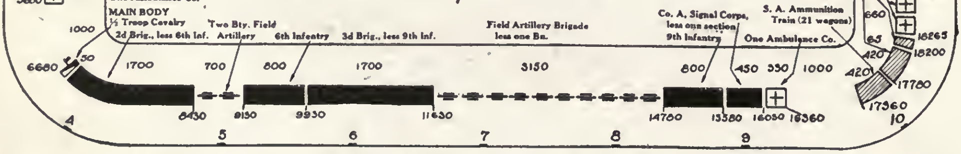
The accompanying diagram of a division on the march is so clearly drawn and fully lettered, that it calls for no detailed description. The order of march is determined, first, by tactical considerations, which, in the presence of the enemy, are of prime importance; and second, by the general principle that the hardships of the troops must be reduced to a minimum. The column is preceded by a strong body of cavalry, who locate and determine the strength of the enemy, and are generally about three miles in advance of the "Point" (see diagram) or head of the main body. Also, a detachment of engineers usually marches near the head of the main column, to repair roads, strengthen bridges, etc.

On the march the troops usually keep to the right of the road. On muddy, sandy, or very dusty roads the column divides longitudinally, thereby making it easier for men and animals to pick their way, the middle of the road being clear.

As far as possible, marches begin in the morning; and, as a rule, foot soldiers do not start before broad daylight, and mounted troops an hour after broad daylight.







THIS DIAGRAM, DRAWN TO SCALE, SHOWS THE LENGTH OF ROAD OCCUPIED BY THE VARIOUS UNITS OF A DIVISION OF 20,000 MEN ON THE MARCH IN THE PRESENCE OF THE ENEMY

The rate of march is regulated by the foot troops. It varies according to the length of the march, size of the body of troops, their condition, and other circumstances. The rate is reduced by sandy, rough, muddy, or slippery roads, great heat and dust, strong head winds, storms, and swampy, hilly or broken country.

For infantry the maximum rate is 3 miles an hour, or, including halts, 2½ to 2¾ miles. Under average conditions the rate of infantry columns is 2¼ to 2½ miles an hour. For large bodies of troops the rate is about 12 miles a day; but small bodies of seasoned troops marching on good roads in cool weather are considered by our army men to be capable of 20 miles per day, though on forced marches this, of course, has been greatly exceeded.

The average march of cavalry, when men and horses are seasoned, is about 25 miles a day.

The daily march of field artillery is about the same as that of the command of which it forms a part. Alone it can cover from 15 to 20 miles.

The daily march of a wagon train is about the same as that of the infantry.

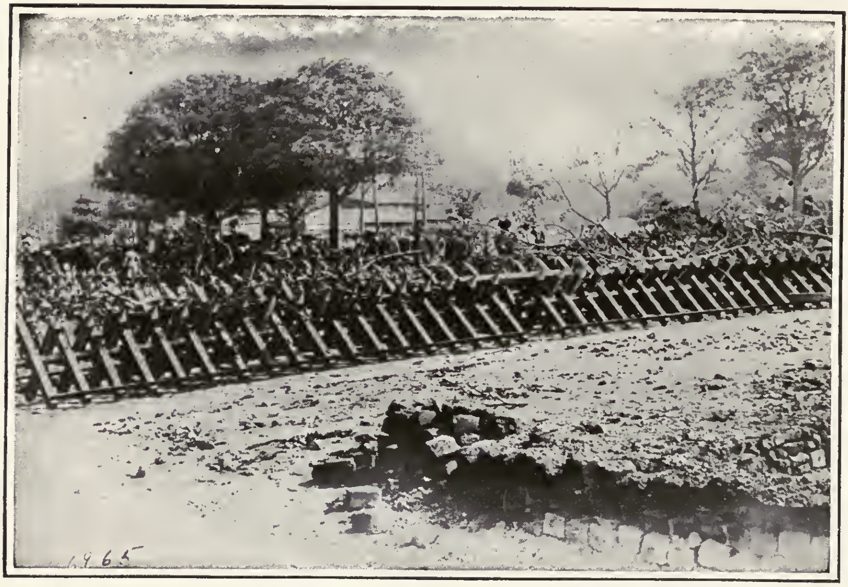
To rest the men and animals, and for other purposes, a command on the march is occasionally halted. The first halt is made after marching about three quarters of an hour, and is about fifteen minutes long. After the first rest, there is for infantry a halt of ten minutes every hour. The men are allowed to fall out, but in the vicinity of their places only. Cavalry halts are for five minutes only, and artillery for five to ten minutes.

When contact with the enemy is probable, the columns are closed up and march on broad fronts; communication is maintained between the columns on parallel roads, and all baggage not needed in the conflict is kept in the rear.

Military trains, etc., are at all times provided with the necessary guards, and in marches into action the trains are held far enough in the rear not to interfere with the movements of troops or check withdrawal in case of defeat.

OBSERVATION MAST BUILT OF STEEL RIBBONS

Although there are certain military formations which must be strictly adhered to when on the march in order to have complete unanimity of movement, still the regulations are not so strictly adhered to, and the men are allowed considerable freedom, especially in the carrying of their arms and accouterments and, greatest boon of all, smoking, while not officially sanctioned, is openly tolerated.



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AN OBSTACLE OUTSIDE PARIS IN ANTICIPATION OF A GERMAN ADVANCE.

COUNTRY AROUND ANTWERP FLOODED BY CUTTING THE DIKES.

Chapter II.

PROTECTION FOR THE FIGHTING LINE OF AN ARMY

Fortifications and Their Relation to the Operations of Armies in the Field

BY LIEUTENANT-COLONEL LEON S. ROUDIEZ, UNITED STATES ARMY

THE principal object of this article is to present in as simple a form as possible —free from technicalities—a general description of the various types of fortifications in use in modern warfare.

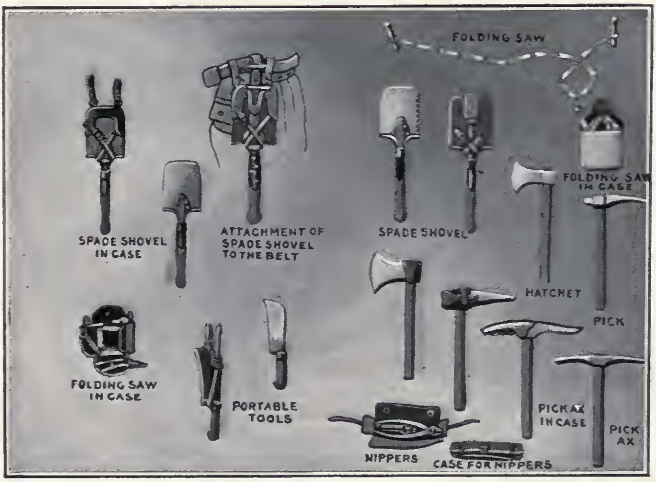


FIG. 1—TOOLS OF THE BELGIAN INFANTRY. EACH INFANTRY COMPANY CARRIES AN EQUIPMENT CONSISTING OF 100 LINNEMANN SHOVELS, 12 BILLHOOKS, 6 JOINTED OR FOLDING SAWS, 1 ROSE NIPPER, 1 THREE-CORNERED FILE, 24 CANVAS BUCKETS, 12 FIELD LANTERNS

FIG. 2—FRENCH INFANTRY. PORTABLE TOOLS CARRIED ON THE PERSON OF THE SOLDIER AS A PART OF THE FIELD EQUIPMENT. EACH COMPANY RECEIVES 8 SHOVELS, 4 PICKAXES (DOUBLE HEAD), 4 PICKS (SINGLE HEAD), 3 AXES, 1 FOLDING SAW, 1 WIRE NIPPERS

Offensive operations demand a high degree of mobility. This naturally suggests a careful consideration of the relation existing between fortifications and the mobility of an army in the field. The writer hopes that with the assistance of the accompanying illustrations, the non-military reader, for whom this is especially intended, may obtain a clearer idea than he had before of the uses and means of providing artificial cover and protection for the fighting lines of an army.

Fortifications may be divided into two classes, permanent fortifications and field fortifications. No attempt will be made to describe the former class any further than is absolutely necessary to point out the difference between that class and the one designated as "Field Fortifications," which is the real subject of this chapter.

THE OBJECT OF FORTIFICATIONS.

Permanent fortifications consist of defensive works constructed by a nation to secure permanent possession of strategical positions of importance within the territory under its control. These would generally include national capitals, great commercial and railway centers, harbors, important bridges and mountain passes, great concentration camps and depots of supplies.

The decision as to whether or not a city shall be fortified depends first on its location, second, on its importance.

Many European cities are really large forts surrounded by one or more lines of smaller detached forts located at strategic points some distance, varying from 5 to 15 miles, from the walls of the city. Paris, Belfort, Strassburg are some of the many examples of this type. Other cities, like Liège, are surrounded by one or more lines of detached forts, while the city itself is practically open or unfortified.

Earth embankments, stone and concrete walls and steel shields and turrets enter into the construction of the modern permanent fortifications. They are built in time of peace, armed with the latest type of heavy guns, and are supposed to embody the best thoughts of the strategic and of the military engineer.

THE BIG GUN IS THE DEATH KNELL OF PERMANENT FORTIFICATIONS.

Our text books tell us that "a position protected by permanent fortifications and properly garrisoned should yield only after a protracted siege." This was quite true yesterday, but to-day the gunmaker is turning out a new portable howitzer of wonderful power which, if we can trust the proof of photography, has sounded the death knell of the permanent fortifications of modern times, such as the Gruson armored fort.

Long before the advent of the 11-inch howitzer a number of military writers expressed strong doubts of the value of permanent fortifications as applied to large cities and great camps. They argued, and cited many instances in support, that a fortified city does not prevent an invasion of the national terri-

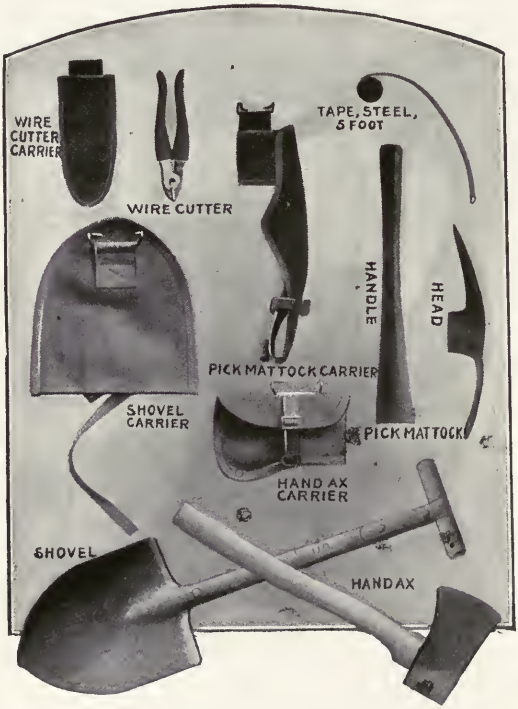


FIG. 3—UNITED STATES INFANTRY. TO EACH COMPANY OF 65 MEN: ONE 2-FOOT RULE, 21 SHOVELS WITH CARRIERS, 1 60-FOOT AND 1 5-FOOT STEEL TAPE, 3 HAND AXES AND CARRIERS, 7 PICK-MATTOCKS AND CARRIERS, AND 9 WIRE CUTTERS AND CARRIERS

tory by a strong and numerous enemy who can well afford to detach a force sufficient to invest the fortified place and immobilize its defenders—compelling them to capitulate within a comparatively short time—while he proceeds with the main operations with the bulk of his troops.

An army in the field may meet with daily reverses, but, if skilfully handled, it can avoid disaster, and even if brushed aside by a much stronger force it can retain its mobility and thus continue to annoy the enemy and endanger his lines of communication. It continues to be a factor in the game. It cannot be ignored.

An army operating within its national territory may even cut loose from its fortified base of supplies, and falling back on its own country, procure its supplies from local sources, until a new base can be established. By keeping constantly in touch with the enemy this mobile army may have the opportunity of inflicting serious damage, if not defeat, on the invaders.

THE TEMPTATION OFFERED BY PERMANENT FORTIFICATIONS.

No such opportunities are opened to the commander who, in the face of reverses, allows himself to be tempted by the fancied security offered by permanent fortifications. He may deceive himself into believing that he is simply taking refuge within the fortifi-

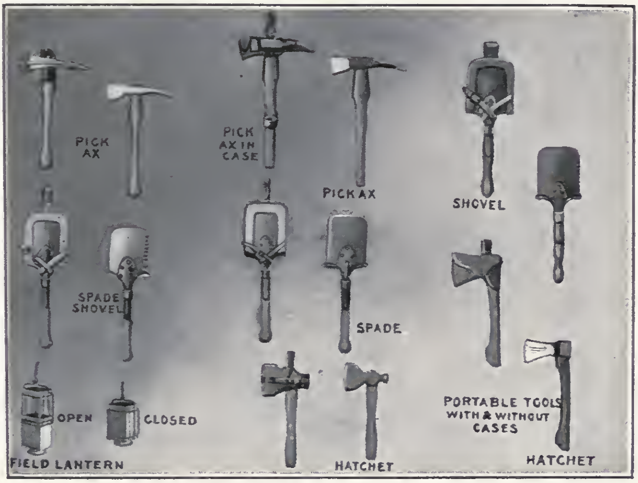


FIG. 4—AUSTRIAN INFANTRY. EACH COMPANY CARRIES ABOUT 5 LANTERNS, 1 HANDSAW, 1 SPADE FOR EVERY TWO MEN, AND 1 PICKAX FOR EVERY FIFTEEN MEN

FIG. 5—GERMAN INFANTRY. THE NUMBER OF PORTABLE TOOLS AMOUNTS TO 115 TO A COMPANY, AS FOLLOWS: 100 SMALL SPADES, 10 PICK HATCHETS, AND 5 HATCHETS

FIG. 6—IN THE DUTCH ARMY EACH INFANTRY COMPANY CARRIES RIFLES, AMMUNITION, 16 AXES AND 100 SMALL SHOVELS

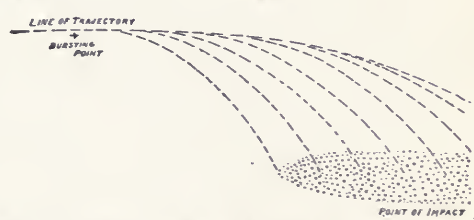


FIG. 8—THE GROUND COVERED BY A SHRAPNEL IS ELLIPTICAL IN FORM AND AT THE EFFECTIVE RANGES DOES NOT EXCEED 200 YARDS IN DEPTH BY 25 IN WIDTH. SHRAPNEL IS THE MOST IMPORTANT PROJECTILE. THE CASE IS OF DRAWN STEEL WITH SOLID BASE. THE MOUTH OF THE CASE HAS AN ALUMINIUM HEAD SCREWED IN AND TAPPED TO TAKE A COMBINATION TIME AND PERCUSSION FUSE. THE CASE CONTAINS 262 BALLS, EACH 0.49 INCH IN DIAMETER. THE BURSTING CHARGE CONSISTS OF 2 3-4 OUNCES OF LOOSE BLACK POWDER; IT IS PLACED IN THE BASE, AND COVERED BY A STEEL DIAPHRAGM. THE FUSE IS TIMED SO THAT THE CASE WILL BURST JUST IN FRONT AND ABOVE THE TRENCHES OR LINE OF TROOPS.

FIG. 7—PROFILE OF HILL. POINT M.C. IS THE "MILITARY CREST," ALTHOUGH IT IS NOT THE HIGHEST POINT OR CREST OF THE HILL

cations for a few days in order to give his men a little much-needed rest or to replenish his supply of food or ammunition, and that he will soon again take the field better prepared to fight than ever before. But the chances are against him. When he thinks he is ready to take the field, he finds that the

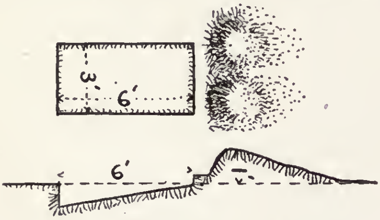


FIG. 9—LYING DOWN TRENCH

enemy has invested the place. If he is to get out, he must practically cut his way out. This would mean that most, if not all, his baggage and supply trains would probably be lost or have to be left behind. He would then be a great deal worse off than before. As a matter of fact, when an army takes refuge

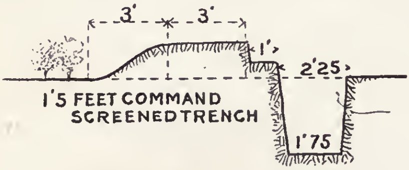


FIG. 10—STANDING TRENCH

behind permanent fortifications it seldom comes out again except as "prisoners of war." The moral effect of capitulation, even after a "heroic siege," is almost as serious as the loss of men and material.

It is not the intention to condemn all permanent fortifications. There are many cases

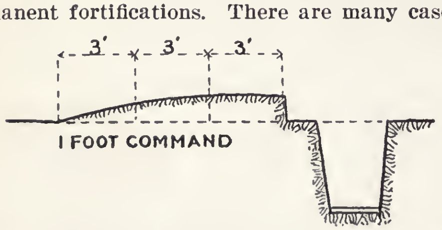


FIG. 11—STANDING TRENCH WITHOUT SCREEN, BUT WITH LOW PARAPET FOR BETTER CONCEALMENT

where, in certain locations, fortifications will be found invaluable in preventing or delaying an invasion, but these should be of a type that clearly illustrate the principle on which the value of fortifications is based, to wit: Greatly to increase the fighting power of troops occupying the position, by increasing the effect of the fire action of the troops protected by the fortification and to diminish the effect of the fire action of the assailant and limit his mobility, thus enabling a comparatively small garrison to resist the attacks of a greatly superior force successfully, and prevent its advance into the guarded territory.

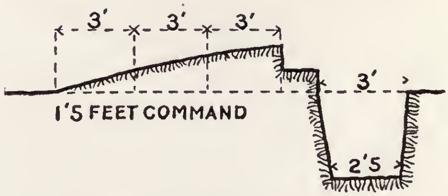


FIG. 12—STANDING TRENCH, A LITTLE WIDER AND WITH 6 INCHES MORE "COMMAND," I. E., THE SOLDIER STANDS SO THAT HIS EYES CAN SEE OVER A PARAPET 18 INCHES HIGHER THAN THE NATURAL LEVEL OF THE GROUND, INSTEAD OF 12 INCHES, AS IN FIG. 11

OFFENSIVE OPERATIONS MORE LIKELY TO BE SUCCESSFUL.

It has been generally conceded that real success in war results only from offensive operations.

It is true that in order to gain time to com-

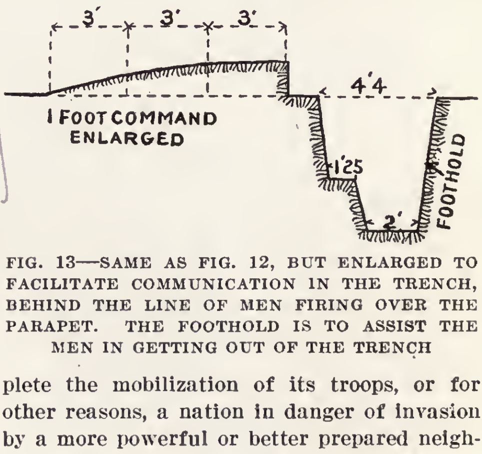


FIG. 13—SAME AS FIG. 12, BUT ENLARGED TO FACILITATE COMMUNICATION IN THE TRENCH, BEHIND THE LINE OF MEN FIRING OVER THE PARAPET. THE FOOTHOLD IS TO ASSIST THE MEN IN GETTING OUT OF THE TRENCH

plete the mobilization of its troops, or for other reasons, a nation in danger of invasion by a more powerful or better prepared neighbor may be compelled to assume a defensive

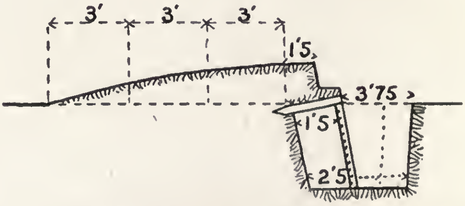


FIG. 14—SAME AS FIG. 13, BUT WITH SPLINTER-PROOF COVER. THIS IS FOR PROTECTION AGAINST SHRAPNEL BULLETS

attitude. Its highly disciplined and efficient armies, skilfully handled, may be able to inflict tremendous losses on the invader by repeatedly compelling him to attack and carry strong defensive positions, previously prepared, in order to continue his advance into the defender's territory. The defenders, by a succession of well timed and orderly retreats to selected positions in the rear, may succeed in drawing their more aggressive opponent into a position where all the advantages, strategic and tactical, will then be on the side of the defenders. All this, however, will result in little or no advantage to the defenders unless they are prepared and willing promptly to assume the offensive at the psychological moment, and thus turn the tables on the weakened enemy and drive him out of the country. A protracted defensive is a dangerous game. Recent events show that a commander can play it successfully against the best armies the world has ever seen.

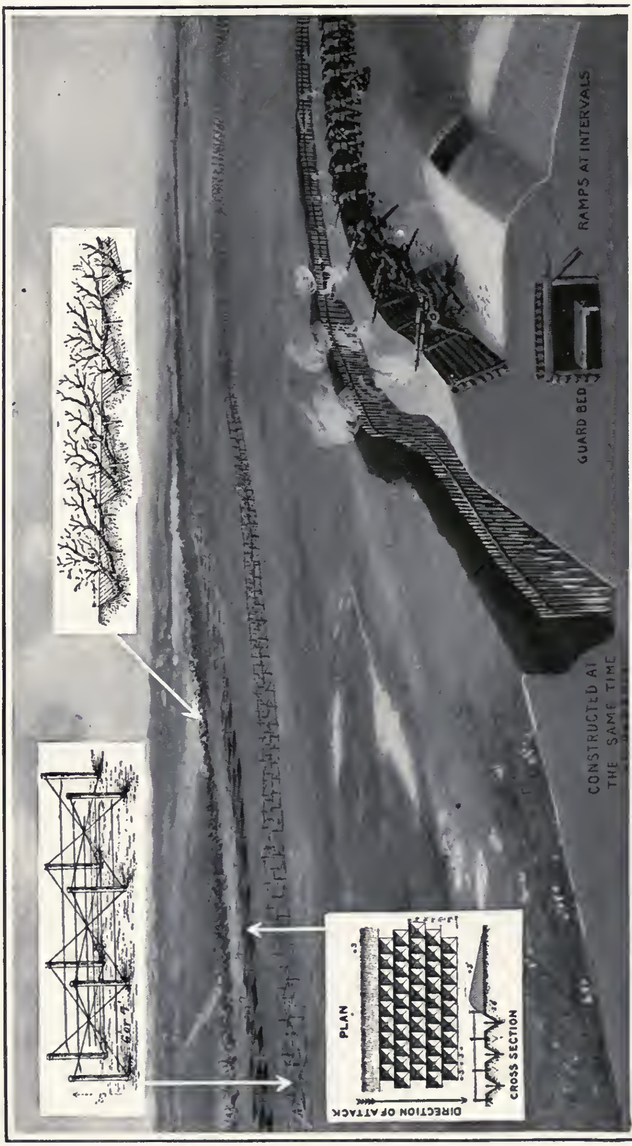


FIG. 15 — REDOUBT, SHOWING TYPES OF FIELD CASEMENTS AND BOMB-PROOFS. THE SMALL INSERTS INDICATE THE MORE USUAL TYPES OF OBSTACLES EMPLOYED IN THE DEFENSE OF REDOUBTS. THE ARROWS INDICATE WHERE THEY ARE TO BE FOUND IN THE MAIN PICTURE

To elucidate: in connection with the disadvantages of a strictly defensive campaign, let us assume that the armies of a strong nation have invaded the territory of one of its neighbors. The latter, for reasons of its own, assumes a defensive attitude, and by a succession of skilfully-managed retreats within his own territory, during which it has been able to inflict severe losses on the enemy, it succeeds in drawing the invaders far from their base, and, as a result of the losses inflicted and of the dangers to which their lines of communication are exposed, the latter reach a point where they must halt for a while to recuperate or await reinforcements. Let us suppose that the defenders are then either unable or unwilling to assume the offensive. Military operations with the exception of unimportant clashes between advance guards and reconnoitering patrols, will practically come to a standstill for the time being.

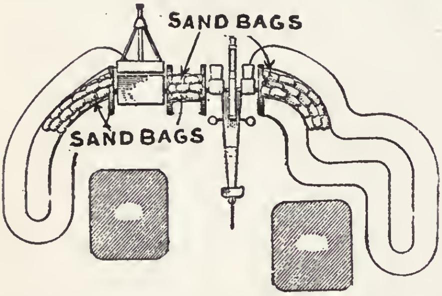


FIG. 16—HASTY INTRENCHMENTS FOR FIELD ARTILLERY; PROTECTION AGAINST RIFLE FIRE AND SHRAPNEL

Both combatants might be willing to make peace under certain conditions, but neither is in position to suggest it. The invaders cannot propose it because it would be taken as an indication that, while successful up to date, they fear for the future, and would be willing to quit while they have the advantage. As for the defenders, a proposition from them would be equal to acknowledging that they are hopelessly beaten. Therefore both await developments.

This, however, is the opportunity of the peacemakers, especially the "peace at all cost" advocates. Considering the strong public sentiment against war in any form existing throughout the world to-day, several allied nations might decline to consider offers of mediation from neutral powers on the ground that the time had not yet arrived for such action; but no one nation would risk antagonizing public opinion by refusing to accept the good offices of neutral, friendly nations under the circumstances outlined in the foregoing situation. Therefore, we may assume that in response to friendly advances and representations, both belligerents agree to an armistice for the purpose of discussing peace preliminaries.

The military situation would then be about as follows: The invaders have not crushed the defenders, they have not captured any of their armies, or decisively defeated them, or caused any of their fortresses with their garrison to capitulate; neither have they captured their capital nor seriously interfered with their national government. But they have invaded the defender's territory and are occupying a more or less extensive portion of it in force, and are preparing to resume the offensive. The defenders on their side have retreated, it is true, but they have not been decisively defeated at any point. Their defensive operations have compelled the invad-

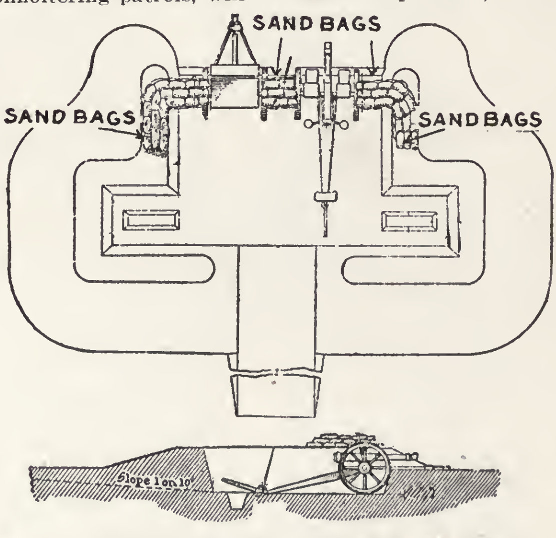


FIG. 17—DELIBERATE INTRENCHMENTS FOR FIELD ARTILLERY WHEN DEPRESSION IS NECESSARY FOR CONCEALMENT

ers entirely to change their original plan of campaign and to abandon strategic operations that had promised results of great importance in bringing the war to a successful close, and yet the defenders, by their failure to take the offensive at this time, are clearly at a great moral and physical disadvantage, and will be greatly handicapped when the question of peace terms is brought up for discussion. It must be quite evident that the invaders are in position practically to dictate the terms on which peace shall finally be declared.

Hence the axiom in war: Real success results only from offensive operations.

FIELD FORTIFICATIONS.

Field fortifications deal with such works of a temporary character as may be constructed in time of war by troops in the field, for a specific purpose, with the tools usually carried by the troops as part of their equipment and with the material found in the locality. It may sometimes happen that the necessity for the field works under preparation may pass before the job is completed.

Field fortifications may be divided into hasty intrenchments used by troops upon the battlefield to increase or prolong their powers; and deliberate intrenchments, not in line of battle, such as may be required to protect lines of communications and supply, lines of retreat or to strengthen a position in readiness.

It often happens that a line of lying down trenches may develop into a line of deep trenches with splinter proofs, cover, and communication trenches for the supports as well as gun emplacements for the artillery; thus taking on all the characteristics of a position in readiness.

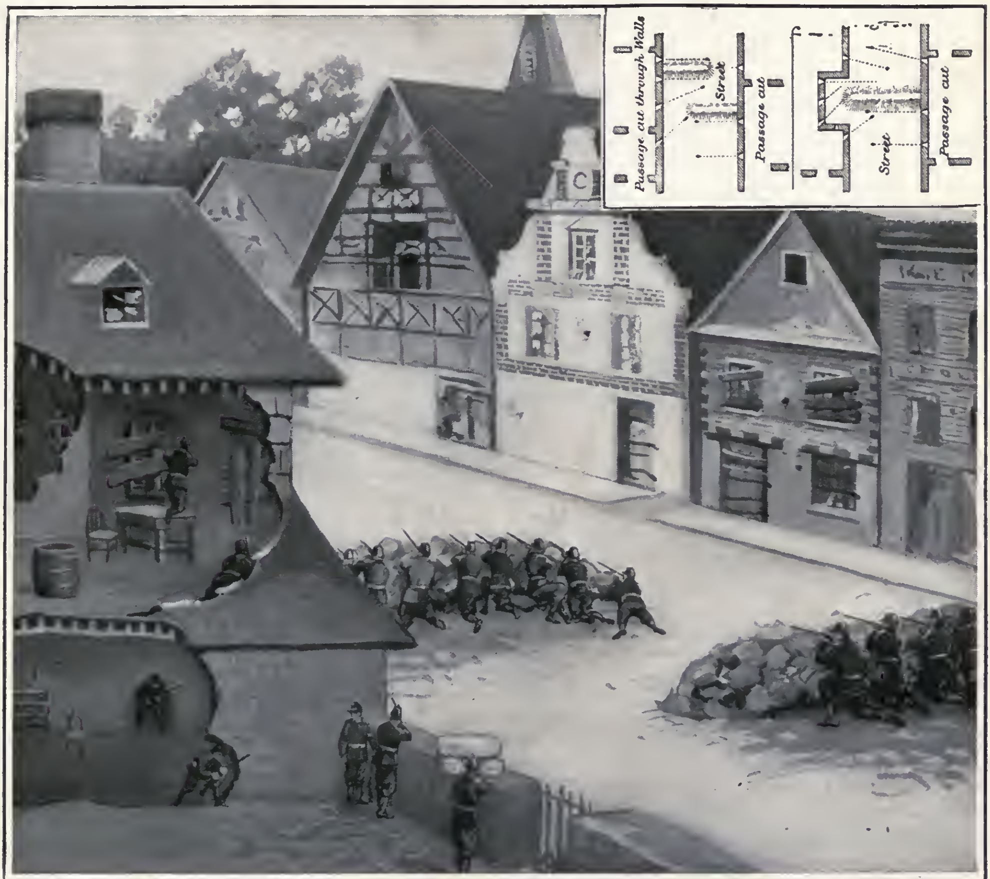


FIG. 18—STREET BARRICADES, SHOWING LOOP HOLES CUT THROUGH WALLS. NOTE ALSO PASSAGEWAY CUT THROUGH WALLS CONNECTING THE HOUSES ON EACH SIDE. THE DEADLY HOUSE-TO-HOUSE FIGHTING MENTIONED IN BATTLE REPORTS, TAKES PLACE ALONG THE LINE OF THESE PASSAGES. THE INSERT SHOWS THE GENERAL ARRANGEMENT OF SUCH PASSAGES CLEARLY

Redoubts (see Fig. 15) are the most complicated types of field fortifications, and in some instances have compelled an assailant to resort to a siege to secure the capture of the position. This, however, was before the days of the 11-inch howitzer.

When conditions and time permit and the materials and men are plentiful, a great deal of care may be devoted to the details of constructon so as to produce finished work, per-

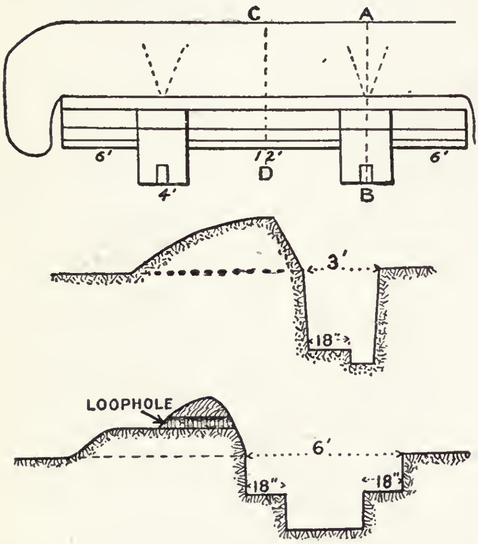


FIG. 19—EMPLACEMENT FOR MACHINE GUNS

fect in efficiency as well as in appearance. To this end the trace and profile are carefully laid by actual measurements, etc., but on the field of battle where quick results are required, where men are nearly exhausted by long marches and strenuous fighting, etc., even "positions in readiness" are prepared without much regard to beauty of design or absolute correctness of details.

HOW INTRENCHMENTS ARE MADE.

Intrenchments are used both on the offensive and on the defensive whenever circum-

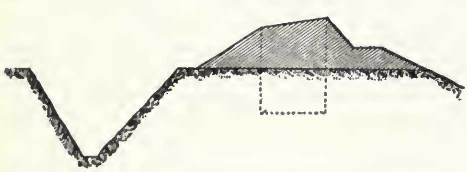


FIG. 20—SECTION OF PARAPET IN LOOSE SOIL

stances permit. The cover provided by intrenchments is a defensive weapon of which full use should be made by commanders of all grades on their own initiative. The intrenching tools provided for infantry (Figs. 1 to 6) form a part of the combat equipment of that arm and are invariably carried into action. Additional axes, picks, and shovels of the regular size are carried in the battalion ammunition wagon and in the regimental engineer wagon.

The primary object of intrenchments on the defensive is to enable a comparatively small part of a command to hold an extend-

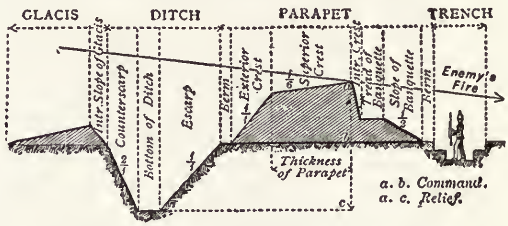


FIG. 20A—SECTION OF INTRENCHMENT MADE IN STIFF SOIL. THE LEGENDS DESIGNATE IN MILITARY TERMS THE VARIOUS PORTIONS OF SUCH AN INTRENCHMENT

ed front in order that the remainder may be available for offensive operations. It is, therefore, essential that higher commanders realize the full possibilities of field intrenchments, and that subordinate commanders be prepared to construct and mend them in the shortest possible time.

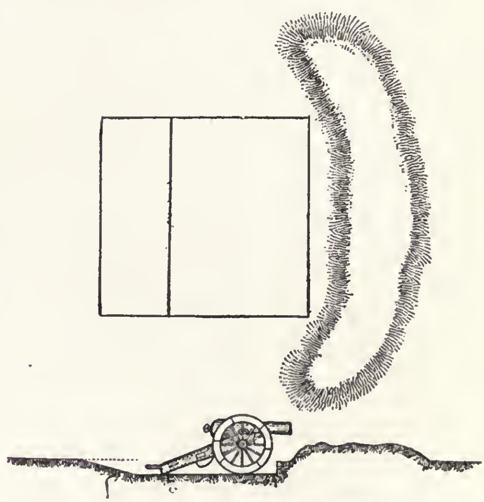


FIG. 21—A SIMPLE TYPE OF HASTY GUN PIT; EASY TO CONSTRUCT; GIVES PRACTICALLY AS MUCH PROTECTION AS FIG. 17 (WITHOUT THE SPLINTER-PROOF COVER), AND IS VERY SUITABLE IN CONNECTION WITH SHELTER TRENCHES

We are told that the Japanese soldier is an indefatigable digger. During the Russo-Japanese war, the little men of Nippon were either marching, fighting, or digging. It is well to consider, in this connection, the fact that racial characteristics vary greatly, and what may be expected of the soldiers of one race may prove impracticable for those of another race. The successful commander will know when the endurance of his men is near the breaking point, and he will stop with a fair margin of safety between himself and possible disaster.

EFFECT OF ARTILLERY FIRE.

Up to 3,000 yards, the 3-inch field gun, using high explosive shell, is effective against ordinary types of overhead cover for field trenches, brick buildings, and stone walls 2 feet thick. It is ineffective against earthen parapets.

The heavier types of field guns and howitzers are effective against all kinds of field works, and protection against this kind of fire must be secured by concealment.

AVERAGE RESULTS OF ONE MAN HOUR LABOR.

Excavation—

In easy soil—

First hour ....cubic feet 30
Second hour .... " " 25
Third hour .... " " 15
Thereafter continuous work " " 10

In hard soil, about half the above.

In loose earth, 60 cubic feet.

Filling sand bags, 20 bags (0.5 cubic foot each).

Revetment construction (material and tools on hand):

	Sq. ft. per man hour
Rough brush wood or plank	40
Brushwood hurdles, rough—	
Making	15
Placing	30
Sand bags—	
Filling	10
Placing	20
Sod—	
Obtaining sod for	7
Placing	10

Obstacle construction (material and tools on hand)—*Abattis*, wired (1 strong row) ....linear feet 1.5

Wire entanglement—

High ....sq. ft. 27
Low ....sq. ft. 90

Clearing—

Thickets up to 1.5 inch diameter.sq. yds. 25
Light clearing of soft woods, trees to 12 inches in diameter.sq. yds. 25
Medium clearing ....sq. yds. 15

THE PRINCIPLE REGULATING USE OF INTRENCHMENTS.

The principle that regulates the use of intrenchments by troops on the defensive and by troops on the offensive is expressed in the following words taken from the Field Service Regulations of the Army of the United States, page 72:

"On the defensive the artificial strengthening of the position taken up is limited only by the time and the facilities available. On

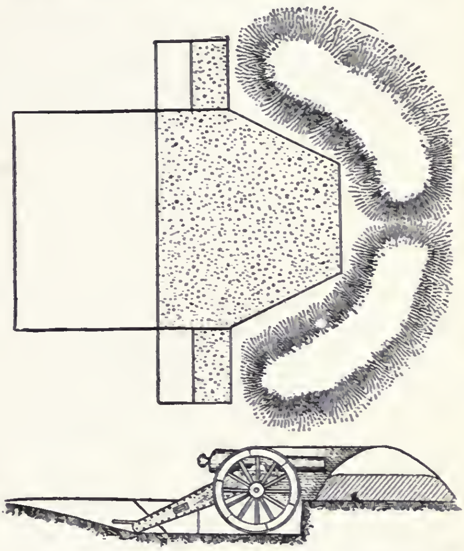


FIG. 22.—HASTY GUN PIT; PROTECTION IN FRONT AND ON THE SIDES. SEVEN MEN, WITH FULL SIZE PICKS AND SHOVELS, WILL CONSTRUCT THIS IN ONE HOUR.

the offensive, intrenchments are used on all lines that are to be held for any length of time. Troops advancing to the attack must understand that the best protection against losses is afforded by an uninterrupted and vigorous advance toward the enemy's posi-

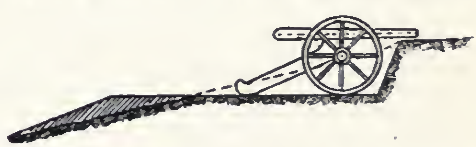


FIG. 23—SIMPLE GUN PIT. GUN IN POSITION FOR INDIRECT FIRING OVER THE CREST OF THE HILL

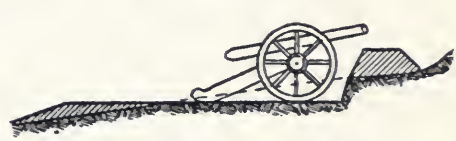


FIG. 24—SIMPLE GUN PIT ON CREST OF A HILL. GUN IN POSITION FOR DIRECT FIRING

tion, and by the use of such natural cover as the ground offers. In the attack intrenchments will be used only when further advance is for some time impossible, and to hold ground already gained."

It is quite evident that as a general rule troops on the offensive will be restricted to the use of the types of trenches shown in Figs. 9, 10, 11, and 12.

It may happen that when fighting extends along a front of many miles, some troops may be more successful than others, and thus gain ground much in advance of the general opponent. Furthermore, the success of the campaign does not depend on isolated advantages of individual units, but on the successful advance of the entire line, the several units (divisions, army corps, or field armies) supporting each other in the forward movement, all under the general supervision of the

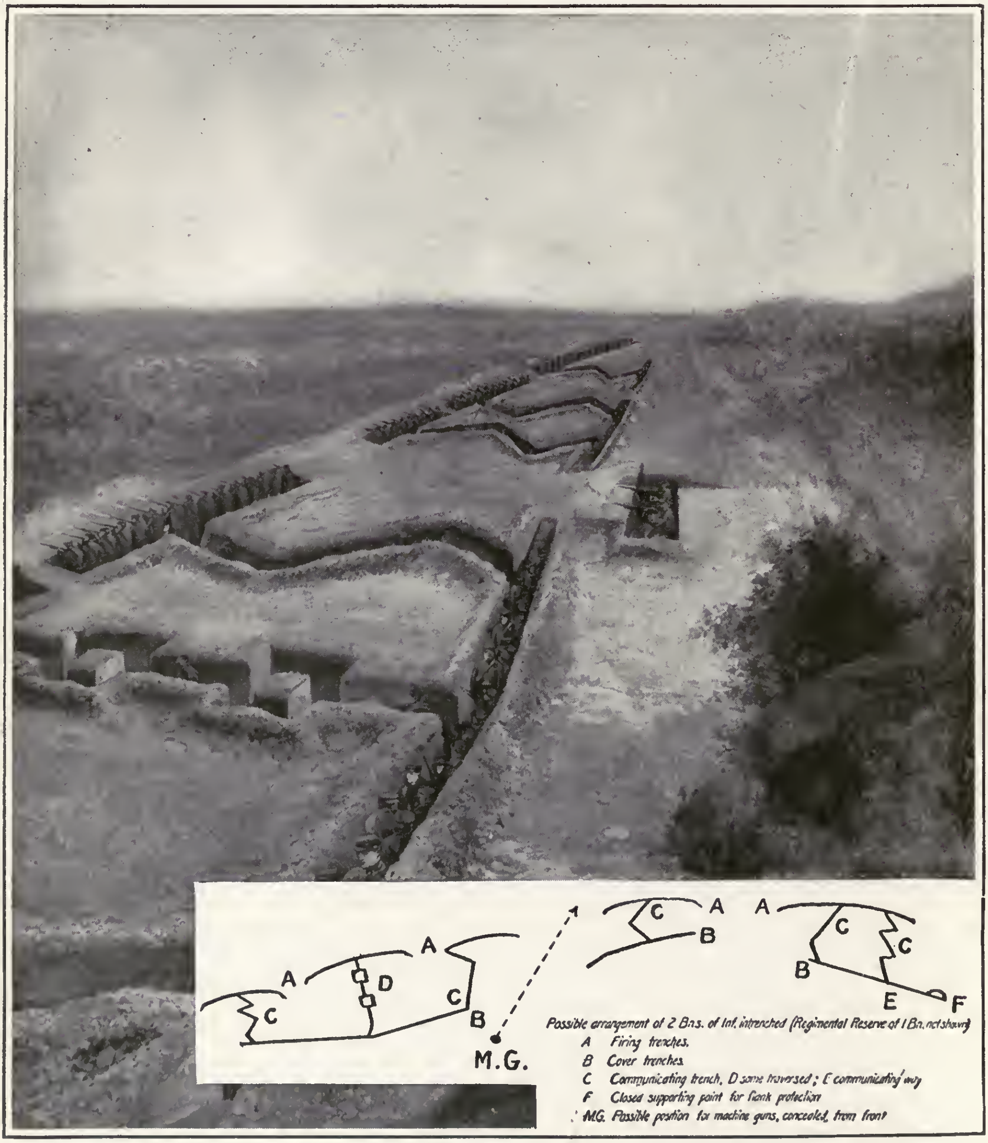


FIG. 25—THE LINE OR LINES OF TRENCHES MAY OR MAY NOT BE CONTINUOUS

line. This, if permitted to proceed to any great distance, would have the tendency to leave gaps in the line, or weak spots on the flanks of the successful troops which would prove most dangerous to the general line, as well as to the advanced troops themselves, if confronted by a tenacious and aggressive commander-in-chief. Therefore, it may be necessary to hold back the more advanced portion of the line until the other units are able to come up to it. To enable them to hold what they have won the advanced troops will intrench. The type of trench selected would probably be one of those shown in

Fig. 10 or Fig. 11, to be enlarged later, if time permits, into that shown in Fig. 13.

If time will permit, the position may be further strengthened by digging cover trenches for the supports and reserves, building bomb-proof shelters for the men in the trenches, Figs. 14 and 15, and intrenchments for machine guns, Fig. 19, and field artillery, Figs. 16 and 17.

The line or lines of trenches are not necessarily continuous. They usually form irregular groups of intrenchments distributed along the front of the position, the firing trenches facing the enemy's lines or the avenues of approach (see Fig. 25).

It would be well to note at this point that this advanced part of the line, while still a factor in the general offensive movement, has now assumed a defensive attitude "seeking a favorable decision," which means that it is simply waiting for the opportunity to resume the offensive, and that is the only form of defense that can secure positive results.

FIG. 26—LOOPHOLES MADE OF SANDBAGS. NOTE THE USE OF BARRICADES

Time is a great factor in connection with field works, especially hasty intrenchments.

DIFFERENT TRENCHES AND WHEN THEY ARE USED.

The simplest form is generally used by the advance under fire. The advancing line may have suffered great losses, or the ammunition may be running low. At all events, it finds itself unable to gain ground to the front. To retreat would be fatal. It must remain where it is—some of the men find natural cover, but many must provide artificial protection from the enemy's rifle fire. The men are lying down as flat as they can. To arise, even to a kneeling position means death or a disabling wound. The necessity for cover under these circumstances caused men to devise the lying down trench, sometimes called the skirmishers' trench, Fig. 9, it gives cover from rifle fire to a man lying down, but is absolutely no protection from shrapnel bullets. The height of the parapet should not exceed one foot. The trench itself is about two and a half feet wide and about six feet long. It can be constructed by one man in soft ground, using the portable intrenching tools, in about 20 minutes. Under fire, as outlined in the foregoing, the man being compelled to remain in the prone position, he can mask himself from view in from 10 to 15 minutes and complete the trench in 40 to 45 minutes. In this position, and in view of the small number of portable intrenching tools carried by the company, the man would be obliged to use his knife bayonet to loosen the earth and the cover of his meat can to shovel it in front of him. One of the methods of working suggested by the text books, is to dig a trench 18 inches wide as far back as the knees; roll into it and dig 12 inches wide along side of it and down to the feet; then roll into the second cut and extend the first one back to the feet. This trench was seldom used in the Manchurian war. The best that can be said for it is that men can obtain slight cover under a hot fire with a minimum of casualties because it involves less digging, and they are partially protected from the very beginning of the work.

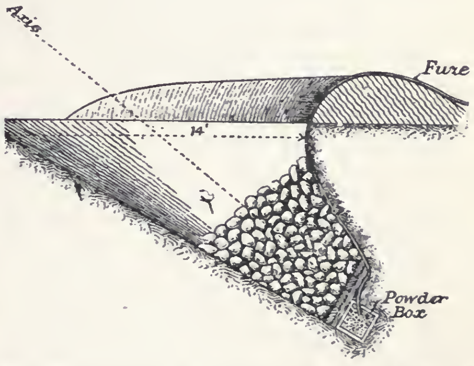


FIG. 27—FOUGASSE, A TYPE OF LAND MINE OF DOUBTFUL VALUE

The kneeling trench, not illustrated, is the simplest form of trench for troops on the main line of resistance, but is fast going out of favor. It does not afford sufficient protection, and it is too visible.

Normally, the first objective will be the simplest form of the standing trench, Fig. 10. A good standing trench can be constructed in from one to one and a half hours by using regular sized tools. This trench may be enlarged and improved to obtain results shown in Figs. 11, 12, 13, and 14.

HOW IMPROVED FIRE-ARMS HAVE AFFECTED TRENCH DIGGING.

Military experts have greatly modified their views in the matter of profiles of infantry trenches. These changes are due to the improvements made in firearms of all caliber, both in range and penetration, to the development of indirect and high angle fire of light and heavy field artillery, and to the possibilities of aeronautics in connection with military scouting.

A great deal more weight has been given to concealment from view. The greater depression angle of lines of vision made possible by aeroplane observation should also receive consideration.

The trench that shows the least alteration in the appearance of the surface of the ground will be found to be the most satisfactory. For this reason, instead of making the exterior slope as steep as the material of which it consists will stand (Fig. 20) it will be better to make it "as flat as the supply of material and the labor of placing it will permit, and the superior and exterior slopes should either be merged (Figs. 10, 11, and 12), or make a small angle with each other, and in the latter case should be joined by a curve."

Elbow rests and overhead cover, no matter how slight, are considered essential.

So great is the necessity of concealment as shown in recent war experiences, that many experts are beginning to question the value of great redoubts and similar types of field fortifications, as these cannot be used in positions exposed to artillery fire unless they can be so constructed and disguised that they cannot be recognized as such from the enemy's artillery positions. When we consider the possibility of discovery by the military observer scouting in his aeroplane several thousand feet above the position, with his ability to indicate by signals while in the air or by means of a position sketch after he returns to his lines, the exact location of the redoubt and supporting batteries, we must realize that imposing works with prominent parapets and gun emplacements as illustrated in the text books, are things of the past. In ordinary rolling country the conditions of defense will be fully met by the infantry standing trench with communication and cover trenches for the supports, reserves and ammunition. These, if located on carefully selected points, will answer all the requirements of redoubts without resorting to the use of closed works.

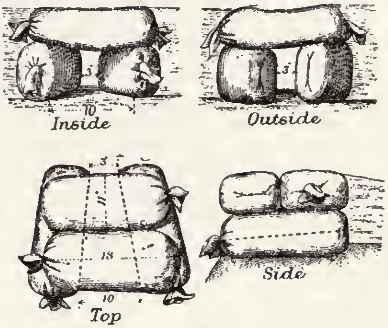


FIG. 29—LOOPHOLES MADE OF SAND BAGS

The improvements made in field artillery fire make it possible for batteries to do effective work without much exposure or danger from rifle fire.

The simplest form of protection, Figs. 21, 22, 23, and 24, will probably answer all the requirements.

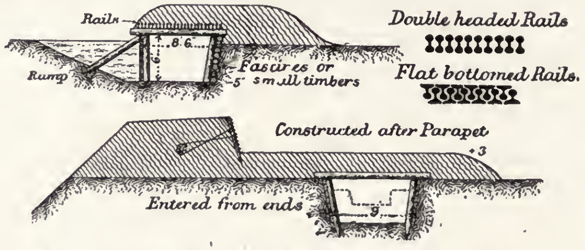


FIG. 28—TYPES OF FIELD CASEMENTS AND BOMB-PROOFS

CONCEALED MEN FIRING AT CONCEALED TARGETS.

In the old days, the gunner had to see his target. He stood at the elevating wheel, looking through the rear sight and indicating the horizontal direction of the piece to the man who stood at the trail, ready to move it to the right or left as directed by the gun corporal; the latter raised or lowered the breech until the front sight rested on the target; the signal was given and the gun fired. Now, however, things are done differently. The gunners need not see the target at all. The battery commander with his assistants stationed on a flank of the line of guns, in prolongation of this line or directly in rear of and above it, watches the effect of the firing and gives all the directions as to the aiming point—which is *not* the target—and the range elevation, kind of fire, type of projectile, etc., to be used. The battery commander gets most of his data by means of a wonderful instrument called the battery commander's telescope. His station is connected with each gun by telephone or buzzer.

The aiming point (not the target) must be selected with care, "something tall and slender, such as a flag staff or church steeple, is best. It should preferably be a mile or more distant."

The battery commander's problem is "to determine the deflection that must be set off on the sight, so that when the sight is brought to bear upon the aiming point the gun shall be trained upon the target." This sounds very complicated, but the trained artillerist gets wonderful results in an astonishingly short time—just a few minutes from the time the position has been selected.

THE USE OF MINES.

Land mines are usually formed by excavation from the surface and are designed to be exploded at the moment the enemy is over them. Such mines are usually employed in

FIG. 31—FELLED TREE OBSTACLE. BRANCHES POINTING OUTWARD

front of defensive positions, prepared in advance, in connection with visible obstacles, such as abattis, wire entanglements, etc. The charge is placed near the surface, just deep enough to avoid artillery projectiles. The mines may be placed in several rows and their positions concealed as completely as possible.

If everything works well and the enemy will congregate on the mined ground these mines and the fougasses (Fig. 27) should do great execution. As a matter of fact, past

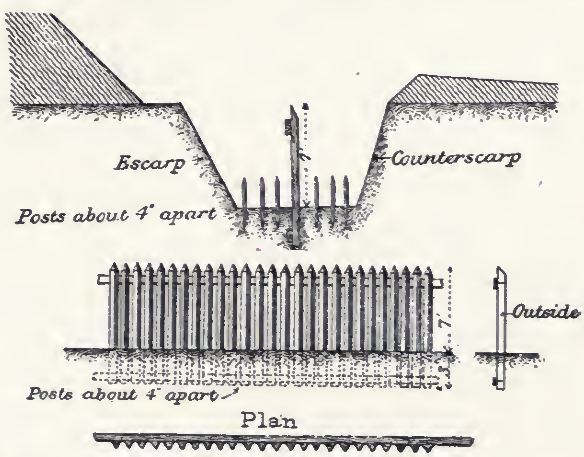


FIG. 30—PALISADES IN DRY DITCH IN FRONT OF PARAPET

experience shows that the results do not warrant the time and labor expended in their preparation. In addition to this, the craters formed by the explosions make an excellent line of trenches for the attackers.

In conclusion, we may say that many of the simpler forms of field fortifications described in this article and in text books will continue to be used, more or less extensively,

In addition to the trenches, including parapets, ditches, abattis, trous de loup, wire entanglements, etc., shown in Fig. 15 as means of defense, we must not forget that in thickly populated countries armies often find it necessary to hold small towns and villages, as these often form part of the line of defense, or are included in it on account of their location in proximity thereto. (Figs. 18 and 26.)

by troops on the defensive and to a lesser degree by troops on the offensive.

That greater weight should be given to concealment of the line of works. That in the preparation of the trenches provisions should be made to enable the troops manning them to leave them quickly to take part in a counter attack on the assailant or to take up a new position in rear. Troops that have been fighting for days or weeks with varying success are apt, when they find themselves behind strong intrenchments that have cost them additional efforts, to hesitate about leaving them; they feel secure and know that they need rest. Their mobility is seriously affected, if not paralyzed. Commanders of troops must realize the advantages as well as the disadvantages of intrenchments, bearing in mind that real success in war depends on offensive operations, and that troops on the offensive should be taught and encouraged to depend for their protection on the intelligent use of such natural cover as the ground over which they are advancing may offer; on the accuracy and intensity of their rifle fire; and, above all, on their determination to get close to the enemy and drive him out at the point of the bayonet.

Photo by Meurisse

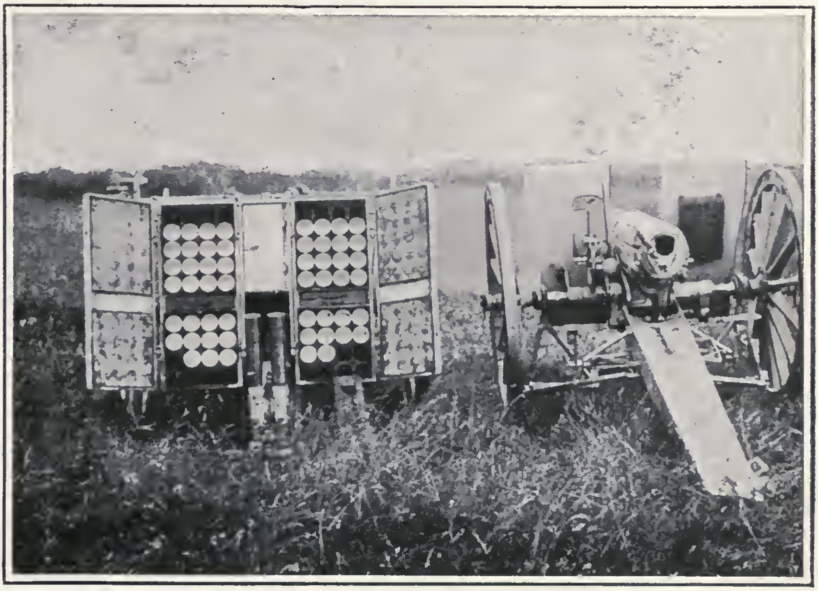
CUIRASSIERS OF THE FRENCH ARMY ASSISTING A WOUNDED COMRADE

Chapter III.

THE MECHANISM OF A BATTLE

The Arms of the Service

THE three most important branches of an Army are: the Cavalry, the Artillery, and the Infantry. In addition to these there are the Coast Artillery, which among European nations is generally not very far developed, and the various general service branches, engineers, quartermasters, and commissaries. All of the latter are, of course, important in their spheres, but in the battles to be fought in a general European land war, the Cavalry, Artillery, and Infantry are by far the most important, and a more detailed consideration of the arms as used by these branches in the various countries will follow.



FRENCH FIELD GUN, WITH LOADED CAISSON, IN ACTION. TRAVERSE OF GUN IS 8 DEGREES

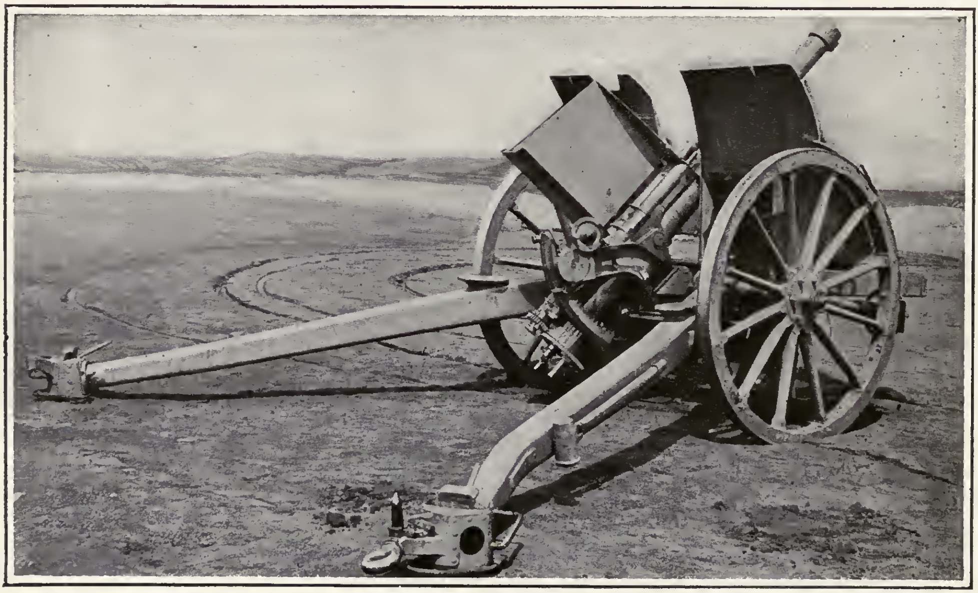
CAVALRY.

The main object of the Cavalry in all of these armies is to reconnoiter and obtain information of the enemy and the *terrain* on which he operates. For that purpose it is sent out ahead of the main army, and is therefore generally the first arm drawn into active engagement with the enemy's advance troops. During the fighting of the Infantry and Artillery it must be in readiness, in addition to its scouting duties on the flanks, to throw its support to wherever it may be most needed for the success of the Army.

The Cavalry is armed with a rifle or sword or both, and in some cases with the lance. They are called by various names, as in Germany: "Hussars," "Uhlans," "Dragoons"; Russia: "Cossacks," "Dragoons," "Hussars"; France: "Cuirassiers," "Hussars," "Dragoons"; Great Britain: "Hussars," "Lancers"; Austria-Hungary: "Dragoons" and "Uhlans." They are always mounted, and their ultimate training has in view their ability for long service in the saddle without rest.

It aims to hit the part of the enemy which is most dangerous to the friendly Infantry and which would hinder its success. Since the enemy's Artillery would do the same thing, it is evident that a modern battle will generally begin with an artillery duel, and that whichever side is able to silence the other side's Artillery will have a tremendous advantage. In fact, until the enemy's Field Artillery is silenced an advance of the Infantry would be practically impossible.

As the Infantry advances the Field Artillery must be in readiness to fire over the advancing lines and attack parts of the enemy's troops, or must be able to move with light-



FRENCH DEPORT FIELD ARTILLERY AND BALLOON GUN. PERMITS TRAVERSE OF 45 DEGREES WITHOUT MOVING CARRIAGE

ning rapidity to any other position where its fire is needed or is more effective.

A battery of Field Artillery is a tactical unit composed of from four to eight guns and ammunition wagons, loaded with shell and shrapnel.

Since its first object is to destroy the enemy's Artillery, it will be seen that the longer the effective range of the guns is, the better will it be able to damage the enemy before the latter is able to reach it. On the other hand, in order to be able to shift its position quickly, it must be light and able to be put into action easily. The three objects to be obtained, therefore, are: Power, making possible accurate shooting at long ranges; Rapidity of Fire, and Mobility. The gun on which the various armies are depending more

FIELD ARTILLERY.

The Field Artillery arm of a modern Army is undoubtedly the most important branch, next to the Infantry. In fact, the success of a modern battle depends on the superiority of the Field Artillery, and enormous sums of money have been spent with a view of providing field artillery guns and ammunition in each of the countries involved.

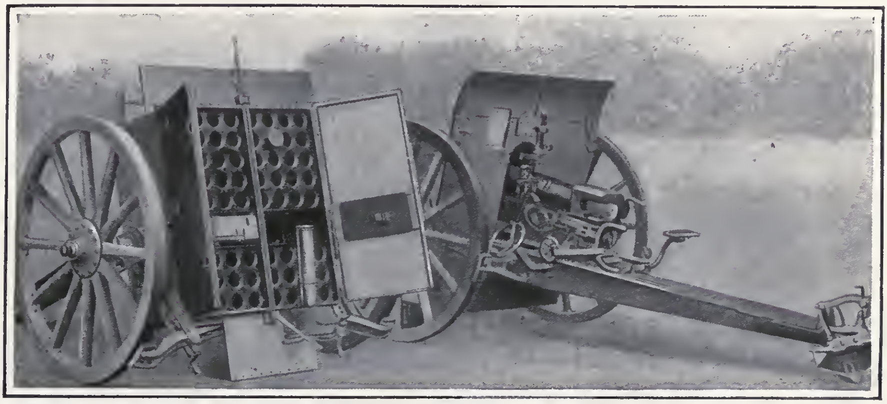
The two nations that have led in the development of Field Artillery are undoubtedly France and Germany. Each has followed its own line of development to a certain extent, but if reports contained in military magazines are correct, it may be assumed that the French Field Artillery is the more efficient.

The object of Field Artillery is to support the Infantry in its advances or its retreats.

than anything else is undoubtedly what is called the light field piece, all of which are approximately 3-inch caliber. To apportion to the best advantage the various qualities desired in a 3-inch light field gun has been a difficult problem, and each country has developed its own piece differing from any other. As will be seen from the following table, the French are equipped with a heavier gun, firing a heavier projectile at a much higher velocity, than are the Germans. Since the energy of a projectile varies directly as the mass and the square of the velocity of the projectile, it is evident that the French projectile is more powerful than the German. Of course, the war produced many novelties in field ordnance.

The following table gives the more important and interesting data for Field Artillery for various countries:

This deflection is calculated by a triangulation method by the Battery Commander, who is located some distance away from the battery either on elevated ground, on a ladder, or in a tree. The German system of obtaining the deflection is to measure the angles carefully, by means of instruments, thereby attempting to make the first shots effective; while the tendency of the French system is to estimate the first deflection, fire quickly, and by observing the shot, make necessary corrections for succeeding shots. The ranges are obtained by self-contained base range-finders, which are accurate within 200 yards for 5,000 or 6,000 yard ranges.



KRUPP 7.5-CENTIMETER FIELD-PIECE IN BATTERY

HEAVY GUNS.

Within the last few years the subject of equipping the Field Artillery with large caliber siege guns and howitzers has been given extended studies.

FIELD ARTILLERY OF THE EUROPEAN ARMIES

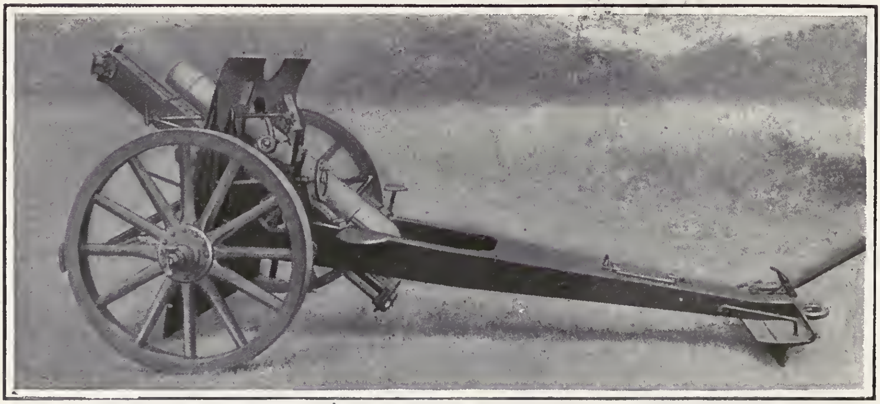
Country	England	France	Russia	Belgium	Germany	Austria	Italy
Made by	England	France	Russia	Krupp	Krupp-Ehrhardt	Austria	Krupp
Caliber, inches	3.3	2.95	2.95	2.95	3.03	3	2.95
Weight of projectile, pounds	18	15.9	14.3	14.3	15.1	14.7	14.3
Muzzle velocity, feet per second	1,600	1,740	1,945	1,630	1,500	1,630	1,675
Rate of fire, shots per minute	29	20	20	30	20	25	30
Maximum effective range, yards	6,300	6,000	6,000	6,000	5,500	6,700	6,600
Muzzle energy, foot tons	320	334	360	258	236	272	260
Weight of gun and carriage, pounds	2,690	2,500	2,300	2,300	2,080	2,350	2,200
Number of guns in a battery	6	4	8	6	6	6	4
Rounds of ammunition per gun with a battery	176	312	212	242	126	168	312

In actual battle the guns of a battery are lined up and one loaded caisson is placed next to each gun. The entire battery is behind cover and generally cannot see the targets. The fire is directed by each gunner aiming on a designated aiming point, with an instrument set at a given deflection, so that the gun will actually point at the target.

The object of howitzers is mainly to fire a heavier projectile with a lower velocity at a much higher elevation and longer range. Assume, for instance, the enemy's Infantry entrenched behind embankments. With a high velocity the trajectory of the projectile for a given range is very flat, so that the troops would be able to sit behind the cover and have all the projectiles either strike the embankment or pass over their heads. For this emergency a battery of howitzers is called into action. By reducing the charge the projectile may be started at a higher elevation, which causes the projectile to fall to the ground in a much more nearly vertical path and enables it to be dropped back of the embankment.

Another object of these heavy cannon is, that a battery can be put in position to sweep a large field, and with its long ranges prevent the enemy's lighter artillery from coming within effective reach.

The velocity of these howitzers is practically the same for all countries, and is about 900 feet per second for the longest zones, while the calibers are approximately 3.8-inch with a 30-pound projectile, 4.7-inch with a 60-pound projectile, 6-inch with a 120-pound projectile.



GERMAN 4.7-INCH RAPID-FIRE FIELD HOWITZER

The number of rounds that will be fired during an ordinary battle can only be imagined. In the great European war it was enormous, reaching into the hundreds of thousands a day.

The most common projectile of the 3-inch caliber is the shrapnel, which is in itself a gun, arranged by time fuses so that at the desired height it is made to burst, shooting forward out of a shell 250 lead balls, each effective to kill a man. This is referred to in Chapter IV.

THE AEROPLANE SCOUTS AND THEIR DESTRUCTION.

Due to the rapid advance of science within the last few years, another element must be contended with. The aeroplane is to-day one of the best means for obtaining accurate information concerning the enemy.

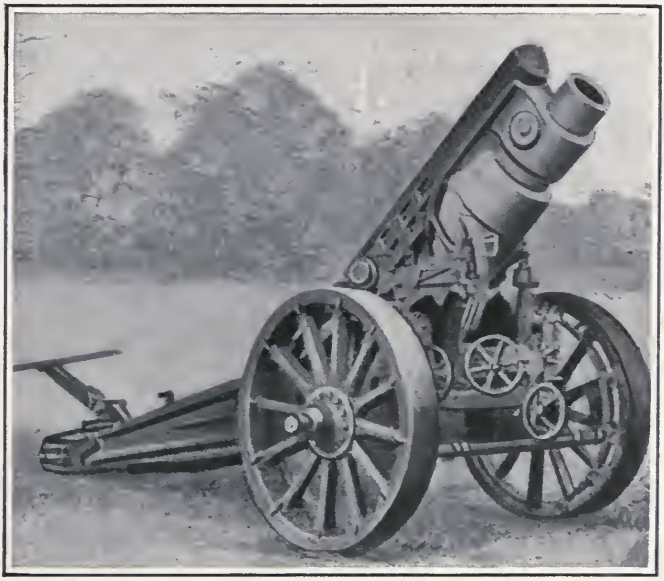
There are two means of combating a flying machine. Many military students contend that the way to destroy an aeroplane is to put a machine rifle in another aeroplane and attempt to combat it in the air. Another means is to provide field artillery guns able to fire in the air, and many balloon guns of this type have been tried out by various countries. One notable cannon of this type is the Deport field gun, which is so arranged that it can be used as a field artillery gun for low targets, but may be trained for aerial targets as well.

There are a number of difficulties connected with firing against balloons or aeroplanes, and extensive experiments have been carried on in various countries for the purpose of solving this problem. The large ordnance manufacturing concerns of the Krupp and Ehrhardt companies in Germany, have designed and manufactured guns firing 3-inch projectiles mounted on automobiles or on wheels.

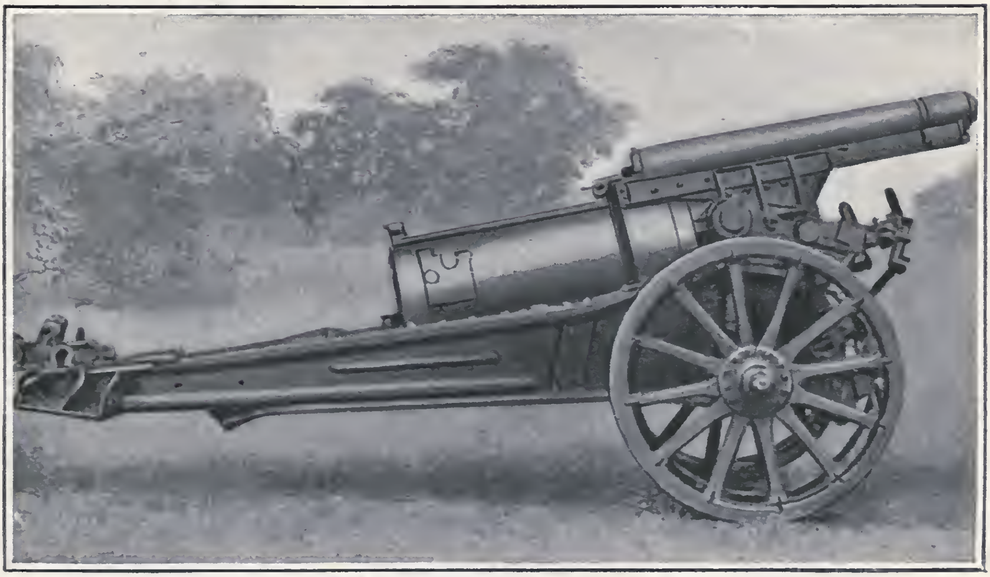
Among the difficulties experienced is the fact that the aeroplanes move very rapidly, making it difficult to follow them through the sights of the gun. Another difficulty to be encountered is the fact that the required angle of departure for a projectile to reach a certain range varies as the target moves above the horizon. For instance, a target on the same level with the gun at 5,000 yards range may require an angle of departure of 11 degrees; while if this target should be located 45 degrees above the horizontal the super-elevation, which is the elevation of the gun above the line drawn from the gun to the target, would be only 4 degrees or 5 degrees. If the aeroplane should be the same distance but vertically above the gun, no elevation over the direction of the line of sight would be necessary.

It is also a difficult matter to estimate the distance to these balloons, and the use of range-finding instruments, due to the rapid movement of the targets, is at times almost impossible. In some cases experiments have been carried on with a view of firing projectiles with burning tracers attached to them. These tracers, by burning in the air, will show the path of the projectile and will show how close the projectile may be to the target.

That rifles or small guns can be fired from aeroplanes has been demonstrated. While these guns are not very effective against troops on the ground, bombs dropped from balloons are a very dangerous inconvenience for the enemy. Experiments carried on have shown that these bombs can be dropped with great accuracy from a considerable height, and a sighting arrangement for dropping them has been fairly well perfected. The principle of such a sighting device is to set the sight at a certain elevation, depending



THE KRUPP 8.25-INCH FIELD MORTAR IN FIRING POSITION



THE 8.25-INCH FIELD MORTAR, LIMBERED UP FOR TRANSIT

on the speed of the aeroplane and its height, aim at the target, and release the bomb as soon as the sight is on the proper target.

SIEGE ARTILLERY.

There is yet another field of use for field artillery. In Germany and France there are a number of cities, which are protected by extensive fortifications. In addition, temporary fortifications will be thrown up by each side for the purpose of protecting important strategic places. To destroy these fortifications and drive the troops out, the siege artillery is brought into action. The guns for this purpose are brought up on wheels, as in the case of the smaller calibers, but are placed in more or less permanent positions for action.

There is no standard proportion of number of these batteries used in the various armies. The weights of the projectiles and velocities are more or less the same for all, and for Germany and France are about the following:

- 7.6-inch caliber, firing a projectile weighing 240 pounds with 1,100 feet per second velocity.
- 9.5-inch, with a 480-pound projectile and 1,000 feet per second velocity.
- 10.3-inch, with a 700-pound projectile and 1,000 feet per second velocity.

INFANTRY.

While it is probable the success of a battle will depend to a large extent on the support of the Field Artillery, it is certain that the principal and most important arm is the Infantry, which in practically every case must decide the final issue. The Cavalry may be the first to be drawn into a battle and the Artillery may destroy the enemy's Artillery, but a battle is never won until the Infantry has driven back the enemy's lines.

The usual mode of advancing for the Infantry is to deploy them in a line with a long interval between each soldier. This, naturally, is for the purpose of offering a smaller target for the enemy. It makes it more difficult, however, for the leaders to keep as good control over the men, and for that reason one of the objects of Field Artillery is to make the enemy's troops deploy early.

The Infantry soldier is armed in all the countries with a rifle and bayonet. The rifle is the weapon upon which reliance is placed, the bayonet being used only as a last means, when in a hand-to-hand encounter with the enemy.

The opening of fire from the Infantry will generally be delayed until accurate aiming is possible, unless it is desired to cause the enemy to deploy its forces earlier, and although the bullets are effective at 1,500 and 2,000 yards range, the real fighting will not begin until at much closer ranges.

Photograph by Branger

A FRENCH BATTERY OF 155 MILLIMETER GUNS IN THE ARGONNE COUNTRY

With each regiment of Infantry there belongs a platoon or company equipped with two or four machine guns. These machine guns generally fire the same ammunition as is used for the rifle of the army, but fire it semi-automatically from clips or belts containing 30 to 250 rounds each.

MACHINE GUNS.

The most notable of these machine guns are the Hotchkiss (French) and Vickers (English), the former firing from clips containing 30 cartridges and the latter firing from belts containing 250 cartridges. The rate of fire of these guns is about 400 to 500 shots per minute.

The Lewis gun, an American invention, is also very prominent in the great European war.

These rifles are transported either on light wheeled mounts or packed on mules or horses. Their prime object is to be able to take up a position and be able to deliver an overwhelming volume of fire where needed.

fortifications are of comparatively small caliber, none exceeding 9.5 inches. These guns are mounted on disappearing carriages, but cannot be very effective against the large calibers as, for instance, the 13-inch and 14-

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GERMAN SHORT-RANGE MORTARS CAPTURED IN FLANDERS

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BELGIAN ARMORED TRAIN IN ACTION AT ANTWERP

The coast artillery was mentioned above as not being very well developed in European countries. This undoubtedly is due to the dependence they place in the battle fleets and the short shore lines. The guns in the coast inch guns on a battleship. It is possible that every country feels that, with their land forces, they are perfectly able to repel any landing party that might desire to venture ashore.

DESTROYING A RIGID DIRIGIBLE WITH AERIAL MINES

Chapter IV.

FIELD GUN AND AERIAL PROJECTILES

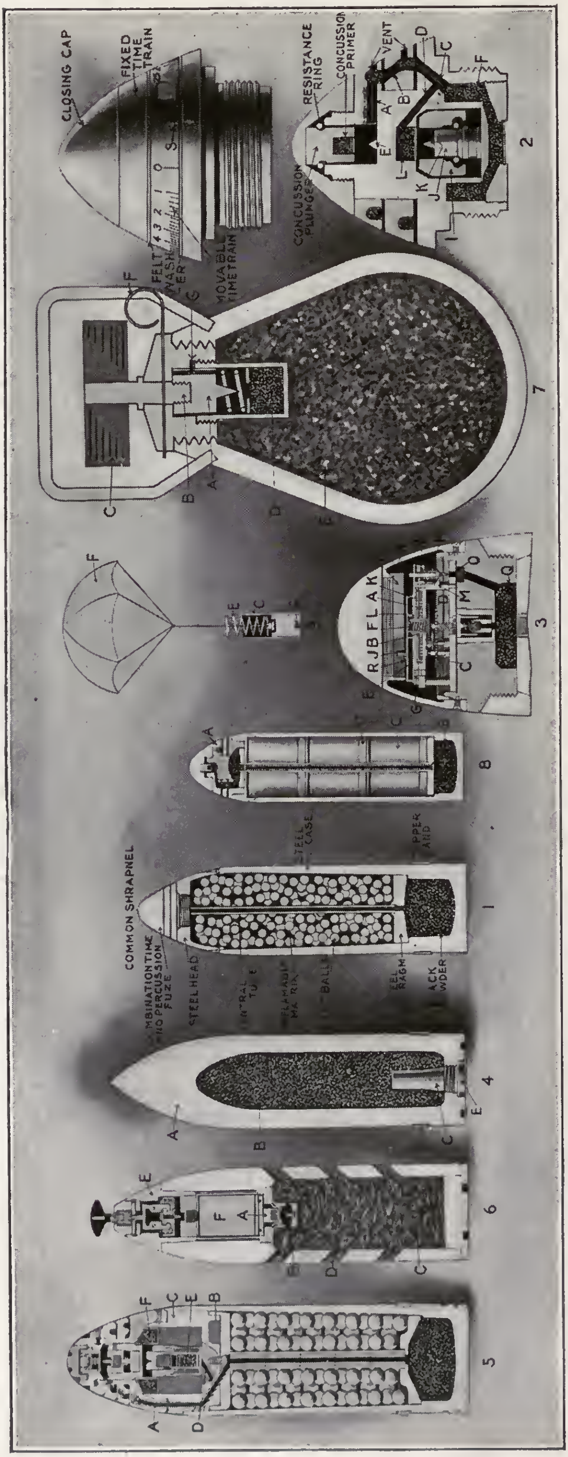
Construction of Shrapnel, Smoke and Searchlight Shells and Bombs for the Use of Aircraft

FROM the earliest days of artillery it has been found necessary to have one type of projectiles for the destruction of men and animals and another type for a small amount of inanimate objects. In the first case only a small amount of energy is required to disable an individual, and the energy of an artillery projectile must be divided many times to make it efficient. In the latter case the entire energy concentrated at one point is usually none too great. At the present time the common shrapnel which is separated into many smaller projectiles by explosion in the air, is the simplest for the attack upon animate targets and the high explosive shell which remains intact until impact is the typical projectile for the attack upon material objects. The fields of the two overlap to a small extent only and complications have been added by the necessity of having projectiles that are efficient against aircraft.

The construction of the common shrapnel, except that of the time fuse, is shown in Fig. 1. When the time fuse has burned the length of time for which set at the time of loading, a small magazine of powder in the fuse is ignited and the flame from this shoots down the central tube and explodes the black powder bursting charge in the base of the shrapnel. The case is made of a high grade of steel and does not break up at the time of explosion, but the entire contents and head are blown out to the front with increased velocity. The effect resembles suspending a huge shotgun in the air about one hundred yards in front of the enemy and firing it in that position. Each ball is intended to have sufficient energy to inflict a disabling wound, and effort is made to regulate the burst so that it will be in air and at a sufficient distance in front of the target to have an average distribution of balls of about one to the square yard of surface. In case of failure to burst in air the fuse is so arranged that explosion will take place on impact, but the small bursting charge causes little damage.

The light field guns of the various armies are of approximately 3-inch diameter of bore and fire projectiles weighing about 15 pounds. A shrapnel of this weight contains about 250 lead balls each ½ inch in diameter, and upon explosion drives them to the front with a velocity of about 300 feet per second, which must be added to the velocity with which the projectile was moving at the time of explosion. This increased velocity is of importance at extreme ranges, at which the projectile velocity may be as low as six or eight hundred feet per second. The matrix which is ignited upon explosion prevents deformation of the balls when fired from the gun, increases the visibility of burst and has considerable incendiary effect upon inflammable objects.

Fig. 2 shows a typical fuse used in the common shrapnel. As the projectile is driven down the bore the inertia of the concussion plunger causes it to slip through the resistance ring and strike the pin *E*, which explodes the concussion primer. The flame from the primer passes through *A* and ignites the fixed time train. To increase the length of the time train it is usually made in two parts, as shown, one of which is contained



TYPICAL PROJECTILES OF FIELD ARTILLERY AND AIRCRAFT, SHOWN IN SECTION

in a movable ring by turning which the time of burning is regulated. In the typical fuse the annular fixed train burns from the point of ignition hole *A*, until hole *B* in the movable train is reached. The movable train is then ignited through *B* and burns back to

FIRING A SEARCHLIGHT TO DISCLOSE THE MOVEMENTS OF THE ENEMY

fixed hole *C*, communicating with magazine *F*. The greater the angular distance between hole *B* and hole *A* the longer the fuse will burn before explosion. By setting the movable ring so that *B* is opposite *A*, flame is at once permitted to pass through *B* and *C*, and the projectile is exploded within a few feet of the muzzle. The annular rings of time train composition do not form complete circles, and during transportation the blank space in the fixed circle is over hole *B*, so that in case of accidental ignition of the primer the flame cannot pass from the fixed to the movable time train.

A simple percussion or impact fuse is ordinarily combined with the time fuse. In the typical fuse sleeve *I* slips over *J* at the time of firing, exposing pin *K*. Upon striking, *I* and *J* move forward and pin *K* strikes primer *L*, which ignites *F* by way of *D* and *C* and explodes the shrapnel. For percussion firing the fuse is left set as for transportation.

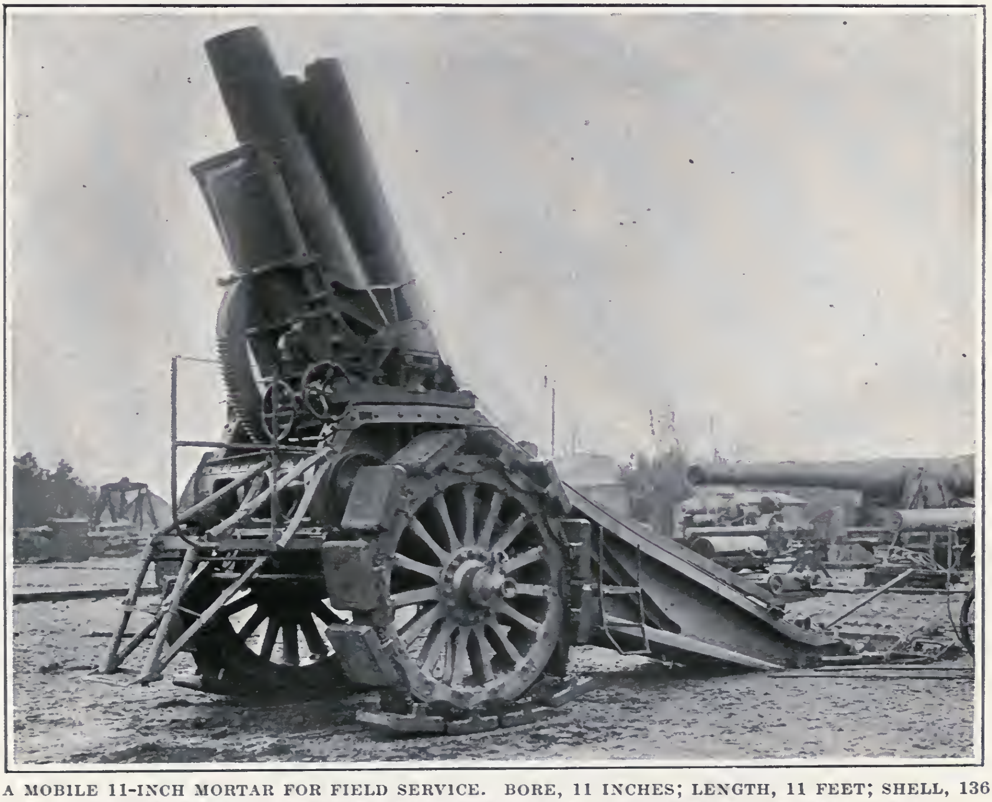
Time fuses of the type described have been highly developed and have excellent uniformity of burning, but, as one authority states, the method of measuring time by burning a train of powder is about as archaic in principle as King Alfred's candle clock. Clockwork fuses naturally suggest themselves as a solution, but the mechanical difficulties are great, owing to the forces exerted in overcoming the inertia of the parts when fired from the gun. The accelerating force on a part weighing 100 grains may be as great as 200 pounds, and deformation of a delicate part will result unless provision is made to support the same during the period of acceleration.

A typical fuse of the clockwork type is shown in Fig. 3. *A* is the main spring under tension, *B* the main spindle, which is hollow, *C* the escapement, and *D* a train of gears. All of these parts are similar to those of an ordinary clock. *E* is a lever which must rotate with the spindle *B*, but which can move forward under the force of spring *F*. *G* is a pawl which locks the clockwork and also lever *E* in the position shown. *H* is a cap which can be rotated to set the fuse at the desired time of burning. The action is as follows: The inertia of pawl *G* causes it to move to the rear with respect to the other parts at the time of firing. This releases the clockwork and also permits spring *F* to push arm *E* against annular projection *I* of cap *H*. *E* rotates with spindle *B* for the time set, at the end of which it moves forward into notch *J*. This releases lever *K* from the restraint of annular projection *L* on *E*. *K* swings outward under the action of centrifugal force, rotating spindle *M*, thus releasing firing pin *N*, which is driven into primer *O* by spring *P*. The primer ignites powder *Q*, the flame from which passes down the central tube and explodes the base charge of the shrapnel. The percussion elements are similar in principle to those of the combination fuse previously described. When percussion firing is desired, cap *H* is so set that on firing *E* moves directly forward into notch *R*, locking the clockwork.

High explosive shells, as shown in cross section in Fig. 4, are used with light field guns

BOMBS DESIGNED TO BE DROPPED BY AEROPLANES AND DIRIGIBLES for the attack of men behind the shields of field guns, small field works and such other objects as can be appreciably injured with a small charge of explosive. The larger calibers of *mobile* artillery intended for the destruction of permanent fortifications or strong field works use these shells almost exclusively. Few commercial explosives are suitable for shell fillers on account of being unable to withstand the shock of discharge, deteriorating in long storage, being hygroscopic, exuding nitroglycerine, reacting on though less powerful than picric acid, is coming into common use, as it is an almost ideal explosive from a military standpoint. It is manufactured extensively in Germany and probably is being used largely by that country in the present war.

Shells are, as a rule, fused to burst on impact only. The firing pin of the detonating fuse is armed essentially as described, for the percussion firing pin of the combination fuse. Upon impact the firing pin strikes a primer which detonates a small quantity of



A MOBILE 11-INCH MORTAR FOR FIELD SERVICE. BORE, 11 INCHES; LENGTH, 11 FEET; SHELL, 136 POUNDS; POWDER, 38 POUNDS; MAXIMUM ELEVATION, 65 DEGREES; MAXIMUM RANGE AT 65 DEGREES 24,278 FEET; MAXIMUM RANGE AT 42½ DEGREES, 33,135 FEET

the walls of projectiles, etc. Picric acid or its salts either alone or mixed with substances intended to make them less sensitive or to improve the chemical reaction on explosion are most commonly used. To this class belong English lyddite, Japanese shimose, and French melinite. The principal objection to picric acid is its tendency to form sensitive salts when in contact with metals, and care is therefore taken to keep it from the walls of the shells by protective coatings of asphaltum paints, *papier maché* cartons, etc. Trinitrotoluol, derived from certain by-products of the gas works, al-

fulminate of mercury or other detonant, contained in the forward end of the fuse. This in turn detonates the high explosive bursting charge. In Fig. 4 *A* is the shell, *B* the high explosive, *C* the detonating fuse, *D* the copper rotating band, and *E* a copper base cover.

The necessity of carrying both shell and shrapnel and the impossibility of predicting the proper proportion has led to attempts to develop a compromise projectile which would perform the functions of both. This has resulted in the high explosive shrapnel, which has been quite generally adopted, and a type of which is shown in Fig. 5. The construction of the rear portion of this projectile is the same as that of the common shrapnel except that the matrix surrounding the balls is a substance, such as trinitrotoluol, which will merely burn when ignited by black powder, but which will act as a high explosive if a detonating fuse is exploded in contact with it. The head is larger than that of the common shrapnel and contains a small charge of high explosive, which in effect makes a small shell out of the head. The central tube is replaced for a portion of its length by the passage *A* in the wall of the head. The combination fuse is the same in principle as that shown in Fig. 2, except that the small magazine of black powder is replaced by a detonant. If it is desired to use the projectile as a shrapnel, the time fuse is set, and upon explosion of the base charge in air, the head and balls are driven out to the front. The explosive matrix merely burns and makes the point of burst more visible. The percussion elements of the combination fuse detonate the head on striking. The explosion of the head facilitates observation of fire, and under favorable conditions the fragments of the head are effective. When it is desired to secure the effect of a high explosive shell the fuse is not set. Upon impact the head detonates as explained above, and this detonation produces detonation of the matrix. The functions of certain other parts of the projectile shown are described in connection with projectiles for the attack of airships.

Aerial navigation led to the development of guns and projectiles intended especially for the attack of both heavier-than-air machines and balloons. Some of these were practicable, but for service with armies in the field, where transportation is rarely sufficient, it is impossible to provide ample armament for this purpose alone, and the practical solution has been to so modify the design of guns and projectiles in common use as to make them fairly efficient against aircraft without impairing their serviceability for other purposes.

Fig. 6 shows a projectile especially intended for the attack of balloons. At the instant of firing, primer *A* strikes pin *B*, exploding it, which ignites the large mass of incendiary material *C*. The smoke and flame from *C* pass to the air through vents *D D* and enable the flight to be followed with the eye, which aids in adjusting the laying of subsequent shots. A sensitive percussion fuse *E* is provided, which upon impact with the slightest resisting substance, such as balloon fabric, will explode a bursting charge *F* which is sufficient to fragment the shell and seriously injure the parts near the explosion. In the case of a balloon the gas would probably be exploded by either the bursting charge or the burning tracer compound.

Fig. 5, in addition to illustrating the principles of the high explosive shrapnel, shows the modifications made in one type to render it more effective against aircraft. At *B* is a partial annular ring of inflammable material, resembling the time ring of a combination fuse. It is ignited by flame from the passage

THE MORTAR BEING TRANSFERRED FROM ITS TRANSPORT CRADLE TO THE MOUNTING

A at the time the base charge is exploded. As the head *C* continues its flight a trail of smoke is left by *B* and after a certain time *B* burns around to *D* and ignites the detonator *E*, which detonates the head. A quantity of

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MINIATURE OF IMMENSE PAPER SHELL USED AS A SUPPLEMENT TO THE "SCIENTIFIC AMERICAN"

smoke producing material at *F* is intended to increase the visibility of burst. As the two explosions are separated by a considerable distance, the chance of fragments hitting is increased, and the flame from *B* would explode a balloon. The efficiency of the projectile for land warfare has not been appreciably decreased by these modifications.

Bombs or "drop projectiles" adapted to be dropped from aircraft are of relatively simple construction, as they do not have to withstand the accelerating force of powder gas. A typical projectile is shown in Fig. 7. The firing pin *A* is locked by the screw *B* to make explosion impossible during transportation or on landing. A safety wire *F*, which is removed before dropping, is an additional safeguard. When the bomb is dropped the resistance of the air causes vane *C* to rotate, which unscrews the screw *B* and releases the firing pin *A*. A stop pin *G* keeps the firing pin from rotating, but does not interfere with its forward motion. On impact the firing pin *A* strikes the detonator *D* and explodes the high explosive charge *E*.

It is rather early to predict the ultimate use of such bombs, but insofar as field armies in the present war are concerned, it is safe to say that, due to the limited weight that the largest airship can carry, their effects will not be any more terrifying and will be


Courtesy of Illustrated London News
A 42-CENTIMETER SHELL. THIS UNEXPLODED 42-CENTIMETER SHELL FELL IN SOFT GROUND NEAR VERDUN. HEIGHT, 1½ M.; WEIGHT, 2,108 LBS. A FRENCH 75 MM. ON LEFT, AND GERMAN 77 MM. ON RIGHT.

far less important than those of the enormous number of gun projectiles, which are thrown with greater accuracy and usually from guns that cannot be seen by those attacked.

Among recent United States patents may be found several assigned to Fried. Krupp Aktiengesellschaft, on searchlight projectiles. These projectiles are arranged to burst in the air, throwing out a number of "candles" or luminous bodies that light up the surrounding country for a considerable area and reveal the movements of the enemy. Each candle is provided with a parachute that unfolds as soon as it has been discharged from the cell, so that the candle will drop very slowly and will burn for a long time before striking the earth. The arrangement of such a projectile is shown in Fig. 8. It is similar to a base chamber shrapnel and is provided with the usual time fuse *A* and bursting charge *B*. The interior of the shell is provided with a number of candles, each fitted in a casing *C*. The fuse is set to burst the projectile when it is on the descending part of the trajectory, and as soon as the candles are disengaged from the shell, the caps *D* are thrown off by a spring *A*, which releases the parachute *F* (see Fig. 9). At the same time the candle is ignited by means of the match *G*. After their ejection the candles fall slowly to the ground, while the light material *H* burns brightly. The illumination lasts about twenty minutes.

The drawing on page 31 illustrates the effect of one of these shells in disclosing the movements of the enemy without betraying the position of the gun from which it was fired.

Photo by Branger
THE 65 MILLIMETER MOUNTAIN GUN, USED BY FRENCH ALIPNE CHASSEURS, IN BATTERY

Photo by Branger
UNPACKING A 66 MILLIMETER GUN IN THE VOSGES.

Chapter V.

WAR EXPERIENCES OF AN AIR SCOUT

The Diary of an American Volunteer With the Aviatian Corps of the French Army

BY FREDERICK C. HILD

[*The author of this article, a well-known aviator in this country, was impelled by a spirit of adventure to seek his fortune with the French army. His tedious experiences with French red tape before being admitted to service, the tests he was obliged to undergo before qualifying as an army scout, his flights over the enemy's camps, and finally a most thrilling battle in the clouds far within the German lines, together with a number of the interesting side lights on the conditions in France during the war are here described.*]

ON the outbreak of the great European war I was seized with the desire to participate in the conflict, and this desire grew day by day until finally I was obliged to yield to it.

I applied to the French government, on August 31st, 1914, through its consul-general in New York city.

My application was immediately acted upon and my voluntary services accepted. It was arranged that I should leave New York Saturday, September 5th, on the French Line steamer.

The French consul-general presented me with two important letters of introduction, one addressed to the consul-general of France and the other a personal letter addressed to Gen. Goiran, the mayor of Nice; but should Gen. Goiran not be conveniently located, the presentation of the letter to any military official in France would accomplish the same purpose.

When the French steamer "Espagne" left New York, on September 5th, I was on board, together with several Americans and about 700 reservists, who were going to France to fight their country's battles. There was much fun and excitement during the voyage, pleasant weather favoring us during the entire journey.

Upon nearing the French coast we were accosted by two British warships, which escorted our steamer close to the port of Havre. We landed at Havre on September 14th, at 7 A. M., in a heavy rainstorm. The French officials were taking no chances of allowing an enemy to land, because we had to show our papers the day before we landed. and then to the military authorities the day we disembarked on French soil.

Together with a fellow aviator, a M. A. Fileux, a native of France, whom I had known for several years and who returned to France on the same steamer to serve his country, we went to the Bureau de Recruitement, at 55 Rue de Phalsbourg, where, upon presentation of my letters from the consul-general at New York, I was given an immediate interview with the commandant.

The commandant looked through my papers carefully and, after convincing himself that I was the party named therein. he informed me that he must telegraph to the Minister of War at Bordeaux for instructions and must await reply. My case was a new one to the recruiting officer at Havre. as he had not dealt before with any Americans who wished to join the aviation corps.

Four days later the answer from the Minister of War arrived and I was ordered to report to the second aviation reserves at Tours, where I would have to pass the

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THE AUTHOR IN HIS FRENCH AVIATOR'S UNIFORM

French examination for pilot. This was a simple test, as the requirement was that I take an aeroplane up 7,000 feet and remain at or above that altitude for an hour at least.

One of the first sights I saw after I had shown my papers to the soldiers guarding the railroad station at Tours was an aeroplane flying over the city. It gave me a decided thrill for I had come 3,500 miles to do just what the man over my head was doing, and I wanted to get into action as soon as I could.

I presented my papers to Capt. Duperron, the officer in command of the Second Aviation Reserve, and after convincing him also of my ability as an aviator, I was accepted for the service. I had to undergo another physical examination because the commandant at Havre had failed to mention in the papers that I had already passed the test. After passing this second examination I signed up immediately with the French for the period of the war.

An order for my uniform was given me and I stopped at the clothing department on my return to the aviation headquarters. The trousers, with the red stripes, given me were new, but the coat, vest, tie, and cap were old and had been worn by some soldier before me. The shoes furnished me were so heavy that I decided to retain my own, and I was paid 15 francs ($3) for them. I did receive a new leather coat, a helmet, gloves, goggles, and a sweater, all of which I have since found exceedingly useful.

"Palace Hotel" was the name given by the pilots to their quarters, because it is nothing like a hotel and bears no resemblance to a palace. It was formerly a large barn and

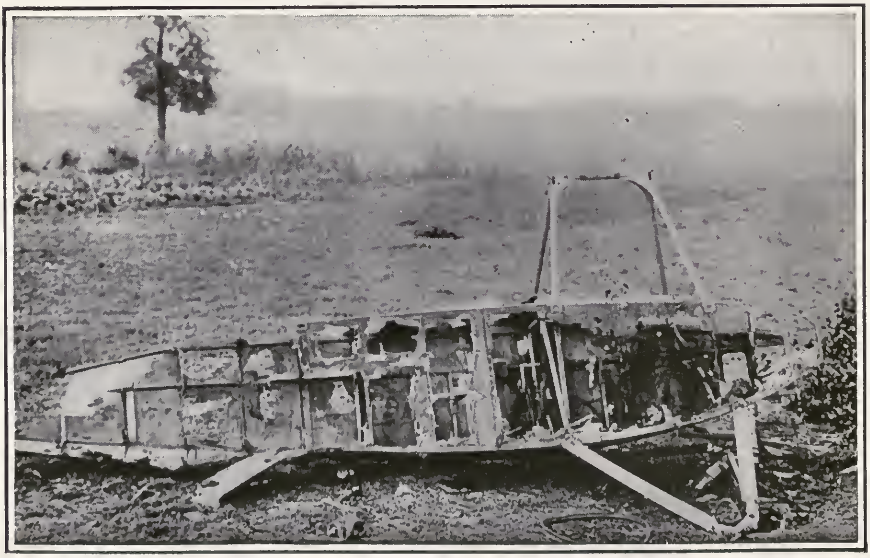


Photo by Underwood & Underwood

WRECK OF A TAUBE AEROPLANE SHOT DOWN BY THE BRITISH was converted (without much conversion, either) into a place for the pilots to sleep. There was absolutely no ventilation whatsoever in the building other than the large sliding door, which was generally kept closed. It did not look at all inviting to me; but I realized that I was now in the service of France and had to do as my superior officers commanded. After securing an order, I went to headquarters and was given two bags and two blankets. The bags I filled with straw and used one for a mattress and the other for a pillow. A fellow Russian pilot loaned me a sheet for my bed, when he saw me turning up my nose in disgust at the sight of the soiled bags. This was the only thing about the bed that was clean and I was thankful to get it. I slept well and forgot all about the repugnance I felt for my bed and my quarters.

A MAD PLUNGE FOR LIFE.

Meals were served to the pilots in an old barn, about five minutes' walk from the aviation field. Dinner was served at half past six that night. I was introduced to the pilots present (about sixty), and they greeted me with cheers when they learned that I had come from America to fight with them. Some who knew the American national anthem sang it, and I was made to feel at home at once. I felt that I was where I belonged at last, and room was made for me at the rough table by several of the pilots squeezing together on a bench and telling me to sit down.

Some of my fellow pilots were quite prominent in the flying game. Others of them were very wealthy. It seemed odd to me to think that we should all be eating at the same table and sleeping in the same room, receiving no more consideration than was given the average French soldier. Among the pilots present were Jules Vedrines, the speed king, who won the Gordon Bennett race at Chi-

2èmes Réserves de Ravitaillement d'aviation-

Centre de Tours
----
nº 232
--

Tours, le 10 8bre 1914

Le Capitaine Duperron, Cdt le 2èmes Réserves de ravitaillement de l'aviation
A Monsieur le Ministre de la Guerre, Direction Aéronautique, 4e Bureau, BORDEAUX

J'ai l'honneur de vous rendre compte qu'une commission chargée de l'examen des épreuves du brevet militaire & composée de M.M. les Lieutenants Noë, des Hautchamps & de Bourdes s'est réunie le 9 8bre 1914 à 14 heures au Centre d'aviation de Tours, pour examiner les titres des candidats du Brevet Militaire.

La commission propose d'accorder le Brevet Militaire aux pilotes dont les noms sont énumérés ci-dessous & dont les performances constituent des équivalences aux épreuves réglementaires nécessaires.

Elle propose également de leur accorder les indemnités réglementaires à dater du jour où ils ont accompli les performances d'équivalence.

Signé: Capitaine Duperron

Direction de l'Aéronautique Militaire
Cabinet du Directeur

DECISION DU MINISTRE

Le Brevet Militaire est accordé aux pilotes dont les noms sont énumérés ci-contre. Les titres seront remis ultérieurement aux intéressés.

nº 1488/12-Communiqué pour exécution à Mr le Capitaine Cdt la 2e Réserve de ravitaillement de l'aviation, à St Cyr

Bordeaux, le 14 8bre 1914
Pour le Ministre & par son ordre
Le Général, Directeur de l'Aéronautique Militaire
Signé : Hirschauer

Copie certifiée conforme :
Le Capitaine Duperron
Cᵗ le groupe des Réserves d'Aviation

Hild (Américain)	soldat	Rep	9	octobre 1914
Jacob	dº	H F		dº
Mauger	caporal	H F		dº
Liger	soldat	M S		dº
Mangeot	dº	M S	8	dº
Auger	caporal	M F	7	dº
Ducas	brigadier	M F	1º	dº
de St Pierre	soldat	M F	2	dº
Val	ens. de vais.	M F	5	dº
Tasdhomme	sergent	M F	3	dº
Biot	soldat	M S	7	dº

MR. HILD'S COMMISSION AS PILOT IN THE AVIATION CORPS cago two years ago; Count de Lambert, the oldest aviator in France and who was the first to learn from the Wright brothers (he was now taking instructions on the Voissan biplane); Fournier, the holder of the French endurance record of 13 hours for many years; Simon (the fool flyer), well known in the United States; Jensen, from Denmark, who months ago flew from France completely across Germany without alighting to land in Russia, one of the longest non-stop cross-country flights on record; and many others too numerous to mention. Messrs. Vedrines, Count de Lambert, and Fournier were holders of the Legion of Honor medal and wore it prominently displayed on their breasts. There were also many pilots of foreign birth present, among them three Russians, several

Catechism of a Soldier in Time of War

To conquer in war I must have:

My courage,

My discipline,

My bayonet,

My ammunition.

My courage, to assure long suffering.

My discipline, in order to carry out blindly all the orders of my commander.

My bayonet, to drive the enemy from his position or to impale him.

My bullets, to permit me to press on up to the moment of assault.

As a sentinel I watch over the army; it is my duty to keep on my feet, in order to see, to listen, and to prevent danger.

As a scout I must protect the army on the march and be audacious in obtaining information.

On the march I must keep my place exactly.

In camp I must look after my equipment, care for my feet, my boots, rest with my rifle near me, so as to be ready at the first call to arms.

In battle, in taking the offensive my motto must be "Always forward" for the assault.

On the defensive I must hold out to the very end, even when I see the effect of fire, commencing and ceasing fire instantly at the order of my commander, supporting my rifle and, if possible, my body in order to fight the better.

When I am alone I will not fire, at more than 400 meters, on a single man, or at more than 600 meters on a group of men.

Given this day on the boat "Espagne."

Sunday, September 13th, 1914.

TRANSLATION OF ORDERS GIVEN TO FRENCH SOLDIERS

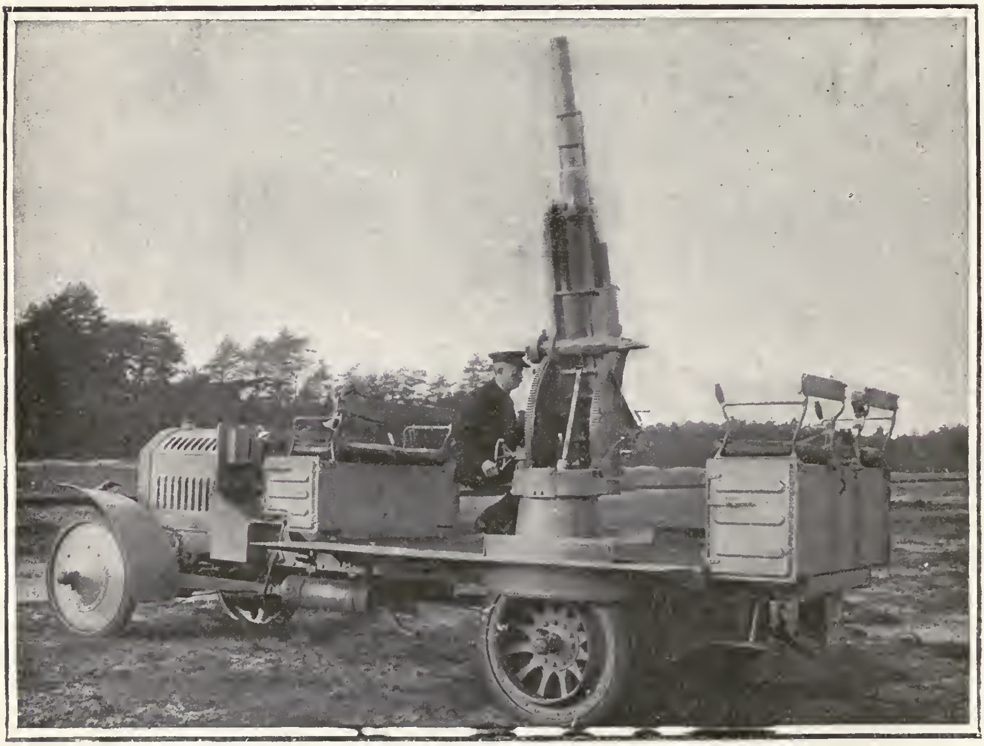
Englishmen, two Belgians, two Italians, and one Spaniard, but apparently I was the only American enrolled.

I was not given an opportunity to fly for several days. I was informed that I must wait until a new machine was completed. It is a rule that all new arrivals must make their first flight on a machine of only 50 horse-power.

My friend, Fileux, who was among the pilots, and I passed our first tests successfully, but the man (Corporal Delmas) who was tried out after us wrecked the machine, which was a 50 horse-power Gnôme-motored, Blériot monoplane, and caused us further delay.

I was beginning to get disgusted with the slowness of the French military system; therefore I besought Capt. Duperron, through an interpreter, for some action, and was henceforth transferred to the "Rep" monoplane, a machine that easily makes 90 miles an hour. The Rep monoplane, equipped with an 80 horse-power Gnôme motor, is quite a heavy apparatus, constructed mostly of steel, and in workmanship and material it represents the best French aeronautical construction that I have seen.

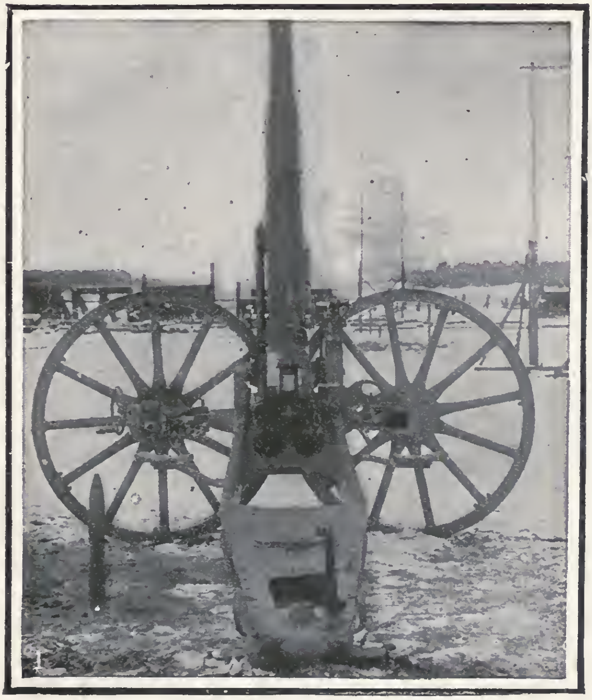
My opportunity to fly came the next day, and for the first time I enjoyed a flight of 30 minutes, which took me 2,000 meters (6,500 feet) high and gave me an opportunity to see the country about me. Tours is indeed a beautiful city. The day being a clear one, I could see the country for miles about; *châteaux* showed themselves here and there, and I should have liked to continue my flight, but, being permitted to fly for only a half hour, I was obliged to come down.



THE 3-INCH 12-POUNDER KRUPP FIELD PIECE FOR AIRSHIP ATTACK. THE WEAPON CAN BE BROUGHT TO A MAXIMUM ELEVATION OF 75 DEGREES. THE MOTOR CAR ON WHICH IT IS MOUNTED IS OF 50 HORSE-POWER AND HAS AN AVERAGE SPEED OF 30 MILES AN HOUR

The following day, not having a machine to fly, and seeing a new Blériot monoplane flying, I requested the captain to let me fly it. I received permission, but was told by the captain that, as I was now in the Rep school, I could fly that machine only, and that, therefore, this would be my last flight on the Blériot. I flew for 45 minutes and enjoyed it immensely, though I narrowly escaped death by collision in the air with a Nieuport monoplane. My machine was flying horizontally at an altitude of about 1,500 feet, when directly above me a pilot in a

Nieuport was spiraling from a height of 5,000 feet and coming directly toward me. I tried to steer out of its path, but he kept on coming toward me, and for the moment it appeared impossible to avert a collision. I attempted to dive, but had it not been for the fact that he peered out of the machine in my direction, nothing in the world would have saved me, since the speed of his machine doubled that of mine, and it was only by his immediate jerking of the elevating control toward him that he saved the situation. His machine was so close that the tail of his machine seemed to graze that of my machine, and the sudden rush of disturbed air was so violent that I had the greatest difficulty in keeping my apparatus from capsizing.



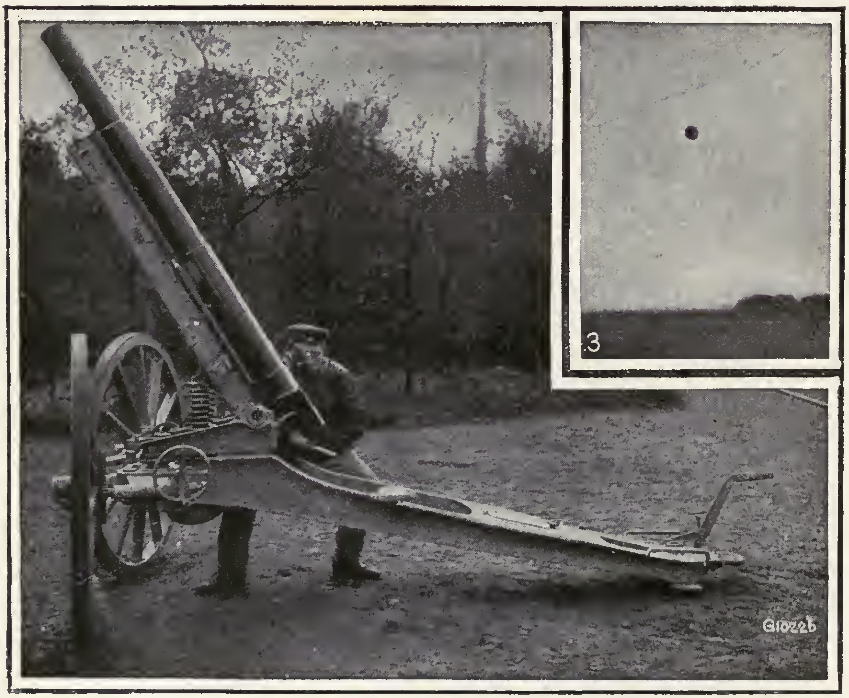
NINE-POUNDER GUN IN BATTERY. IT FIRES A SMOKING SHELL

TWELVE-POUNDER FOR SHIPS AND FORTIFICATIONS

Two days later, Friday, October 9th, proved an eventful day for me. A new 80 horse-power Rep monoplane had arrived and I was given permission to fly it. I did so for twenty minutes, and then I was given permission to qualify for my military brevet. The recording barometer was secured and fastened to the machine by the mechanics, but after flying for five minutes it worked loose and I was forced to descend for a fresh start. This time it was fastened more securely. I arose to a height of 2,500 meters (8,200 feet) in twenty minutes and then straightened out my machine to remain there for one hour or more; but alas! after flying for thirty minutes at this altitude, the barometer refused to operate and I had to descend.

I made a fresh start at three o'clock in the afternoon. This time I fastened the barograph myself, by a cord around my neck, the barograph resting against my chest, to which I had fastened a mirror in order to note its operation while in flight. A small aneroid, a stationary part of the machine, capable of registering 3,000 meters, acted as a guide when once I attained the height of 2,000 meters.

I bundled up good and warm with safety helmet, goggles, sweater, leather coat, and gloves. I flew for one hour and forty-five minutes, one hour and fifteen minutes of this at the height of 2,200 meters (7,200 feet). The barometer worked perfectly, and I had flown all over the neighboring country, which consisted of large dense woods, rivers Share and Loire, large cities and small towns, and I certainly enjoyed my stay in the air at this altitude, although it was terribly cold, and I was really glad to descend once again to Mother Earth. The recording barometer having worked satisfactorily, I was given my military license by the military officials, who congratulated me upon being the first and only American licensed aviator to fulfill the test. I now await the arrival of the brevet from the Minister of War and the Director of Aeronautics, both of whose approvals I must have before it is issued, since upon its receipt I am ready to be sent to the front. I was informed by the captain that he had received instructions from headquarters that four licensed Rep monoplane pilots were wanted in a few days to pilot machines to the front; so I was rather pleased to have obtained my license, as I was tired of wasting valuable time when I could be accomplishing something and be of some use to France.



GUN CARRIAGE MAY BE SWUNG IN COMPLETE CIRCLE AROUND A PIN AT END OF TAIL
FLIGHT OF SHELL MARKED BY STREAK OF SMOKE

Three days after having qualified for my military brevet, an important order was issued by the Director of Aeronautics, which affected a great many pilots and demonstrated the inefficiency of certain apparatus. The order ran as follows:

In future there shall be no more Blériot, Rep, Nieuport, or Deperdussin monoplanes used by the French government, and all those pilots learning or now operating any of these machines must immediately change to either of the following apparatus: Morane-Saulner monoplane, Henry Farman biplane, Maurice Farman biplane, Caudron biplane, or the Voissan biplane.

I immediately changed to the Morane-Saulner monoplane, a smaller machine in comparison to the Rep monoplane, but considerably faster in speed and capable of climbing 7,000 feet in fifteen minutes, thus making it a very desirable machine for scouting purposes as well as to give fight to any of the German machines, since some of these machines were equipped with machine guns operated by the passengers, while others were fitted with bomb-dropping devices. It is excellent also for observation work and the dropping of small round, pointed, and grooved iron pencils in quantities of a thousand at a time. The latter proved very efficient when dropped over the enemy on the march or into their trenches.

On October 17th I received the long-looked-for order to go to the front in an *escadrille* of six Morane-Saulner monoplanes. That night five other pilots and myself left Tours for Saint Cyr, a few miles outside of Paris, where we found the six Morane-Saulner machines awaiting our arrival the next morning. The six of us visited the captain in charge at Saint Cyr, who ordered us to fly that day to the aviation headquarters near Arras, 150 kilometers from Paris. Maps were furnished us, which we prepared and placed in the map cases which are a part of every machine, as well as a compass with which every apparatus in France is steered. A flight of ten minutes demonstrated to me that my apparatus was in perfect condition. At 1 P. M. on the 18th of October the six of us started at a few seconds intervals on our journey. Upon attaining a height of 2,000 meters, the six of us sailed from Saint Cyr toward the point where civilized men were murdering each other, and the fact that it would be but a matter of a few hours ere we would be accomplishing the same purpose with our deadly bombs seemed hardly believable.

The journey, a short one, seemed awfully long to me. Several times, with the aid of field glasses, I could see far below me thousands of soldiers marching toward the battle front. Destroyed bridges over the Oise and Somme rivers showed me ground that had been occupied by the Germans a few weeks before. After flying for one hour and a half the portable hangars of the temporary aviation headquarters just to the south of Arras appeared visible. A few minutes later I was directly above them. Shutting off the motor I volplaned down in a spiral glide, and

HOW STEEL DARTS ARE DROPPED FROM AN AEROPLANE. INSERT ON THE LEFT SHOWS A DART ABOUT HALF SIZE; ON THE RIGHT, THE BOX FROM WHICH THEY ARE DISCHARGED a few seconds later was again on *terra firma.* The six of us had made the flight of 150 kilometers without mishap. I was anxious to get into the fray at the earliest possible moment, so I immediately reported to the commanding officer, who appointed a junior officer to accompany me as observer of my flights, the first to be made the following morning at six o'clock.

Photo by Levick FRENCH MITRAILLEUSE FIRING AT A GERMAN AEROPLANE

The next morning at six o'clock my observer, who was able to speak good English, and I were up and anxious to fulfill the work that lay before us. A heavy fog was a great disappointment to me and caused a delay in our start. It was at least ten o'clock before the captain would permit us to start away on our flight. Our course had been prearranged, and it was the duty of my observer to make notes of the movements of the enemy's troops. Several other apparatus started away at the same time we did. Rising to a height of 2,250 meters (7,000 feet) I headed the machine toward Douai and thence toward Lens. The flight lasted a little longer than one hour and proved to be intensely exciting. At times it was impossible to see the earth directly along the line of battle owing to the terrific cannonading that was going on; the smoke was so dense that it seemed as though we were flying above the clouds. We penetrated the enemy's line for a distance of half a dozen miles, where the actual movement of troops was going on, the data on which was quite important to the French. There appeared vast columns of soldiers that, in the winding roads, seemed like great big snakes crawling slowly along. From our extreme height it was hardly possible to make out the direction the troops were traveling; but after circling over the point for ten minutes, my observer detected with the aid of glasses the direction in which they were heading.

alighting his notes were immediately dispatched to the front. Three bomb-dropping machines and one equipped with several thousand of the sharp-pointed steel arrows, or pencils, as they are sometimes called, were

THE PHONOGRAPH LEAVES THE AIR SCOUT'S HANDS UNHAMPERED

In one hour of flying the observer who accompanied me had sufficient time to note nearly every action of troops belonging to the enemy that we had flown over, and upon

dispatched to raise havoc with the enemy's troops that were on the march. For this purpose the steel arrows, which are about 4½ inches long, round, and sharp on one end and grooved out on the other end, prove a very good weapon. They are dropped from the aeroplane while in motion in quantities of 1,000 at a time. They spread out over an area of 300 square feet, and after a fall of say 6,000 feet, they will penetrate almost anything. The French were the first to invent them, and the Germans, seeing their good work through the damage done to their own men, copied them with the following words cast thereon: "Invented in France, but made in Germany."

The next morning at eight o'clock I was ordered to duplicate the flight I had made the day before. The day being a hazy one, it was quite difficult for both the observer and me to see the activity upon the ground beneath us from our established elevation of 7,000 feet, so I descended to a level of 4,000 feet, which made my flight a rather dangerous undertaking. We covered nearly the same ground as we had on the day before, with excellent results; but the fact that I was not brought down by the enemy's guns was a wonder, since terrific rifle and machine gun fire must have been directed against my apparatus. Examination of the wings and body showed where they had been penetrated by six bullets. A small circle, drawn by crayon, around each hole, together with the date and time of my flight, served for future reference. The weather was beginning to get extremely cold, which made flying at high altitude a rather cold proposition; so I was quite happy to have again alighted after flying one hour and fifteen minutes.

In the early part of the afternoon on the same day I was ordered to make my third flight over the battling armies. This flight very nearly proved to be my last flight upon this earth. The sky was then cloudy, which proved to be a rather excellent time for both observation and bomb-dropping, as it enabled us to fly at a ridiculously low height with comparative safety from the enemy's rifle and machine-gun fire, my apparatus being obscured from time to time by the low-lying clouds. After flying about half an hour at a 3,000-foot altitude, we sighted the enemy a few miles away, and the observer who accompanied me proceeded to get ready to dispatch a thousand of the little death-dealing steel darts that we had been directed to take along. My apparatus was then dashing in and out of the clouds, which presented a rather difficult target to the enemy below. As a rule, when an enemy's flying machine is sighted the gunners on both sides are on the lookout for it. In the early days of the war French airmen were shot down by mistake by French gunners, who fired at nearly every aeroplane they sighted. To prevent this, all the French machines had the national colors painted beneath each wing. The German machines were likewise designated; but at a height of 6,000 feet the flag is invisible, and

Photo by Levick

THE FABRE DEVICE FOR DROPPING BOMBS FROM AN AEROPLANE. NOTE THE SIGHTS it is only by their shape and the direction from which the apparatus is coming that the two types of aeroplanes are detected. Flying at only 3,000 feet our machine could have been easily seen and detected; but the fact that we were nearly all of the time obscured by clouds either prevented our detection or fooled the Germans into believing that it was one of their own apparatus. Suddenly through an opening in the clouds we sighted about 20,000 Germans directly beneath us on the march. My observer immediately dispatched the steel darts on their deadly errand; but with what result we were unable to ascertain. Almost instantly we were obscured in another cloud, and by turning the machine sharply to the right, which nearly threw out my observer, I instantly changed my course and fooled the thousands of Germans below, who must have emptied their rifles into open space in an endeavor to avenge the murder of many of their comrades that my apparatus must have caused.

Having finished my errand, I proceeded to return to headquarters, steering by compass, and at the same time congratulating myself upon getting away safely from the most dangerous position I was ever in. Then I pursued a downward grade in order to get out of the clouds and ascertain whether my compass was guiding me correctly. This proved to be nearly the end of my activity with the French government, for a few moments later I sighted one of the famous German machines, an Etrich Taube. Being over-stimulated with our previous success, I decided to give chase, though both the observer and I were armed merely with a revolver apiece provided for just such an emergency. My apparatus, being capable of making 90 miles an hour, soon caught up with the German machine, who upon seeing us had headed for a bank of clouds, and my observer was just getting ready to fire when suddenly there appeared from the bank of clouds another German machine of the biplane type, which immediately opened fire upon my apparatus with what looked to me like a machine gun. Of course, no sound could be heard above the roar of my motor. Being unprepared for such an attack, immediate action was necessary. The German armored machine was now nearly over our apparatus, while the Taube had since turned about and was coming straight for us. Our position was most dangerous and for a second it looked as though we would soon be dashing headlong into space. I then did the only thing possible; pushing my elevating lever forward my apparatus dived head first so steeply that it nearly turned upside down, and in a moment I was a thousand feet away, quite low, but, fortunately for both of us, we were well behind the German lines and over country where there were few or no German soldiers to be seen; otherwise we should have been facing further difficulties to hamper our escape.

Upon arriving at the bottom of our steep descent, I leveled out my machine and soon left the German machines in the rear. Evidently they had thought that their rifle fire had found its mark and brought us down. Upon seeing that our machine was again flying normally, they gave chase immediately, but the tremendous speed of my monoplane soon outdistanced both of them. As I had been gradually climbing throughout the chase, I soon regained my normal height and faded out of sight into the welcome clouds. Again I headed my apparatus toward the French lines. This time I maintained my altitude and was quite satisfied with an occasional peek at the ground below, through the opening of the clouds, to ascertain my direction. It seemed hours to me ere we were again flying inside the French lines, where it was quite safe to lower my apparatus from our obscure place of hiding. A most welcome sight to both the observer and me were the hangars upon the aviation field that loomed up in the distance, and a few minutes later our apparatus was rolling over the ground after flying for nearly two hours, and the most thrilling and exciting two hours that either my observer or I had ever experienced. Further flying that day was out of the question for either of us; in fact, I was all in, and it was really a wonder that I was able to return safely after our mad plunge for life.

[Since the foregoing article was written the European war has developed with titanic strides. Nation after nation have hurled themselves madly into the mighty struggle for supremacy and Europe has become a vast charnel house. In this unhappy development the air-craft has been conspicuous. The huge Zeppelins to which the Germans pin their faith make nightly raids on the English coast with, however, a woful lack of success, as, apart from the slaughter of a few non-combatants, nothing of importance from a military point of view has been accomplished; the monoplanes, hydroplanes and biplanes of the Allies are all likewise active, buzzing aloft like gigantic vultures with unceasing activity seeking their prey. The damage done to opposing armies by these raids is an unknown quantity, but the practicability of the aeroplane as an offensive adjunct has been abundantly proved.]

Mechanical Aids for Air Scouts

IN carrying out scouting observations with military aeroplanes it is essential that there be two men in the machine, namely, a pilot whose sole duty it is to operate and steer the craft, and an observer who can devote undivided attention to scanning the ground below him and making sketches of fortified works, the disposition of the enemy's guns, the movements of their troops, and the like. Unfortunately, the great noise made by the motor renders it impossible for the two men to carry on any conversation. Often this proves quite a drawback for a proper understanding between pilot and observer. To remedy this defect a loud-speaking telephone system is now in use between pilot and observer in some of the French military aeroplanes. As the accompanying photograph shows, each man is provided with a special helmet fitted with receivers over the ears and a transmitter located in convenient range of the mouth. This has proved to be a most practical way of keeping up a conversation in spite of the deafening noise of the motor. A still further improvement is shown in our engraving on page 47. If the observer is to make sketches of the ground over which he is flying, he will be so much occupied, probably, as not to have time to jot down notes. Sometimes events may follow in such rapid sequence that he may not have time to write down all he would like to. In certain conditions of flight it might be difficult to use pencil and paper. In order to remove all obstacles that might hamper the observer's work, a phonograph is now provided, with a speaking tube running to the observer's mouth, so that he may talk into the machine at any time during the flight and thus make a record of his observations, while at the same time his hands are free for the use of field glasses or the sketching pencil. At the end of the flight the phonograph delivers its message.

THE ROARING AEROPLANE MOTOR MAKES TELEPHONE COMMUNICATION NECESSARY

Chapter VI.

THE ART OF DECEPTION IN WAR

Methods of Military Mimicry and Protective Concealment Employed on Land and Sea

IN all nature there is hardly an animal which is not characteristically marked for deceiving its enemies or its prey. The Indian kallima butterfly, for example, is veined and marked like a leaf with such amazing accuracy that when it folds its wings and perches upon a stem it is absolutely impossible to distinguish it from the surrounding foliage; even spots of leaf decay are thus accurately reproduced. So, too, the walking-stick insect, when it crouches among green leaves, cannot be distinguished from a twig. It is not a mere whim of Nature's that has striped the zebra; the characteristic markings of the animal, conspicuous enough in a menagerie, render him almost indistinguishable from the tall grasses and saplings among which he more habitually stands. Bird hunters know how difficult it is to discover grouse and partridge because of their bark-like coloring. So perfect is this adaptation of an animal to its environment that we even find colors changing with the seasons. Almost every Arctic animal changes from brown to white as winter approaches, and some species of fishes seem to have the ability of changing their color not only with the seasons, but to suit the particular character of bottom upon which they happen to be lying at the moment. The lesson has not been lost upon man. From time immemorial hunters have clad themselves in green, and from time immemorial, deception of this kind has been practised in the art of war. This old artifice of deceiving an enemy still lives. Indeed, it is more than ever necessary because the aero-

GERMAN TRACTION ENGINES MASQUERADING AS TREES SO AS TO AVOID DETECTION plane and the airship see so much. The modern telescope, too, brings the distant enemy so near that his movements and his ultimate object must inevitably be detected unless he hides himself in some way.

In the Boer war the first systematic attempt at concealment was made in modern warfare. It was then that khaki first came into general use. Since that time there has been a general adoption of olive or drab for uniforms. The gaudy trappings, the shining epaulets, the bright-colored trousers and coats that we associate with the soldier have disappeared, at least in battle. Red cloth and gold trimmings are seen only in parades and in comic operas. In the present war, for example, the Germans and Austrians are taking particular pains not only to dress themselves in uniforms of neutral tints, but even to conceal buttons and the metal decorations of helmets. The French army is the only one that still adheres to the old traditions. Some of its dragoon regiments still wear the old French breastplate and plumed helmet. Red trousers, too, have not yet been abolished. Still, the new uniforms designed about two years ago are far less conspicuous than the trappings of old.

Just as the ermine changes his coat from brown to white with the approach of winter, so the infantry regiments of Germany and Austria change their uniforms. Some of the Austrian regiments, for example, are expected to perfect themselves in tactics which will prove particularly useful in mountainous country. Accordingly, the men are trained to use skis. More to the point, however, they are clad in white, so that they are absolutely indistinguishable from the snow beneath their feet.

This adaptation of the soldier to his surroundings extends not only to uniforms, but to all kinds of military equipment. During the Russian-Japanese war we found perhaps the first deliberate use of mimicry. The Japanese concealed their army transport wagons from distant telescopes by means of boughs, cunningly arranged, so that a long line of leafy wagons looked for all the world like a row of distant trees. In the present war this artifice is still more necessary because of the ubiquitous aeroplane. One of the accompanying illustrations shows how the Germans disguise their traction engines with trees. Seen from above, such a foliage-concealed train must surely deceive even the most practised eye. The engines and the loads which they haul move so slowly that they must be taken for part of a surrounding forest or wood. Even the most skillful aeroplane scout finds it very difficult to distinguish cavalry from horse artillery. What must be his predicament when he is sent aloft to discover the movements of heavy guns hauled by traction engines ingeniously concealed with a mass of foliage?

A BRITISH GUN DISGUISED AS A BUSH SO AS TO ESCAPE THE OBSERVATION OF GERMAN AEROPLANES

A SEARCHLIGHT DISGUISED AS A CLUMP OF BUSHES AND ALMOST IMPOSSIBLE TO LOCATE

The necessity of tricking the air scout has been recognized for several years, so much so that in the German army, for example, it has been the practice during the maneuvers of recent years to exercise troops in the art of deceiving airmen. This is more easily done than may be supposed. It seems not very difficult to mislead a pilot by ingenious groupings of troops as well as by actual concealment in bushes and woods. Two years ago an airship fell into the hands of its imaginary enemies, during the German maneuvers, simply because it had been fooled by this ruse.

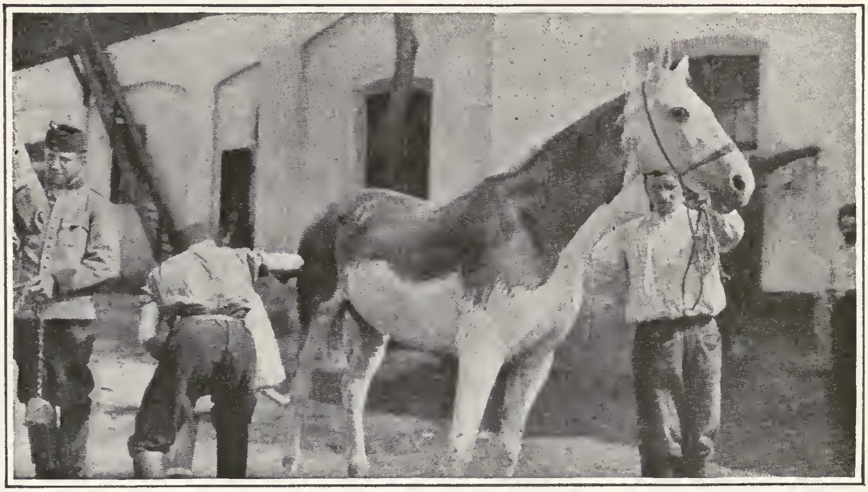
The agents of the warring European powers intrusted with the purchase of horses have instructions to reject white and other conspicuously colored animals. But since the number of horses whose coats are not too glaring is necessarily limited, they cannot be too particular. The Germans have hit upon the idea of dyeing the coats of white cavalry horses, so that they may meet the military requirements that Nature had failed to observe.

The use of smokeless powder has simplified the art of deception. A battlefield enshrouded in smoke, such as the painters of historic canvases love to depict, is an anachronism. Were it not so, any attempt at concealment would be almost ridiculous. As it is, artillery is screened by trees, with such success that it is often hard to locate it. Even the momentary flash of the gun is not always visible if the screening is thick enough.

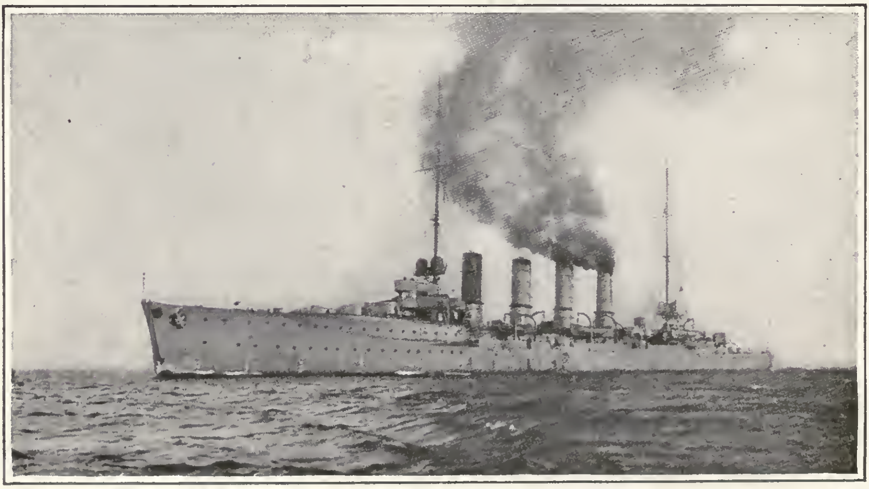
At sea, too, we find the same devices employed. In thé old days of the sailing ship it was a common practice for East Indiamen to paint dummy portholes on the sides of their vessels to frighten off Malay pirates as well as to intimidate the buccaneers of other nationalities. Thus, a merchant ship masqueraded as a man-o'-war. Smugglers have converted brigs into brigantines and barks into barkentines. In the present war these traditions of the sea have been not only employed to meet the requirements of steamers, but employed on a more elaborate scale. The German cruiser "Emden," for example, had three smokestacks. Because of them she was easily identified. To make recognition more difficult—necessary because of her commerce-destroying activities—her captain gave her a fourth dummy smokestack mounted immediately behind the foremast. Thus disguised, she must have fooled some of the ships which she captured and sank.

AN AUSTRIAN DETACHMENT OF INFANTRY MOUNTED ON SKIS AND CLAD IN WHITE, SO THAT THEY WILL BLEND WITH THE SNOW

The "Koenigsberg" was another German commerce destroyer that employed the art of mimicry. A number of fast cruisers were sent by the British Admiralty to East African waters to make a thorough search for her. She was discovered by H. M. S. "Chatham," hiding in shoal water, about six miles up the Rufigi River opposite Mafia Island (German East Africa). The "Chatham" could not reach the "Koenigsberg" because of her great draft. The "Koenigsberg" landed part of her crew and entrenched them on the banks of the river. To prevent the escape of the German ship, the "Chatham" blocked the entrance to the channel by sinking colliers. A correspondent of the *Illustrated London News*, a naval man who took part in the operations against the "Koenigsberg," writes to that paper as follows: "We had a scrap a week ago. We located the 'Koenigsberg.' She was stowed away in a creek in a very secure position. She was 14,700 yards off, or that was the range we had in our guns when we opened fire, and could fire at the masts as a mark. We could not get up the channel as it was too shallow for us, but as soon as we dropped a few around her, she cleared three miles farther up the creek out of sight. At spring tides we got up and had a job to make her out from our masthead, as she had disguised her masts by lashing palm leaves on them."



UHLANS DYEING A WHITE HORSE, SO THAT HE MAY BLEND BETTER WITH THE LANDSCAPE AND MEET THE MILITARY REQUIREMENTS THAT NATURE FAILS TO OBSERVE



THE "EMDEN" HAD THREE SMOKESTACKS. HER CAPTAIN ADDED A DUMMY FOURTH SMOKESTACK IMMEDIATELY BEHIND THE FOREMAST SO AS TO DECEIVE HIS PURSUERS AS WELL AS THE CAPTAINS OF THE SHIPS THAT HE WAS CHASING

Apparently the "Koenigsberg" must have looked like a small tropical island.

Chapter VII.

BLOWING UP BARBED WIRE ENTANGLEMENTS

The Poles Bearing Explosives Used by the French, Russian and English Armies

A DEEP network of barbed wire is one of the most formidable obstacles with which a military position can be surrounded. Before the men behind it can be attacked in a bayonet charge it must be removed. Artillery fire is only partially effective. The most obvious way of forcing a passage through a barbed wire entanglement is to cut it. In most armies a pair of nippers is considered almost as necessary a part of an infantryman's equipment as a rifle. Two rows of gloved men, fitted with nippers, can make a passage seven feet wide in ninety-five seconds —this during maneuvers. What the time would be in actual battle under fire it is hard to state. Would it be less when machine guns are pouring in several hundred shots a minute? Or will the tense excitement of the moment and the sense of danger slow up the wire cutters? One can only guess. Psychologically it is more reasonable to expect slow rather than fast work during an engagement. There is bound to be much fumbling.

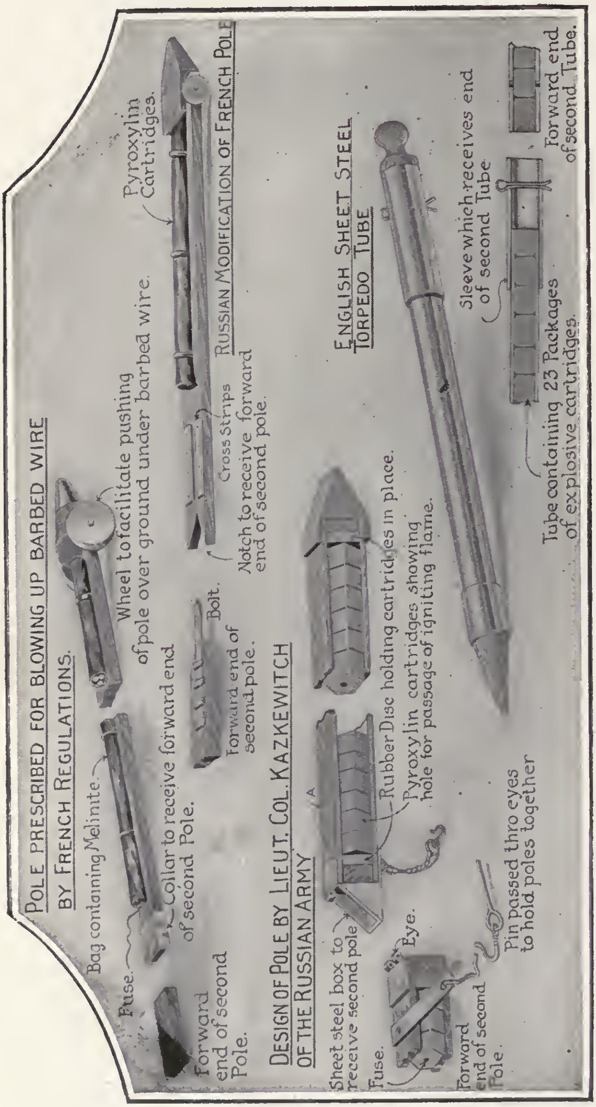
BLOWING A PASSAGE THROUGH A BARBED WIRE ENTANGLEMENT

But the nippers have seemed too slow even during maneuvers. Experiments have been made in removing whole sections of wire at once by means of a rake to which a wire rope is fastened. This is thrown over an obstacle, and thirty men pull upon the rope. Thus a section eleven and one half feet wide and

POLES, TO WHICH PACKAGES OR CARTRIDGES CONTAINING POWERFUL EXPLOSIVES ARE ATTACHED, ARE PUSHED THROUGH THE BARBED WIRE ENTANGLEMENT. A TIME FUSE IS LIT, AND THEN THE MEN RETIRE FOR THE BLAST sixteen and one half feet deep is torn out. In order to reduce the time required to pass through a barbed trap (the glint of the wire is usually concealed by a bank of earth) some military engineers have thought that it is a waste of precious minutes to cut or tear it down, and that it is more rational to surmount the obstacle in some way. Structures of boards, ladders, and bags should be thrown over the wire, according to their ideas, and upon the platform thus made the men can press forward. Boards eight feet long, nine

SURMOUNTING BARBED WIRE WITH BAGS

RUSHING THROUGH A BREACH MADE IN A BARBED WIRE ENTANGLEMENT BY A BLAST inches wide, and three quarters of an inch thick are fastened together by means of three cross pieces, leaving a clear space of three inches between the boards. The weight of the double board is thirty-two pounds, and sixteen of them are employed, each carried



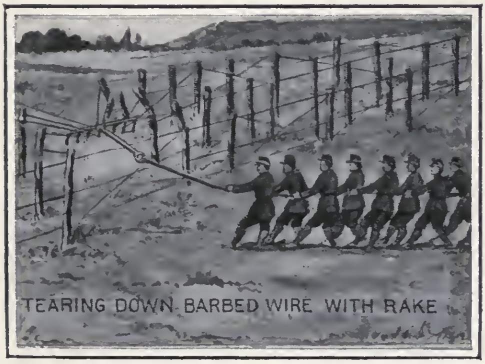
by a single man. To place the sixteen double boards on the wire net requires about one hundred and forty seconds, as actual tests have shown, and it takes seventeen men sixty seconds to pass over the boards. As a time-saving expedient, therefore, the method is hardly a success over that of wire-cutting.

Nor are ladders much better. In some experiments, conducted in England, ten ladders with nine rungs each were used. Each ladder, twelve feet long and twenty-two inches wide, weighed thirty-two pounds and was carried by a single man. The ladders were laid down in one hundred and forty-five seconds, a speed that is not practicable.

That this idea of surmounting an obstacle rather than cutting a way through it is not practicable, is better shown by the experiments which have been made with bags of cloth and wire. Twelve bags, each eight feet long and four and one half feet wide (measured empty) and weighing forty pounds when filled with straw, were placed upon a net in ninety-five seconds, and seventeen men passed over them in forty-five seconds. When the bags are made of wire poorer results are obtained. Such bags are composed of two pieces of wire meshing, eight feet long and four and one half feet wide, laid on top of each other and laced together at the sides with wire. A quantity of straw three inches thick is pushed into the wire bag, which then weighs only twenty pounds. It takes ninety seconds to lay sixteen of these bags on a barbed wire entanglement, and it takes seventeen men sixty-five seconds to pass over them.

So important is this problem of coping with barbed wire that military engineers in Europe have given to it an immense amount of time and thought. Just before the war it was decided that the quickest way of disposing of barbed wire was to blow it up, and to achieve that end a system was devised by the French, which has been adopted in modified form by some of the great European powers.

The French instructions for the removal of barbed wire obstacles definitely call for the use of explosives. For this purpose long rods of melinite are fastened in bundles of three to a pole sixteen and one half feet long, three inches wide, and one and three quarter inches thick. At the end of the pole is a collar which projects forward eight inches and into which the end of a second pole is fitted, if the extent of the explosion is to be more than the length of a single pole. Each pole has a wooden head of almost conical form, with a steel cap and two little wooden wheels five inches in diameter. The pole is pushed straight into the maze of barbed wire or along the ground beneath it. Thanks to its form and to the little wheels with which the head is provided, it glides in easily enough. If necessary, another pole is fitted into the collar of that already in the network of wire. The charge is ignited by means of a fuse connected with the last bundle of melinite in the pole. Each pole supports ninety-nine bundles or packages of explosive, equivalent to about six pounds of melinite per meter (3.28 feet), and is carried by two men. A single pole will blow open a passage about thirteen feet wide.



TEARING DOWN BARBED WIRE WITH RAKE

Very much the same system is used by the Russian army. The explosive is carried on poles seven to ten feet long, which are thrown upon the obstacle. The success obtained depends largely on the manner in which the poles are cast, particularly if the netting of barbed wire is very broad. The last pole may be thrust into the netting, but this procedure is uncertain, as the tip of the pole must not strike the ground. The width of the passage effected by the Russian method is not more than four feet. In actual practice it has been found that parts of the obstacle are not destroyed.

To overcome many difficulties, Lieut.-Col. Kazkewitsch of the Russian army has designed still another type of pole. He abandons the two little wheels and in their stead fastens a rope to the end of the foremost pole. If a stone or a hole is encountered in pushing the pole forward, it can be lifted over the obstacle by means of this rope. The illustration explains the principle clearly. Another rope at the rear end of the last pole controls the lateral movement of the pole. Each pole consists of two wooden strips, *A* and *B*, held together by two perforated pieces of wood. The pyroxylin cartridges are held between these two strips *A* and *B* in such a manner that a long hole or conduit is formed through the entire charge. This hole serves the purpose of enabling the fuse to ignite in the whole charge. The cartridges are held in place by rubber disks, as shown. Each of these poles is four inches wide, five and one half inches deep, and about ten feet long. Two poles are joined in the manner shown in the illustration, by means of a sheet steel box, to which a ring is fastened. By means of a pin the ring of one pole box can be secured to the double ring of another pole box.

This design has the merit of holding the charge in a very compact form, also the merit of flexibility when stones are to be avoided. But the projecting rings are likely to catch in wires and offset these advantages. All things considered, the French pole is much simpler.

MIRED TO THE AXLES IN A WHEATFIELD. GERMAN AND AUSTRIAN HEAVY SIEGE ARTILLERY GETS INTO DIFFICULTIES WHEN IT LEAVES THE MACADAM HIGHWAY FOR PLOUGHED FIELDS

THIS SEEMS TO PROVE THAT "THERE IS NOTHING LEFT BUT THE MOBILE FIELD ARMY"

Chapter VIII.

THE TURRET FORT

A Description of the Famous Gruson Armored Turret Used in European Fortifications

BY MAJOR A. G. PIORKOWSKI

AFTER their first swift advance into Belgium and the withdrawal of the Belgian government from Brussels, the Germans set about the business of besieging Antwerp, not only because it had acquired new importance as the capital of Belgium, but because of its strategic value as an important point. The turning of the left wing of the Allies southward, moreover, facilitated the investment of the city. Although the Germans have been diverted from a formal siege, Antwerp claims its share of attention, chiefly because of the character of its fortifications.

Antwerp has always been a fortress and its history is full of fighting and sieges. But now its fortifications count among the most modern and are considered an example of the present state of the military engineer's art and science. Their designer and builder, Gen. A. H. Brialmont, the Belgian engineer and writer on fortifications, has made himself famous not only by his work for the strongholds of Antwerp, but by his planning and building the defenses of Bucharest, the capital of Rumania, and of Liège and Namur. His close connection and friendship with Col. Max Schumann of the Gruson Works of Magdeburg in Germany enabled him to introduce iron and steel batteries and turrets into his fortifications, and these modern constructions probably will now have their first test in real warfare. I may say right here that modern ordnance and gunnery have made great progress in the last thirty years, since Antwerp's ramparts and forts were built, as they are now, so that it is quite doubtful whether they would prove formidable and make the siege a long one. The range and power of penetration and accuracy of modern ordnance is far superior to what it was when the tests at Bucharest, in 1883, and at Spezia, Italy, in 1886, spread the fame of the so-called Gruson turrets, which form the citadels of the Antwerp forts, and which were then adopted by the military engineers of Germany, Austria, Italy, Belgium, Rumania, Switzerland, and Holland.

Hermann Gruson was an engineer of great talent, born in Magdeburg, and whose works, now owned by the Krupp Company, are near that city. He invented what is often called the Gruson metal, a special excellent low carbon cast iron, chilled by being cast in partly iron molds, thereby attaining an extraordinary hardness of surface, without apparently weakening the tenacity.

He first used this metal for parts of machinery that required such hardness, also for railway switches and crossings and other parts which require great resistance against wearing off by friction. His next step was to use his metal for armor-piercing projectiles which were very efficient for penetrating into and perforating armor plates, which at that time were rolled of soft iron or low steel. His successes in this directon carried him to the construction of chilled cast iron armor batteries and rotating turrets of such metal. The larger size and higher weight of the castings for armor brought him new problems to solve, and quite a number of inventions and new constructions were the result. Special furnaces, large troughs in which the molten metal was poured to be collected in the necessary quantity, where it was stirred and allowed to cool off to the proper temperature before it was run into the mold so as to solidify quickly after casting; new cranes to move the enormous molds, new tools to work the hard surfaces; in fact, nearly every part of the manufacture was a novelty and made it a monopoly for Gruson.

The bulk of the Gruson armor and the hardness of its outer surface, however, are not the only great qualities which make it a powerful shield against the heavy armor-piercing projectiles. It is its characteristic dome-like shape, its curved outline, which prevents the shell from striking under an angle of impact greater than 45 degrees. Instead of striking by its point, the shell strikes by its side, is shattered, and the pieces glance off and leave the turret practically uninjured.

In the Spezia trials the test plate weighed 120 tons, the cast iron part of the mold in which it was cast weighed 180 tons; a special combination of four railway platform cars was built to carry the big plate from Magdeburg to Spezia. It was fired upon from an Armstrong 100-ton gun. To make the fire more efficient the plate was tipped up on an angle so as to increase the impact angle. It was placed in a tunnel to receive the pieces of the shattered shell. The first round left the surface intact, simply smoothing and polishing it at the striking point. As the firing was continued, the hits lying close together, cracks appeared, radiating from the striking points and penetrating into the interior normal to the surface. As these cracks met and formed a network of fissures, pieces separated from the main body, but being more or less of the shape of vault stones, remained in place and helped even after a number of heavy rounds to what remained of the resistance of the plate. In this manner the test-plate surpassed by its resistance anything that was expected from it by the number of distinguished engineers who witnessed the test. The plates of this kind in contrast to rolled iron or steel plates are made with a thickness varying according to the inclination of the surface toward the horizontal. The Spezia test-plate and the plates for the two great Italian turrets at Spezia and Tarento were 60 inches thick in the breast and tapered off to 24 inches where they join the top plates of the cupola. We need hardly say that turrets consisting of fifteen such segments and two semi-circular

A LIÈGE CUPOLA THROWN FROM ITS MOUNTING BY GERMAN SIEGE GUNS top plates cannot be placed on a ship. The Gruson turrets are all in land defenses, the bigger ones in coast defenses. The plates need no backing and no bolts to fasten them and hold them together; they are only dovetailed by steel keys at the joints. The circle of plates rests on a framework made of plates and angles of rolled iron or steel riveted, and this again rests on a circle of rollers, rotating on a strong circular rail. From the breast of the cupola down this substructure with the gun-carriages rotating machinery, and all the rest is protected by another, fixed, circle of chilled iron plates from whose upper surface runs the glacis of stone and concrete. This so-called circular or ring gallery allows the communication between turret and the masonry cellars for the service—the engines, pumps, magazines, and all other necessities.

The gun or guns rest and move in minimum embrasure gun-carriages. These represent another important invention of Gruson's. As the gun's lateral direction is given by the rotation of the turret itself, the gun-carriages are only designed to control the elevation of the guns. But the horizontal axis of this movement is not the line through the center of the trunnions as in most guns. If it were so the guns swinging up and down would leave open spaces above and below the guns in the portholes. To prevent this the horizontal axis is laid in the middle of the embrasures, which close as near as possible round the outer surface of the guns and do not allow any big splinters of the enemy's shell to penetrate into the interior of the turret. For this purpose the trunnions are in movable bearings, which slide up and down in guidings bent round that axis, which movement is made by means of hydraulic rams and controlled by the aiming gunners.

EFFECT OF GERMAN HEAVY SIEGE GUN FIRE ON LIÈGE ARMORED CUPOLAS

The gun-carriages and through them the guns themselves are supported by heavy girders connected with the framework substructure, and so of course share the rotation of the turret. The rollers for the rotation are of Gruson metal, and so are the broad circular rails for these rollers, and are laid with great accuracy on strong. solid stone foundations. Great accuracy and solidity is a necessity in order to rotate the great weight of the turret, substructure, gun-carriages and guns on a perfectly horizontal basis with comparative facility.

In the case of each of the two Italian 16-

THE GRUSON ARMORED TURRET AND ITS INTERNAL CONSTRUCTION. TURRETS OF THIS TYPE ARE TO BE FOUND IN MANY EUROPEAN FORTIFICATIONS inch turrets, the biggest ever built, the weight amounts to a total of nearly 2,400 tons. Each contains two 16-inch 35-caliber Krupp guns. A fifth gun of this size was exhibited in 1893 in the World's Fair at Chicago, and then was known as the Big Gun. In 1902, at the Pan-American Exhibition, in Buffalo, there was a full-size model of a 12-inch turret with one half open, so that the arrangement and cross-section of the turret and its plates could be seen from the outside. It was then intended to put up such turrets in the coast defenses of America.

The citadels of the Antwerp forts have 6-inch turrets, while smaller calibers for the defense of the moats, etc., are placed and protected in other iron and steel constructions.

Our illustration shows a turret and all its essential parts, the front wall taken away: the rotating cupola, in section, the disposition of the steel dowels between the chilled iron sectors of the cupola, and the location of the top plates. It further shows the two guns in the embrasures, and their carriages, the gunner at the sighting apparatus, the riveted substructure on its rollers and circular rail; the cross-section of the protective outer cast iron ring, the stone and cement glacis, extending from this ring to the surrounding plateau and concealing the interior, the masonry and galleries, so that only the cupola and guns remain visible.

The two smaller illustrations are reproductions of the first photos received, showing the frightful effect of the fire of the big modern German howitzers on the fortifications of Liège. The iron and steel forts were completely demolished after a few rounds.

ALL THAT IS SEEN OF THE GRUSON TURRET BY THE ENEMY

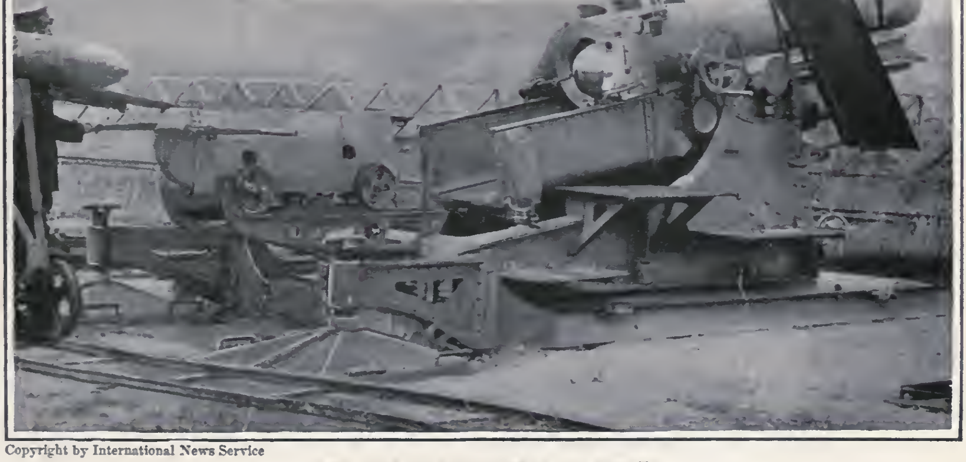
28-CENTIMETER GUN IN ACTION. A POWERFUL WEAPON OF DESTRUCTION WHICH HAS DONE MUCH OF THE HEAVY WORK

Chapter IX.

SIEGE ARTILLERY

Wonderful Work done by Large Mobile Guns

DIRECT fire is used mainly for naval guns on board ship and for rifles in coast fortifications; but it is used only to a limited extent in artillery work on land. Except in those cases where the enemy, through their spy system, is thoroughly acquainted beforehand with the terrain, and are able to place their siege guns in locations, the exact distances of which from the forts to be attacked are accurately known, it is probable that the range is found by firing trial or "range shots" and correcting the errors by observation from some artificial or natural elevation, or from aeroplanes. In the defense of harbors by permanent coast fortifications, the distance to the enemy is determined by triangulation from concealed observation points, located at the ends of a lengthy base line, where instrumental observations determine the angles between the



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LOADING THE 11-INCH SIEGE HOWITZER

base line and the lines to the ship; or else the ship is located by depression finders, such as the Lewis depression finder used in our own coast fortifications, which automatically record the range when the telescope is focused upon the ship.

Direct-fire guns are used mainly for attacking the armored portions of ships or the parapets of fortifications, or bodies of troops in the field—for any form of attack, in fact, in which the gunner can sight directly on the target.

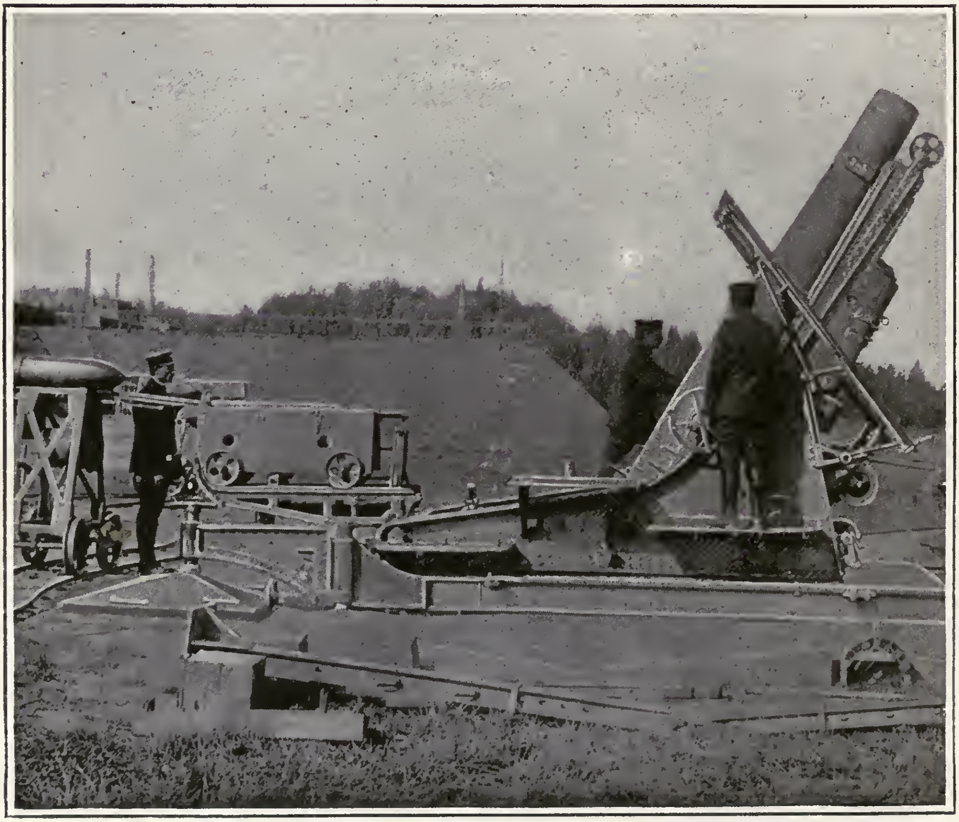
tion given by observers in positions on eminences or in aeroplanes.

"Direct fire" is used with high-velocity guns elevated to not more than 15 degrees.

"Curved fire" is used with howitzers of low velocity, elevated to not less than 15 degrees.

"High-angle fire" is used with mortars of low velocity, elevated to not less than 45 degrees.

At angles of elevation above 65 degrees the time of flight becomes so great as to be



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THE FRENCH (SCHNEIDER) SEMI-MOBILE 11-INCH SIEGE HOWITZER

High angle fire, on the contrary, is directed against the thinner horizontal armor employed on the roofs of turrets, or on the one or more protective decks of a warship. In field operations it is used against the roofs of armored cupolas and the vertical protection of whatever kind, which may be protecting the garrison. In field operations in the open, the 3-inch field pieces use direct fire where it is possible; but because of the concealment, natural and artificial, of the troops in modern fighting, a large part of this attack must be aimed through informa-

prohibitive, and this marks the limit for the highest angle of mortar fire. There are other considerations involved in the strength of carriage and irregularities of flight above this angle, but these are subordinate to the unavoidable objection of excessive time of flight.

So far as its caliber is concerned, the 11-inch howitzer is not a new piece of ordnance: for eleven inches is one of the standard calibers for the permanent coast defense of European nations. We employ an even larger caliber in the 12-inch mortars, with which our coast forts are armed. But up to 1904 the five-ton 7-inch field howitzer was considered the largest gun that could be moved readily enough for use in siege works.

The Japanese started their bombardment of Port Arthur with this type; but found progress so slow that they attempted the unprecedented feat of bringing up several sea coast 11.2-inch (28 centimeters) howitzers. This was accomplished after much time and labor, and in the fourth month of the siege these heavy guns started their fire. The Russian forts were built to withstand only the bombardment of the lighter shell, and were gradually destroyed by the powerful explosions of the shells from these guns. After the bloody battle and capture of 203-Meter Hill the Japanese used this as a lookout point to check up on their fire on the Russian battleships, and then, by the fire of these big mortars, forced the sinking of the warships in the harbor.

The Germans profited by this example and set to work to design an 11-inch gun for transportation over metaled roads. While this last meant a large increase in mobility over the previous rail transportation, it also required a reduction both in total load and in unit load on the wheels. By using moderate charges of slow-burning powder (the so-called smokeless), which makes it possible to secure good ballistic results with low pressures in the gun, the strain on the gun was reduced so that less metal was required. The development of modern gun steels of increased tensile strength permitted a further reduction in the thickness of the gun cylinder. By all of these modifications a gun was developed that weighed considerably less than the one used at Port Arthur.

In order to divide the weight for transportation, the gun is taken out of the frame and is carried on a specially constructed truck, while the carriage is provided with wheels and is transported as a separate piece. The wheel pressure on the roadway is brought within safe limits by providing a broad tire of linked plates similar in principal to the caterpillar traction engines used in soft ground or sandy districts.

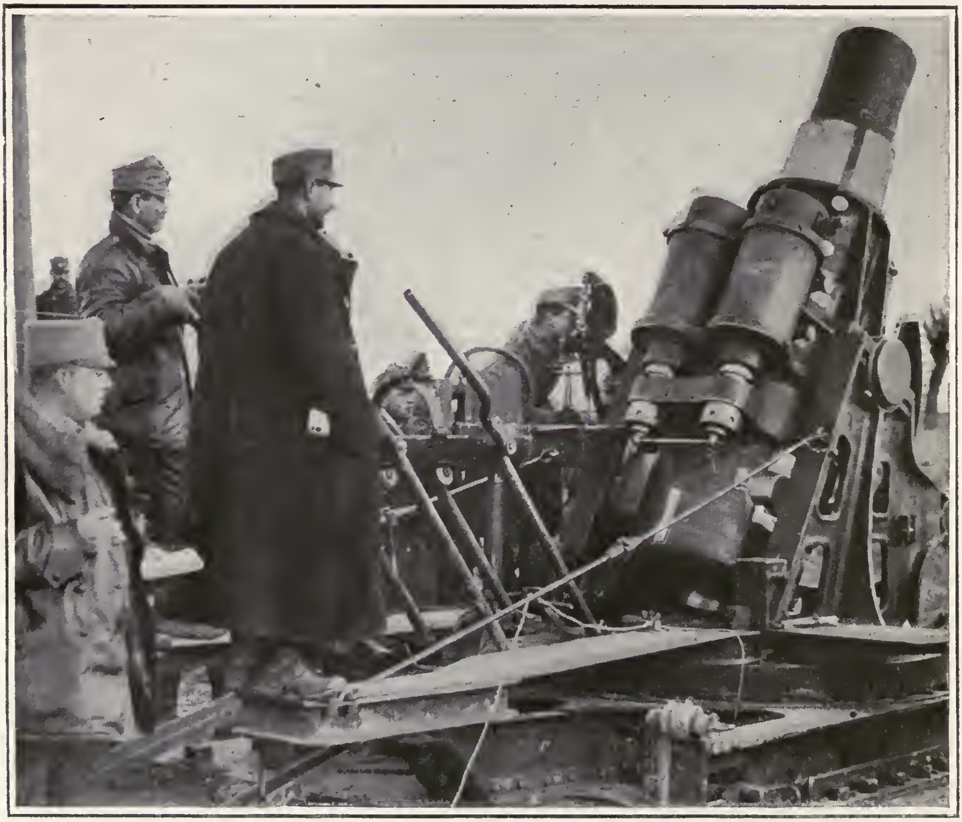
HIGH-EXPLOSIVE SHELLS BURSTING DEEP WITHIN THE EMPLACEMENT HAVE COMPLETELY INVERTED THIS GUN AND ITS TURRET

When firing a 484-pound shell, with a powder charge of 22 pounds, this howitzer has a range of 10,000 yards, or six miles. When firing its heaviest projectile, 760 pounds, with 16.5 pounds of powder, the range is 7,000 yards, or four miles.

The effectiveness of the fire of these heavy guns is due to the large charge of high explosive contained in their shells, about one sixth of the total weight. Fortifications are, for reasons of economy, proportioned to withstand the heaviest ordnance that is expected to come against them. When, as in this case, an unusually powerful bombardment is brought to bear, the roofs and walls of the bomb-proofs and casements are blown in, and the guns of the defenders are put out of action. It was by such tactics that the Germans scored their successes against the Antwerp forts.

Austria's Famous "Skoda" Mortars

SKODA mortars having a caliber of 30.5 centimeters (12 inches) were used in the reduction of the fortifications of Liège, Namur, Maubeuge, Givet, Antwerp, and Przemysl. The accuracy of fire of these mortars is such that a cupola at Antwerp, invisible to the gunners and aimed at by taking its position from a map, was pierced by a shell from a Skoda mortar at a distance of 12 kilometers (7.5 miles). This cupola, with part of the shell imbedded in it, has been presented by the German Kaiser to the Austrian Army Museum in Vienna.



Photograph by Underwood & Underwood

THE FAMOUS AUSTRIAN 30.5 SKODA HOWITZER, WHICH HAS DONE WONDERFUL WORK

It was assumed, at first, that the reduction of the Belgian forts was accomplished entirely by the 42-centimeters (16.5-inch) Krupp mortars. Such mortars are in existence and they appear to have been used at Liège and Antwerp, although no one has seen them, and we hear of only one such gun, the "Big Bertha." The circumstance that these German mortars are imbedded in concrete, from which they can be released only by blasting, diminishes their value for offense. Guns of equally great caliber had already been constructed by Skoda and in England, for ships and coast fortifications. The novelty in these guns consists in their mobility and in the frightful effect of their shells, which do not burst until after they have shattered all hard obstacles and reached their true goal.

The Krupp mortar is said to require a crew of two hundred men and six hours' work for its emplacement. The Skoda mortar is in little danger of being captured, as the time consumed by the enemy's advance over its long range (say forty minutes) suffices for its dismemberment and removal.

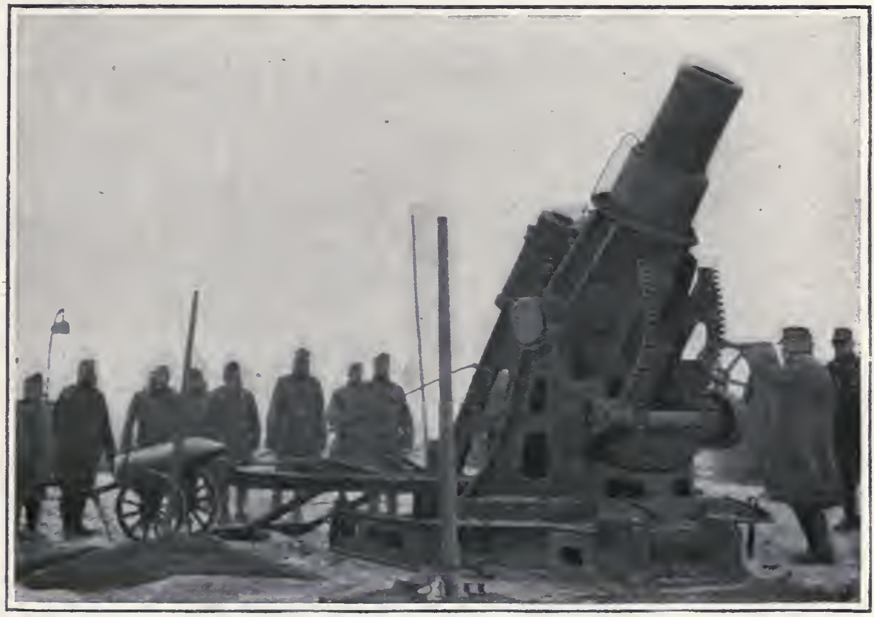
If we compare the long Russian siege of Przemysl, which indeed succumbed to lack of food, with the rapid destruction of the Belgian and French fortifications, we can appreciate the importance and value of the Skoda mortars in the European war. What all the Japanese, French, and Russian guns could not do at Przemysl, was done in Belgium and France by a few shots from the Skoda mortars, and Antwerp was the second strongest fortified place in the world.

The production of a gun so heavy, and yet so remarkably accurate and mobile, was no easy task. The idea, conceived in 1907, was gradually developed until, on July 22nd, 1910, the first of the new mortars was fired with complete success on the proving ground of the Skoda Works near Pilsen.

The 12-inch Skoda mortar is a recoiling gun. It fires a shell weighing about 390 kilogrammes (858 pounds) with an initial velocity of 340 meters (1,115 feet) per second. The work of the recoil is absorbed by a liquid brake, and the gun is replaced in the firing position by air pressure. The brake is attached above, the air compressor beneath the gun. The mortar is loaded in the horizontal position. The maximum horizontal range is about 12 kilometers.

The barrel is built up of steel cylinders according to a method of construction that has stood the test of many years of experience. Some of these mortars have been fired four hundred times in the European war. An experimental gun of this construction was

A SKODA MORTAR PREPARED FOR ACTION



DESPITE ITS GREAT SIZE THE SKODA MORTAR CAN BE TRANSPORTED AT THE RATE OF TWELVE AND ONE HALF MILES AN HOUR fired more than six hundred times, without showing appreciable erosion or decrease in accuracy.

The breech block is of a novel horizontal wedge type and is operated from the right side. The shell is filled with a very powerful high explosive and is provided with a delayed-action fuse, so that it penetrates deeply before it explodes. The base of the gun mount is set directly on hard ground, but a portable foundation is interposed when the ground is soft. In the latter case the gun can be swung 60 degrees to right or left of its median position. The range of deviation is smaller when the foundation is not used.

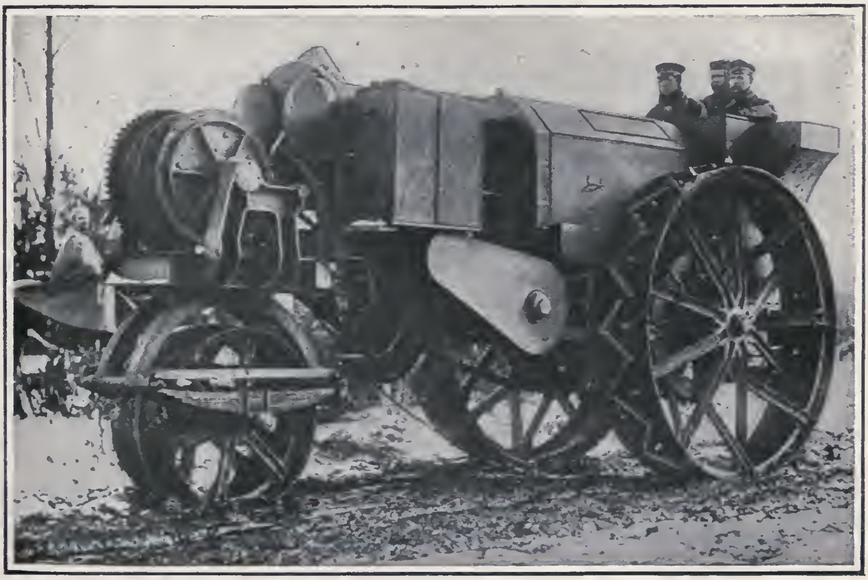
The sighting telescope and the aiming and elevating mechanism are placed at the left side of the mount, from the back of which hangs the loading platform, carrying a loading pan which can be raised by levers. The shell is brought to the gun on a hand car and rolled onto the loading pan. The pan is then raised and the shell is pushed into the breech. The gun is transported by three Skoda-Daimler motorcars of 100 horse-power with four driving wheels—a construction patented by the Archduke Leopold Salvator. The gun is carried on one car, the gun mount on another, and the foundation, which is made in three sections, hinged together, on a third. The highest speed of the train is 20 kilometers (12.5 miles) per hour, which is a very good speed for heavily loaded cars with iron tires. At the lowest speed of about 2.5 kilometers (1.5 miles) per hour grades of 16 per cent can be ascended.

HOISTING THE 858-POUND SHELL INTO POSITION FOR LOADING

The mortar is usually mounted in a pit, into which the foundation is lowered by winches on its car. The car that carries the mount is then driven onto the foundation, and the mount is lowered in the same way and bolted securely to the foundation. Then the third car is brought up and the gun is drawn into its cradle and connected with the liquid brake and the air compressor. The entire operation of mounting the mortar has been performed in 24 minutes and it can always be completed easily in 40 minutes. The rapidity of fire can be pushed to one shot per minute.

THE GUN IS LOADED IN THE HORIZONTAL POSITION

The excellence of material and construction was proved by an accident in practice in a mountainous country, when a car laden with a six-ton mortar plunged into a ravine 16 feet deep and overturned. The axles were bent and the car was damaged in other ways, but



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HUGE GERMAN TRACTOR USED IN POLAND

it was able to proceed to its destination, and the mortar was subsequently mounted ready for firing without any repairs being made.

These heavy mortars can also be used as field-pieces. The explosion of the shell can be timed precisely and it produces an annihilating effect upon troops marching in close formation. In Russian Poland an entire battery of artillery and a battalion of infantry were thus annihilated, the men in the immediate vicinity of the explosion who were not hit by fragments of the shell being killed by the intense air pressure and the suffocating gases produced by the explosion, which, being heavier than air, are hard to disperse.

In Galicia and the Carpathian region a new Skoda howitzer, having a caliber of 42 centimeters (16.5 inches) was employed. This weapon, of course, is far less mobile than the 12-inch mortar.

The shells for all of these murderous weapons are made in Woellersdorf, Austria.

German 42-Centimeter Gun

THERE has been much talk about the German 42-centimeter gun. It is impossible to give a picture of this gun, because, as far as we know, it has never been photographed. There are one hundred and seventy-two pieces to adjust, which have to be transported by twelve railway wagons, of the continental type, and at least twenty-four hours must be required to emplace one of the guns. The foundation must be cement, which must be at least 30 feet deep. The total weight of the mortar is about 50 tons. The weight of the foundation is 35 or 40 tons additional. The actual gun is about 18 feet long and its shell weighs about three-quarters of a ton. The range is about 13 or 14 miles. Under the most favorable circumstances, five or six hours are required to get the gun ready to operate. It is said that it takes 250 men for the gun crew, and that they are provided with special protective shields for the eyes, nose, ears, and mouth.

This is about as much information as seems to be available relative to this gun. Contrary to general opinion, a 42-centimeter gun was not employed for the bombardment of Antwerp. The heaviest gun used was the 305-millimeter gun of the 1914 model. The effect of its fire was simply devastating; the Belgian forts were simply blown to atoms. This also was used against Liège, Namur and Maubeuge, and proved much more serviceable than the "Bogey" '42, round which popular terror has spun such a legend.

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A PILE OF GERMAN 15-CENTIMETER SHELLS AND THE WICKER CASINGS USED IN TRANSPORTING THEM

Chapter X.

MINING AND COUNTERMINING OF FORTIFICATIONS

Capturing a Fortification by Trenches and Tunnels

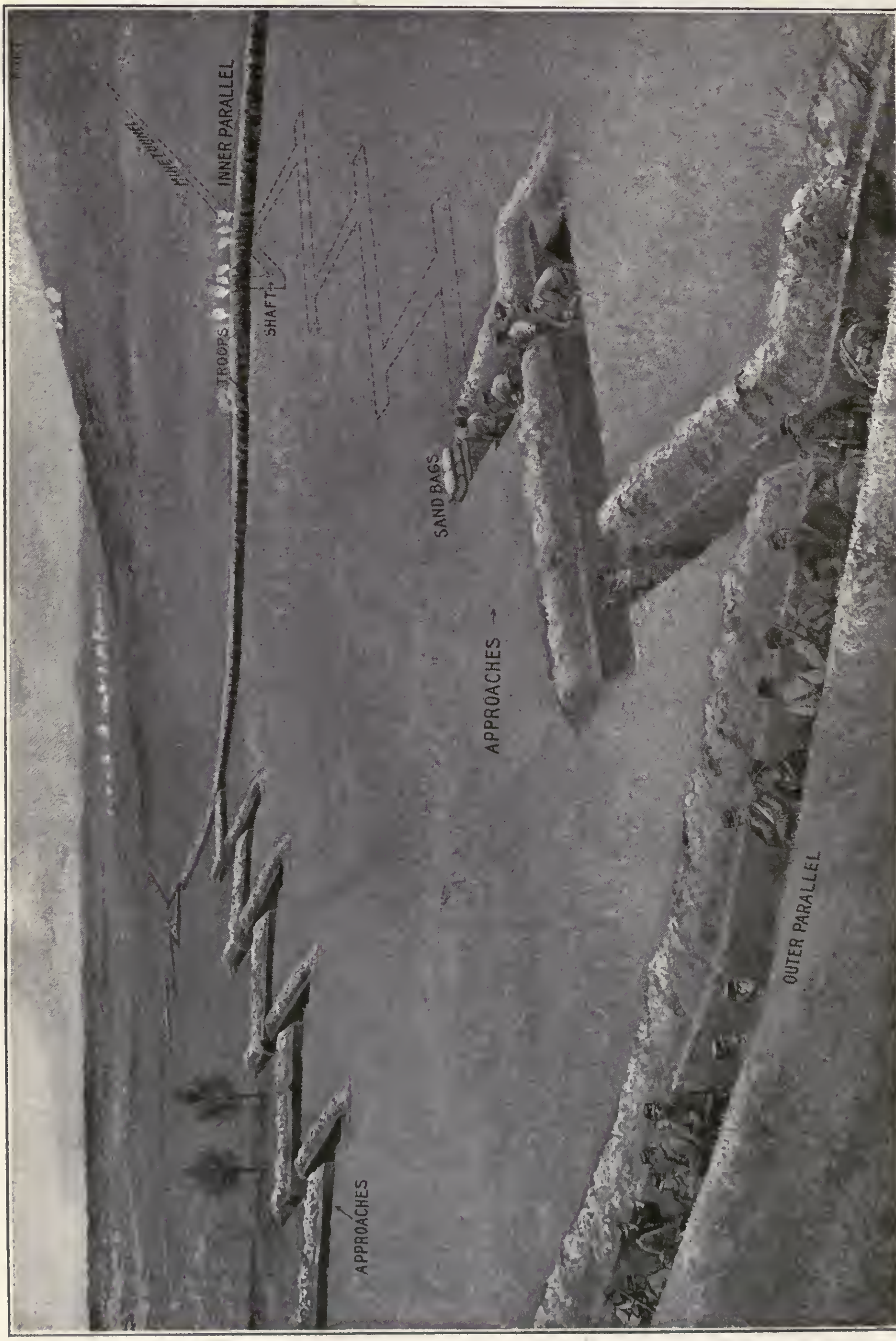
THE Germans and Austrians with their 11-inch and 12-inch howitzers and their 16½-inch siege mortars, have found a new and very speedy way of reducing fortifications—always provided that the troops of the enemy permit them to bring this heavy artillery within range of its objective.

Not all of the nations engaged in the European war, however, were provided with such heavy pieces; and if any one of them attempted the reduction of a first-class fortification, they would have to resort to the time-honored method of attack by open approach trenches and by tunnels, driven below the very walls of the fortification itself.

In reducing a strongly fortified place the first step is to cut off communication with the outside world. A rapidly moving, comparatively small force, followed by reinforcements, is thrown entirely around the position, the force being beyond range of its artillery, or say about three miles from its main line of defense. This is known as the line of investment. It will be held in stronger force at some portions of the line than others; but everywhere it will be sufficient to cut off all exit from or ingress to the fortification. The zone of investment is intrenched, communication by telegraph and telephone is established between the different sections of the investing line, and communication is also established to headquarters.

When the line of investment is complete the attack is pushed forward from one or more positions, the selection of which is determined by the following concomitant conditions: It must afford a good communication with the base; it must offer the best topographical conditions for emplacing the siege batteries, and for working up to the fortification under natural cover of the country; it must offer the most favorable ground for the construction of siege railways; and the selected line of approach must be favorable for digging operations.

When the direction and location of the attack have been decided, sites for the siege batteries are selected at distances of from three thousand to five thousand yards, according to power and range of the siege howitzers available. The attack on the fortress then commences, and the artillery fire is maintained until that of the defense has been silenced or at least partially smothered. The attack then attempts to gain ground toward the fortress; outposts are advanced and an effort is made to control the country in front for a sufficient distance to make it possible to dig the first trench parallel to the line of investment, if it be possible, within about 1,200 yards of the point to be attacked. The position chosen for this trench is reconnoitered, and at night an attack is pushed forward in order to drive the enemy in as far as possible from the position thus selected for this trench, which is known as the first parallel. In the dusk of the evening a party, consisting of an engineer officer, a non-commissioned officer and a private for each fifty yards of the proposed length of parallel, move forward, and they carry with them tracing tapes of white cotton fifty yards in length. The officer carries also a compass to obtain the proper direction, and the line of



CAPTURING A FORTRESS WITH PICK AND SHOVEL. THIS SHOWS HOW THE INVESTING TROOPS, BY USE OF DIAGONAL AND PARALLEL TRENCHES, ARE ABLE TO CONCENTRATE WITHIN STORMING DISTANCE OF THE BESIEGED FORT. FROM THE INNER PARALLEL A TUNNEL IS DRIVEN BELOW THE OUTER WALL AND A CHARGE OF HIGH EXPLOSIVE SERVES TO BREACH THE FORT AND PERMIT THE STORMING PARTY TO MAKE ITS FINAL RUSH the parallel is then "traced" or marked out with the tape.

Usually, if the fire of the defense is vigorous, the outposts commence work on the first parallel, by digging short lengths of it, which are afterward extended to a connection with each other. In the Japanese siege operations at Port Arthur the parallels were about 6 feet in depth and 14 feet in width, or of sufficient width to permit troops to march therein four abreast.

When the first parallel has been completed and occupied two or three lines of zigzag trenches or approaches are dug in the direction of the fortress, until a distance of about six hundred yards from the objective has been reached, and here a second parallel is constructed and occupied. From the second parallel further advance is made by approaches, until a position has been reached within about half the distance between the second parallel and the fortress. Here the third parallel is constructed at a distance from the objective of say about two hundred and fifty to three hundred yards.

The excavation of approach trenches, under fire, is different from the ordinary parallel trench work, in that it proceeds progressively from its outer end, and the men are fairly well protected from the fire while digging. The technical name of these approaches is "saps." The work is done by specially trained men known as "sappers." The head of the trench toward the enemy is known as the "sap head," which is pushed forward by an officer and eight "sappers," who work in two reliefs. The sappers are protected at the end of the trench by a pile of half-filled sandbags, maintained sufficiently high to form a two-foot high parapet. Number one "sapper," kneeling, undercuts the end of the trench and brings down the earth. Then number two takes his place and shovels the loose earth away, which is thrown out on the side of the approach next the enemy to afford protection; or, if the approach is to be covered, the material is carried to the rear on stretchers (as in the case of the Japanese approach to Port Arthur) or by other means, and is deposited out of sight of the enemy. As the "sap head" is advanced, the sandbags are pushed forward by rolling them over by hand, or by the use of a fork, and the undercutting and shoveling are proceeded with until a diagonal trench a hundred feet or so in length has been dug, say in a lefthand direction. Then the approach is driven in a similar way to the right, and so on, until the required distance has been gained.

When the third parallel, within charging distance of the fortification, has been dug and occupied, it may be found that the base of the fortress is too high or difficult for a direct attack with scaling ladders or the other storming equipment. In such a case, it will be decided to make a breach in the wall of the fortress by blowing it up. This operation is achieved by what is known among military men as mining, which consists in driving a horizontal tunnel until it reaches a point below the fortress, placing at the farther end of it a charge of explosive, and blowing a breach through which the attacking troops can enter. These tunnels are known as "galleries," and as the work must be expeditious, they are made as small as possible, the common size being three feet in width by four and one half feet in height. To prevent caving in, they are usually timbered or lined, the lining being prepared beforehand and cut in exact sizes, so that it can be put in place rapidly as the work of excavating advances. When the gallery has been carried to the desired point below the fortress a heavy charge of high explosive is placed at the end of it in a prepared chamber, and everything is ready for the final great attack.

The storming of the fortress will generally be done at night, and it will be preceded by a violent and unceasing bombardment from the siege artillery to the rear, the object of which will be to work all possible damage with high explosive shells, keep down the fire of the defense, and generally shake up its *morale*. Meanwhile the picked troops selected for the first rush will have passed, by way of approaches, to the third parallel, confronting the fortress; and back of them in the other parallel and approaches will be the reserves.

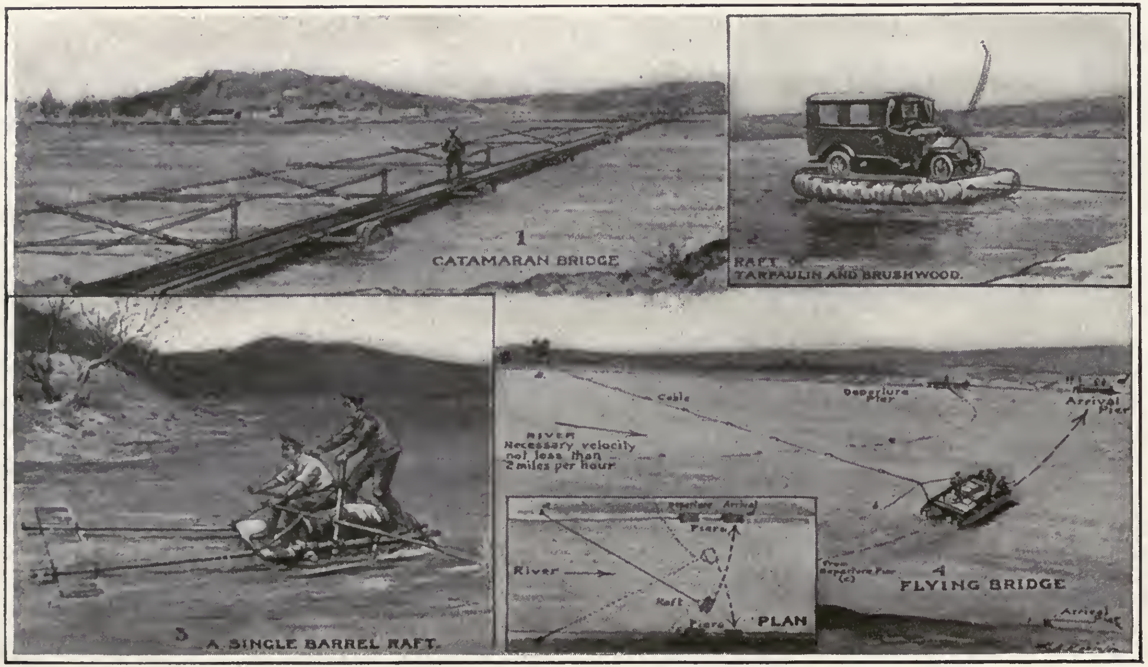
When everything is prepared, the mine is detonated, and through the breach made in the walls or parapets the storming party makes its rush from the third parallel, being strongly supported by the troops in the approaches and parallels to the rear.

In view of the great peril to the defense of the approach by mining, a system of defense known as countermining has been evolved. In countermining a shaft is sunk by the defense within the fortification, and from this a main gallery leads out to a transverse gallery from which a system of small radiating galleries is constructed, covering the terrain

MINING AND COUNTERMINING IN THE ATTACK AND DEFENSE OF A FORTRESS which to military eyes appears to present the most favorable direction for attack. In many permanent fortifications the countermines are dug at the time of the construction of the fortress and form part of its permanent defenses. At other times they are commenced only when the direction of the attack has been approximately located by the defense. Men are sent out into the countermine galleries and they listen for the slightest sound of the working tools of the attack. When the location of the enemy has been determined, explosives are placed in the countermine and the working galleries of the enemy are blown up. It is interesting to note that in the European field operations mining and countermining are reported to have been resorted to by both the Allies and the Germans in the open field entrenchments in France and Belgium.

DETONATION OF A 12-INCH SHELL FILLED WITH HIGH EXPLOSIVE AND BURIED SIX FEET BELOW GROUND

CARTING AWAY THE JUNK LEFT ON A BATTLEFIELD. EVERYTHING IS SAVED AND MADE OVER WHERE POSSIBLE



From the Illustrated War News

VARIOUS METHODS USED BY MILITARY ENGINEERS FOR CROSSING RIVERS BY PONTOON BRIDGES AND RAFTS

Chapter XI.

BUILDING BRIDGES UNDER FIRE

One of the Most Difficult and Spectacular of Army Operations

BY MARTIN WELLS

MORE than once the success or failure of a campaign has depended upon the successful passage of a river, a barrier of flowing water to further advance. Held strongly by an enemy on the far bank, the offensive movement of a greatly superior force has been checked so thoroughly that a strategic victory has resulted for the lesser arms and the strength of an invader rendered impotent.

From these lessons of military history, definite procedure for pontooneers has been evolved. The various parts of material which go to make up a bridge train have been tested and re-tested. Every expedient has been resorted to, to make weight as little as is consistent with strength and adequate service, while an organization has been completed, in every army of the civilized world, with minute attention to detail, to make the pontoon bridge service so efficient that no chance of an upsetting of plans could come about. Every detail has been looked into and provided for.

A STEEL BRIDGE AT LAGNY DESTROYED BY THE FRENCH

In these days of general staffs, it is safe to make the statement that the territory of each country which may become a possible theater of war is thoroughly mapped out and the maps filed away in the steel cases of some war college. Not only is the terrain plotted, but the physical resources of each country are accurately estimated, that an invading army may know where to lessen the amount of supplies of certain kinds to be forwarded by the line of communication service, by knowing what may be secured in the country itself.

From the maps and this data each possible campaign is forecast in minute detail. During the piping days of peace, the staff classes devote hours a day to working out these details, and when they are completed and approved, the plans are filed away, to be unearthed upon the approach of war or altered, to post to date.

In these plans the bridge trains are considered. The maps show where the rivers are. The science of war predicts where a wise enemy will have destroyed his permanent bridges, and the plans of the general staff, ever seeking to make the line of communication and transport columns as light as possible, call for the dispatching of bridge trains to proper points at the proper time.

AUSTRIAN ARMY ENGINEERS AT WORK ON A PONTOON BRIDGE

As used to-day, the pontoon bridge is scarcely a century old, yet it has been used in warfare, in some lesser form, almost since there was war by forces with any pretense of organization. In the early days of Britain, the tousel-headed savages used, as a river-crossing expedient, the skins of animals, inflated, tied, and bound together, to form rough rafts, on which the wild soldiery effected a passage. And at exactly the same time, the legions of Rome used the same method, supplemented by the craft of commerce.

Most of the lessons which are applied to pontooneering to-day come directly from the American civil war. During those horrid days, when the soldiers of a divided nation clawed at one anothers' throats, the science of pontooneering was developed to its highest phase, and the use of bridge trains was so constant that foreign observers gave particular attention to the way in which the problems were worked out in warfare, and the present almost universal system has resulted.

One of the greatest lessons of the service has carried the conviction that a pontoon bridge may not be thrown across a river held by the enemy, in daylight, unless under cover of a fog.

In any case, losses must be sustained, so the lesser evil has been chosen. In modern times, when it is of paramount necessity that a river be crossed by daylight in the face of an enemy, the pontoons are used as bateaux, and detachments are ferried across at the safest points to clear the opposing troops away, while the friendly artillery endeavors to cover the ferriage. When the opposite bank is once held, in spite of the enemy's fire the erection of the bridge may usually proceed.

Bridge trains are divided into two classes, the heavy and the light, sometimes called reserve and advance guard trains. The boats and material of the advance train are much lighter than those of the reserve, for the boats are a mere knockdown framework over which canvas is stretched to form the buoyant float. Mobility is the watchword of the advance guard trains, for they must be able to rush ahead with independent cavalry, sometimes three days' march in advance of the main body.

The very lightness of construction of these trains has its drawbacks, for the frail canvas covering has not the strength to stand the battering of an ice-choked river or the constant strain of a continuous line of transportation. In addition, a canvas boat is much more easily put out of commission by a hostile shot than is one of the heavier wooden boats of the reserve train. There are four methods of constructing a pontoon bridge: by successive pontoons, by parts, by rafts, and by conversion. In the first case, each pontoon is put in place from one or both banks, and the span of the roadway completed in turn. By parts, sections of the bridge are built along the bank, floated to position, and the smooth, unbroken roadway fitted in, with all the boats of the bridge an equal distance apart. By rafts, the pontoon sections, consisting of five or six pontoons, with roadway, are constructed at the bank, floated to position, and the end boats of each raft are lashed to the end boats of the adjoining rafts, with the roadway completed by false balks and roadway over the joint. The method by conversion is the hardest of all, for with it the pontooneers must be thoroughly experienced men and know their business. Even the carelessness of one man, in casting an anchor at the wrong place, may upset the entire scheme and nullify the operation. In conversion, the entire bridge is built along one bank, an end secured, and the entire bridge is then permitted to swing out on the current until, pivoting at the near bank, the bridge is swung into position across the river, when the abutment bays of the roadway are laid.

The method of constructing by successive pontoons is the one usually employed when the stream is not too broad. Assuming that a force of an enemy holds an opposite bank and that it is necessary to dislodge him and cross, the method of procedure is about as follows: Under the protection of rifle and artillery fire, the pontoon wagons are brought as close to the bank as shelter permits, when the pontooneers, aided by details of infantry, lift the boats from their wagons and transport them by hand, at a run, to the edge of the water, then launch them.

Accompanying them, the infantry details which are to make the crossing in the attempt to dislodge the enemy, come up on the run and file into the boats, where the pontooneers already man the oars. The infantrymen take seats alternately, right and left, so as not to disturb the equilibrium of the boat, and as soon as it has its quota of men the boat pushes off for the opposite bank, while the friendly forces redouble their efforts to keep down the enemy's fire. As under no conditions must the stability of the boat be upset, stringent orders are issued that no attempt at rendering assistance to a stricken comrade must be made, and that no shot is to be fired from the boat.

Photo by Meurisse

CONVOY OF SPAHIS CROSSING A PONTOON BRIDGE AT COMPIEGNE

When the boat finally grounds on the opposite bank, the survivors spring out and rush the bank. Probably the entire bridge train has been employed in the ferriage, so a fair number of men can probably be landed on the far shore. These men take up the task of clearing out the enemy, while the pontoons return at once to the other shore to begin the construction of the bridge.

A shallow trench has been dug in the bank and a sill laid, for the security of the abutment span. The first pontoon is anchored in position, the length of the span away from the bank, and the balks or stringers are laid in the notches. Beginning from the shore, the waiting pontooneers rush forward with the flooring, the chess, as it is called, to be followed by the bearers of the side rails, which are securely fastened with rack-lashings. By the time the first span is laid, the second pontoon is in position, and the work continues until the bridge is completed. Each pontoon is securely anchored with an upstream anchor, while every other one, at least, is secured by a downstream anchor, in addition. Spare pontoons and rafts are anchored above the bridge, ready to be floated into position in case of accident, such as the striking of a destructive shell.

By the time the end of the bridge is nearing the opposite bank, the troops which are to cross are approaching the initial point, the entrance to the bridge, where engineer and staff officers keep careful watch to see that there is no crowding. The commanding officer of each column has been told almost the exact second when his command should enter the bridge, and he has his troops under way at the proper time, to prevent any massing of troops about the approach.

Infantry is required to break step in crossing, for the rhythmic beat of marching feet would soon set up such a swaying of the bridge that the anchors would be broken out and the bridge racked to pieces in a few moments. Cavalry and artillery dismount and lead the horses across. Troops and carriages are required to keep certain distances apart.

In case of accident, when there is time or material, one or more boats are posted below the bridge to assist in the rescue of any who may be precipitated into the water, by the enemy's fire or otherwise.

The pontoon trains are so small in comparison with the combatant forces of an army that they receive little attention from the general public. As a matter of fact, the service is about as spectacular and dangerous a one as exists, one that calls for cold nerve and judgment, and it is a service so important, that at times the fate of a nation may hang upon a perfect functioning.

In peace, the engineers are constantly drilling with their bridge trains, using every method and throwing their swaying structures across different waters, in the effort to perfect themselves against the time of need when their drilling may be necessary under the gruelling fire of a determined enemy. It is a great service, and the engineers and pontooneers rather pride themselves upon their unobtrusiveness, yet glory in efficiency. Their motto, "*essayons*," "let us try," is an epitome of their spirit.

AN ENGLISH PONTOON BRIDGE FOR THE CROSSING OF STREAMS

Chapter XII.

PROTECTING A RETREATING ARMY

Effective Methods of Destroying Its Lines of Communications

IN times gone by, when armies were of comparatively small size, and battles were largely hand to hand contests, it was frequently possible to subsist the troops upon the supplies of the surrounding country; and as the weapons consisted of single-shot muskets or rifles and cannon of small size, it was not difficult to carry along a supply of ammunition sufficient for a considerable time. Now this is all changed, and continuous and rapid communication must be at all times maintained between the troops and bases of supplies of all kinds, for upon its supplies depends the effective power of an army; indeed a failure of ammunition in a modern war, even for a few hours, often means the defeat, and possible surrender, of a numerous army unless it can retire rapidly.

TRAIN DESTROYED BY THE BLOWING UP OF A BRIDGE ACROSS THE OURCY

Under these modern conditions, when a retreat is necessary, one of the most effective methods for protecting the retiring army is to destroy the communications behind it; and the most common means of doing this is to destroy the bridges as they are passed, as this effectively cuts off the supplies of the following army, which must wait until these bridges have been repaired or replaced, a work that often requires considerable time. The methods employed in destroying bridges in war time are described as follows in *The Illustrated War News*, published by the *Illustrated London News:*

ANOTHER FOOT AND DESTRUCTION

Bridges may be roughly divided into three classes—namely, arched, girder, and suspension. In order to demolish rapidly an arched bridge having a single span of masonry, it is usual to fracture the crown of the arch, after which the whole thing collapses. To effect this with the least possible delay a board to which slabs of gun-cotton are fixed is suspended under the arch, in contact with the stone-work, the slabs of explosive being fired simultaneously either by a time-fuse or electricity (see No. 1, preceding page). If more time is available for preparation, a hole excavated from the roadway down to the crown of the arch is charged with gun-cotton or dynamite, a time-fuse or electric firing-cable being connected, brought to the surface, and carried to the side of the road in a suitable channel. The whole excavation is then filled in, and the road can be used as long as necessary, but the charge can be fired and the bridge destroyed at any moment. The structure in this case has nothing to show that it is mined, and may therefore be

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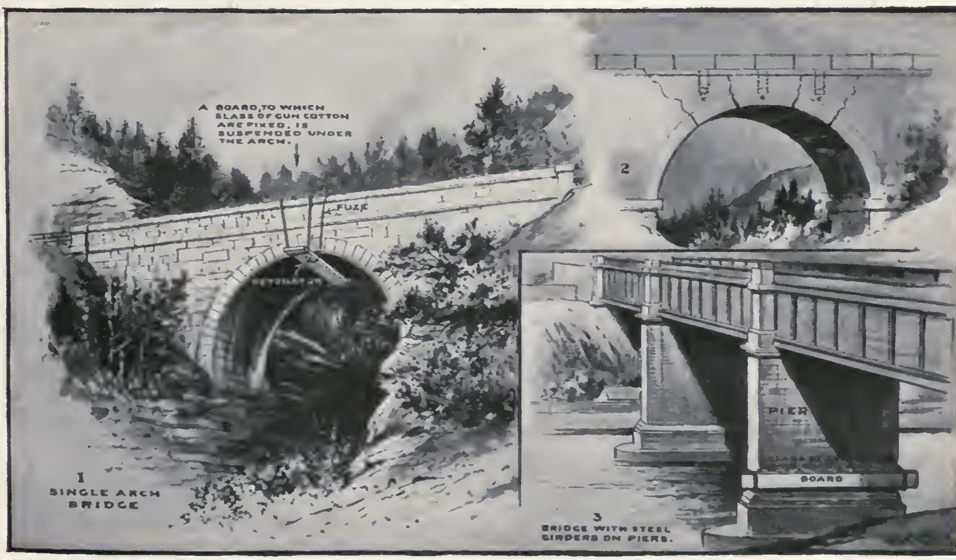
BRIDGE AT ARGENTAU, BLOWN UP BY THE BELGIANS TO IMPEDE THE GERMANS



The Illustrated War News

BRIDGE DESTRUCTION METHODS USED BY MILITARY ENGINEERS IN THE CASE OF ARCHED AND GIRDER BRIDGES blown up if desired while the enemy is actually crossing it. If sufficient time can be given to the work, a very complete demolition of an arch may be effected (see No. 2) by simultaneously exploding three charges (*c c c*) of dynamite placed in parallel trenches cut across the bridge from the roadway down to the crown. In dealing with bridges constructed with steel girders carried on brick or stone piers, it is usual to destroy the piers by means of mines at the base (see No. 3), and to trust to the consequent fall of the girders so to damage them as to render them useless. When, however, it is thought desirable to fracture the girder itself, a charge of gun-cotton is placed below the top flange on one side, and another above the bottom flange on the other side of the center web, on a bed of clay in each case, the whole contrivance being kept in position by wooden struts. When the two charges are simultaneously exploded the girder is cut through.

To destroy a suspension bridge, it is usual to cut the cables in three places. This is done in each case by exploding two slabs of gun-cotton fixed at right angles to each other, the cable lying in the angle.

The interruption of railway traffic is a comparatively simple matter, a slab of dynamite exploded in close contact with a rail, or when fired between switch or cross-over points, causing such distortion and dislocation of the metals as to stop the passage of trains.

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WRECK OF A FRENCH RED CROSS TRAIN AND THE MARY BRIDGE ACROSS THE MARNE.

Chapter XIII.

THE MOTOR TRUCK IN MODERN MILITARY SERVICE

Many Uses for Motor Vehicles Which Have Become Indispensable in War

IN future wars the motor truck will be employed extensively for carrying supplies from the railways to the front. The railway lines in the zone of action are usually destroyed soon after the beginning of hostilities, and weeks are required for their restoration. During the first weeks of the war it was almost impossible to transport supplies adequately from the uninjured parts of the railways to the front by means of horse-drawn wagons, but this essential service can be performed very well by columns of trains, each composed of a motor truck and a trailer. In this way horses are spared for other military uses, and their elimination lessens disease among the troops, as experience has proved.

MOTOR TRUCK FITTED WITH AN ELECTRIC GENERATOR FOR FIELD USE

The material and tactical superiority of motor transport is illustrated by the following example: A column of twenty motor trains, with their heads 160 feet apart, will occupy a stretch of 3,200 feet and will carry 180 tons, allowing 9 tons to each motor truck with its trailer. At a speed of 10 kilometers per hour a distance of 100 kilometers would be traveled in a day of 10 hours. Horse-drawn wagons, with a speed of 4 kilometers per hour, would occupy 26 to 28 hours in traveling 100 kilometers, allowing for the halts required for feeding and rest. If each wagon carried one ton, 180 wagons and 360 horses would be required for the conveyance of 180 tons, and the column of wagons, with twelve meters (40 feet) distance between their heads, would be more than two kilometers (6,400 feet) long.

The motor trains contemplated in this example, composed of military motor trucks and trailers of the heaviest type, would merely connect the railways with the camps, whence the service would be extended to the firing line by lighter motor trains or light motor trucks without trailers. Such light motor trucks have already been adopted in all armies, especially for carrying supplies to cavalry detachments which, advancing far ahead of the main army, urgently need a rapid and efficient transport service, not dependent upon animal traction. Although these cavalry trucks can carry two tons and can, when loaded, ascend steep grades on bad roads, they are constructed with especial reference to facility of turning and general mobility in order to avoid impeding cavalry movements, even in case of retreat.

GERMAN PRISONERS CONVEYED BY MOTOR TRUCK TO CHÂLONS SUR MARNE

Photograph by Meurisse

CONVOY HIDING IN THE WOODS FROM A HOSTILE AEROPLANE

The usefulness of the military motor truck is not limited to supplying an army with rations, fodder, weapons, ammunition, and other necessaries. The many novel technical appliances of modern warfare open additional fields of special usefulness. The newest military arm, the aeroplane corps, requires light motor trucks for the transportation of fuel, lubricants, tools, and repair materials. These trucks are similar to the cavalry trucks and are likewise built to "go through thick and thin," and to escape quickly with their freight in the event of danger. Motor omnibuses of special construction are provided for carrying the helpers required for the landing, housing, and salvage of aeroplanes. France, which has taken the lead in this special field, has experimented with motor omnibuses designed for a speed of 40 kilometers (about 25 miles) per hour, when fully loaded and manned, and even with smaller vehicles, provided with pneumatic tires, and designed for a speed of 60 kilometers (37 miles) per hour.

Airships likewise need motor trucks to carry men, tools, fuel, and lubricants.

The employment of the motor truck for the transmission of dispatches in the field is a subject of some complexity. This was the first military use of the automobile, which served merely as a conveyance for the dispatch bearer.

The introduction of the motor truck as a means of communication is of later date. The motor truck not only carries tools and materials for the telegraph, radio-telegraph, and searchlight corps, but is used in other ways. One European army possesses trucks, on which field telegraph and telephone cables are coiled on drums, which are wound up by the motor when the line is removed. The truck may also carry a dynamo, driven by the motor and supplying current for a radio or searchlight station or for charging telegraph and telephone storage batteries. A Russian military truck has its motor mounted on a detachable part, which also carries a dynamo and searchlight, and which can be pulled or pushed, as a handcart, up a steep hill or through a wood, which the heavy truck could not surmount or traverse. A complete sending and receiving station for wireless telegraphy and telephony, including a telescoping mast, may be constructed in automobile form.

Another very important branch of the motor truck service comprises the care and transportation of the wounded in the field. Russia has recently experimented with automobile field hospitals, equipped with all requisite medical and surgical apparatus, including a dynamo for illumination, operating Roentgen apparatus, etc. Another Russian innovation is an automobile ambulance capable of carrying twelve or more wounded men. This is to be used for the speedy removal of wounded from the firing line. In besieged fortified places, also, these ambulances would go at night, unlighted, from battery to battery, to collect the wounded and transport them to the hospital. Similar vehicles, arranged as omnibuses, and carrying thirty passengers, have been employed experimentally in Russia for the transportation of prisoners of war.

LOADING A PARIS STAGE WITH MEAT

It is evident that the military motor truck has entered into new fields of usefulness, the development and exploitation of which will produce a complete revolution in transportation, communication, and equipment. It is very desirable to use the motors of these trucks for other purposes than propulsion.

Put to the test of war conditions for the first time since its invention, with the exception of its very limited use during the last Balkan war, the gasoline-driven motorcar has more than fulfilled the expectations of its advocates. It has almost become a tiresome "bromidiom" to say that the modern motorcar has been an important factor in the rapid concentration and transportation of armies, and that but for the motor the German army could not have succeeded in advancing to within twenty miles of Paris in the short space of four weeks. The attack failed; the armies have been locked in Flanders and along the eastern frontier of France for months. But the automobile has lost nothing of its importance. It has simply taken up other duties.

CHAUFFEUR'S POST IN BELGIAN ARMORED CAR

Military tactics to-day may be said to rely pre-eminently on the motor and its speed. Attacks reaching forward at the rate of thirty miles a day are no novelty in 1915. Retreats, in complete order, at a speed of fifty miles a day would have been called impossible by military men twenty years ago. The motorcar has revolutionized warfare. In its complete destruction of all the lore of centuries regarding military tactics it has proved as ruthless as the much-talked-of 42-centimeter siege gun of the Germans has to the fortresses of the past century.

In the case of France and Germany, the motorbuses and interurban motor passenger coaches have proved of tremendous value. Germany has an extensive system of passenger coach transportation run under the jurisdiction of the post office "mail coaches." More than 3,000 of these sturdy and capacious vehicles were transformed into military vehicles, especially for meat transport to the front. The same must be said of the French buses.

The military authorities foresaw the great service that power wagons in general were called upon to perform in the event of war, and, as in all the leading countries, they endeavored to have all the power wagon trucks, including the ones used with autobus body, built according to the general standard regulations laid out by the War Department. In this way the trucks of the autobus are in reality a type of power wagon chassis which conforms to the same standard rules as apply to the larger power cars. For emergency cases or rapid maneuvers, a considerable number of troops can be instantly sent to a certain point of the battle either in autobus or on other kinds of power wagon, and this might often change the issue of events.

The popular conception of lines of infantry in trenches, interspersed with motor convoys loaded with ammunition, etc., is pure folly. Motor convoys are miles and miles in the rear of the battle line, as far beyond the range of heavy artillery fire as possible. Connection with the firing line is maintained by telephone and by motorcycle dispatch riders. In fact, the latter are pressing the automobiles hard for honors in this field.

Except on the fast cars used by the officers, pneumatic tires are strictly tabooed. Even on motor ambulances the solid rubber tire is preferred, because of the immense trouble caused by bullets or shrapnel penetrating the pneumatic—usually at the most inopportune moment. On some of the British armored cars twin pneumatics are used on the rear wheels, but in the majority of cases solid tires have been mounted. Safety in this case is preferred to a certain degree of comfort.

Motor truck experts calculate the destruction of vehicles at about 60 per cent of the total, figuring that not more than 40 per cent of the motor trucks sent to the front will ever return in condition to be useful.

Chapter XIV.

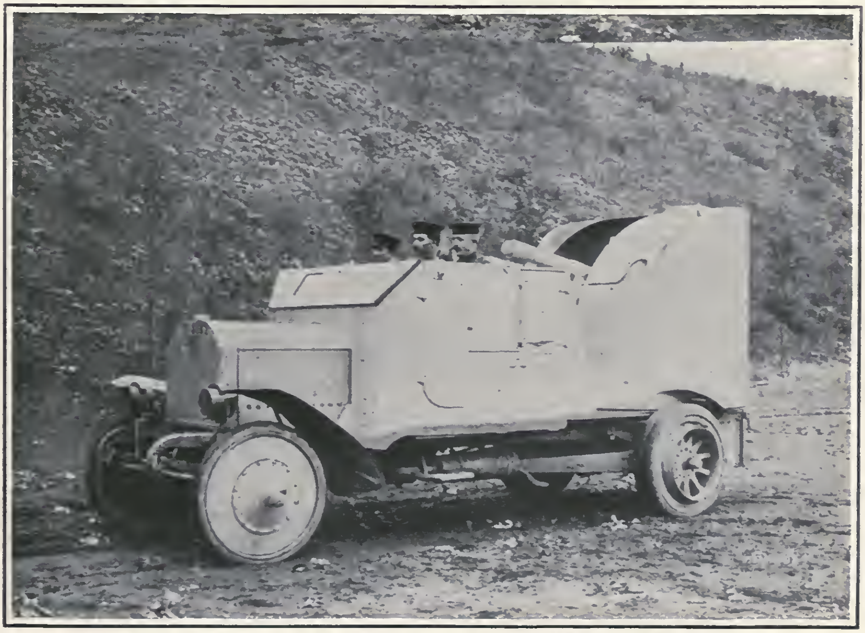
ARMORED AUTOMOBILES IN WAR

Construction of Modern Battle Cars

BY JOHN J. IDE

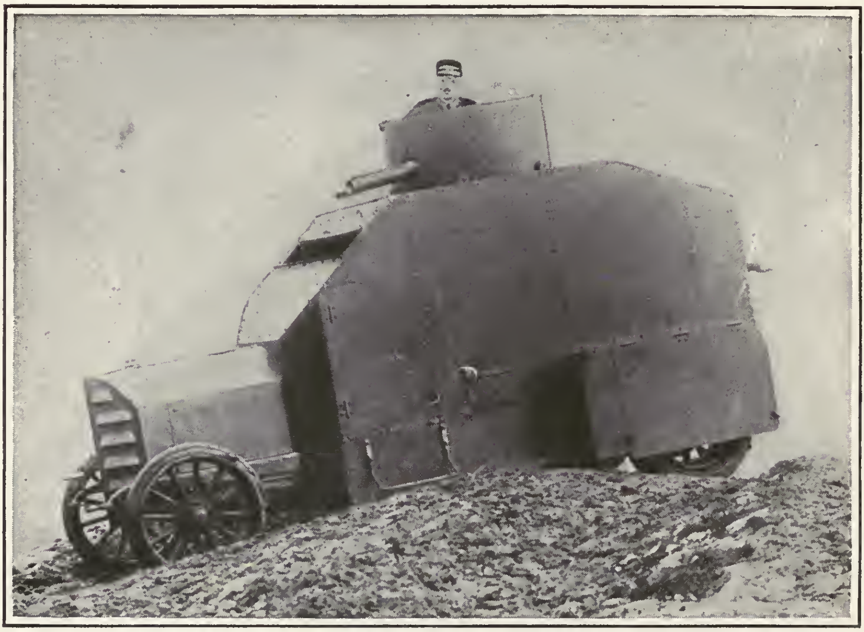
AS was to be expected, reports from the various seats of war told us of the widespread use of armored automobiles. Most of the nations involved have made exhaustive experiments to determine the most suitable of the types which range all the way from ordinary touring cars the sides of which are covered with steel plates, to huge moving forts. The most satisfactory cars have, naturally, proved to be those between the two extremes.

The service required dictates to a large extent the design of the car. In the early days of the war the Germans made great use of standard N. A. G. and Opel touring cars, to the sides of which are fastened steel plates of 4 millimeters thickness. No guns are mounted on the cars, the occupants being armed simply with rifles. Owing to the comparatively slight increase in weight over ordinary touring trim, these cars possess mobility of a high order and are well suited for scouting. They generally carry on each side of the dash a vertical rod having a knife-edge

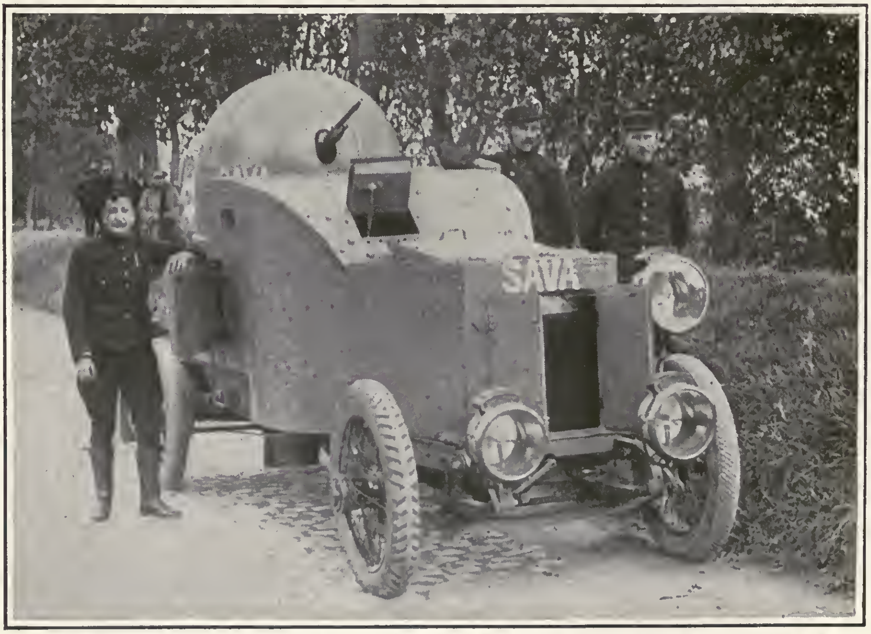


MERCEDES ARMORED CAR USED BY GERMAN ARMY in front. The object of this is to sever any wires which may be stretched across the road, generally at the height of the pilot's head.

The armor plating is very heavy, being about one half inch in thickness. The rear wheels have two solid tires and the front disk wheels have single tires of the same type.



ITALIAN ARMORED CAR OF THE ISOTTA-FRASCHINI TYPE

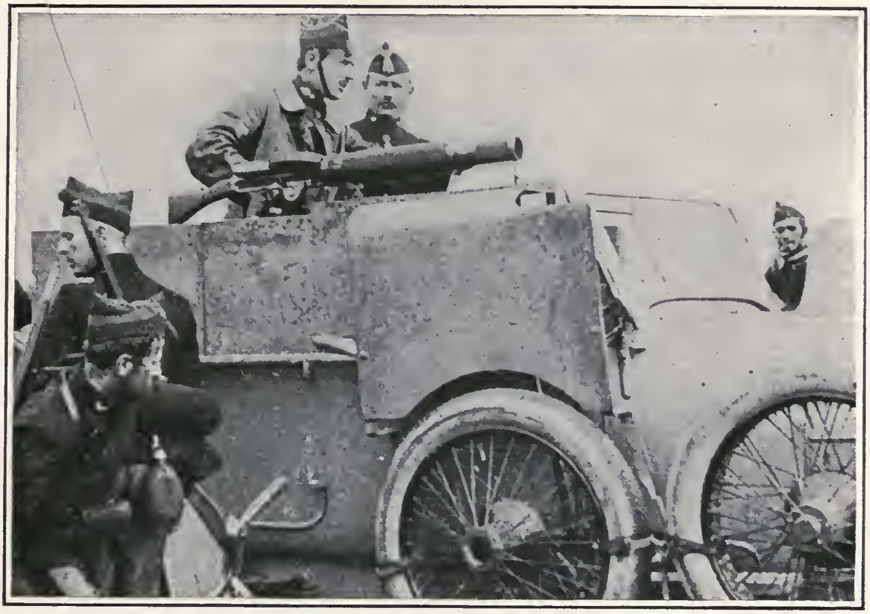


TYPE OF CAR THAT HAS BEEN USED VERY EFFECTIVELY BY THE BELGIAN ARMY

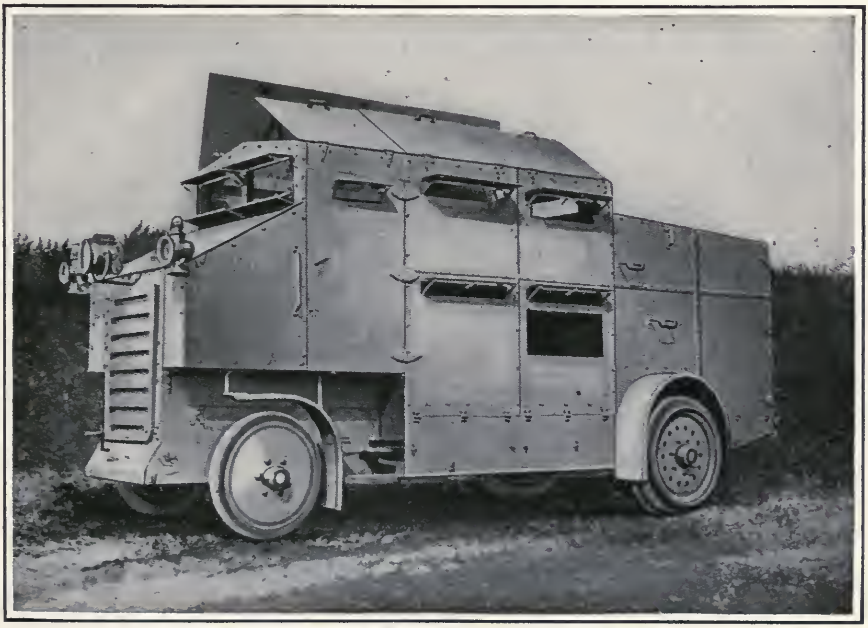
Much heavier armored vehicles have also been made use of by the Germans. These are generally trucks on which are maintained 5- or 7-centimeter Krupp or Erhardt guns.

The Belgians possess few, if any, heavily armored automobiles. They pin their faith to lightly armored, highly mobile cars, which have proved highly successful. Their speed and ease of manipulation enable them to rush to the desired spot, make a sharp attack, and, if necessary, retire quickly.

The detail illustrations show an ordinary



BELGIAN CAR FITTED WITH PROTECTIVE ARMOR AND LEWIS MACHINE GUN



HEAVY ENGLISH ARMORED CAR, A FORT ON WHEELS

touring car fitted with armor plating and carrying a quick-firing gun. Except for the gun, it is almost a replica of the German machines of the corresponding type. The steel plates are fitted to the interior of the body panels and project about twenty inches above the sides. The steel windshield with a hole for the driver to see through will be noticed. An interesting point is the guard on the driver's right to protect him when manipulating the levers, which happen to be mounted outside the body, thus rendering impossible the same protection as elsewhere.

A number of well designed cars armed with quick-firers were recently turned out by the Minerva Works, unfortunately destroyed during the bombardment of Antwerp. The armor throughout is of 5 millimeters compressed steel. A few cars were tried with armor plating ½ inch thick, but they were found too heavy to give the same service as the more lightly armored chassis of similar power.

The radiator is protected by steel flaps which can be hooked in a semi-closed position, allowing sufficient cooling for ordinary purposes. Air circulation around the engine is assisted by an outlet on top of the hood.

Photograph by Meurisse

BELGIAN ARMORED CAR, SHOWING THE REVOLVING TURRET

The twin tires on the rear wheels are a good feature quite apart from their great weight-carrying capacity, as they might enable the car to escape from a dangerous position in case a lucky rifle shot punctured one of them. The steel plate fixed behind the rear tires protects them to some extent. The efficient front wheel mudguards and position of the headlight will be observed. These cars are equipped with Knight engines of 26 and 28 horse-power.

The last word in Belgian armored car design is represented in the photograph of the S. A. V. A. The gun is mounted in a hemispherical revolving turret. These cupola-topped cars have two defects. One is, that there not being quite sufficient ventilation, the cupola gets filled almost to suffocation with gas; the other is that the ejected cartridge cases often strike against the back of the turret, ricochet back and hit the marksman in the head. Better protection to the occupants, however, helps to offset these drawbacks. The increased weight due to the roof certainly seems to demand greater tire support than is here provided. From the number of headlights fitted one would hazard a guess that the car was especially designed for night work.

The Charron machine consists in principle of a closed car of armor plate provided with a machine gun mounted in a rotating turret. Running around the outside of the turret is a flange that rests upon the edge of the circular aperture in the roof. Referring to the sectional drawing, a rubber ring *A* is fitted under the flange to prevent movement of the turret during firing. The cupola is mounted on a central shaft supported from the frame of the car. The shaft is in two sections, the adjacent extremities of which are united by a nut provided with the hand wheel *B*. Rotation of the hand wheel causes the turret to rise and fall slightly. At its lowest point it is pressed down on the rubber ring and is absolutely immovable. When it is desired to train the gun afresh, the hand wheel is turned, thus raising the cupola slightly and allowing it to be rotated in the required direction. The machine gun, mounted upon the cross-bar *C*, is equipped with the usual elevating gear. The ammunition chamber *D* is at the extreme rear in a rather exposed position. Behind that again is fastened a spare tire, for, heavy as this machine is, the tires are pneumatic. In front of the driver is a hinged shield *E* which can be opened to any desired degree or completely closed, if desired.

The radiator, carried in a low position forward, is protected by steel plates with louvres arranged to admit a modicum of air. The machine is provided with two lamps, one mounted on the radiator, and another carried on a bracket behind the dashboard, in which is cut an aperture provided with a shutter, so that signaling can be indulged in. On each side of the vehicle just over the rear wheel is placed a girder, used to bridge over ditches, etc.

The Schneider armored car in general appearance is not dissimilar to the Charron. A special form of cupola is used, however, of which a sectional drawing is given. The turret is in two parts, a lower cylindrical portion of which is attached to the frame of the car and is a fixture, and a rotatable turret above, likewise cylindrical. The latter is provided with rollers *A* running upon an inwardly projecting ring on the fixed turret. On the inner side of the ring are teeth engaged by the rear wheel *B*. A pair of brackets attached to the rotatable turret carry the gun. These brackets also support the shaft on which the gear wheel *B* is fixed. The gear wheel revolves through the agency of the bevel gearing at *C* and a chain connected to the spindle *D*.

A bicycle seat is placed on the gun and the spindle *D* carries cranks and pedals. Thus the gunner, seated on the saddle, is able, by pedaling, to rotate the turret and with it the gun, leaving both hands free for aiming and operating the weapon. The scheme is certainly ingenious, but seated as he is astride the gun, the marksman must feel the full effects of the recoil.

As seen from the accompanying photograph of an Isotta Fraschini, this Italian type more nearly approaches a fort on wheels than any of the machines previously described. The lack of observation facilities at the sides is a point not above criticism. The rear wheels and under body are very well protected, as is the radiator.

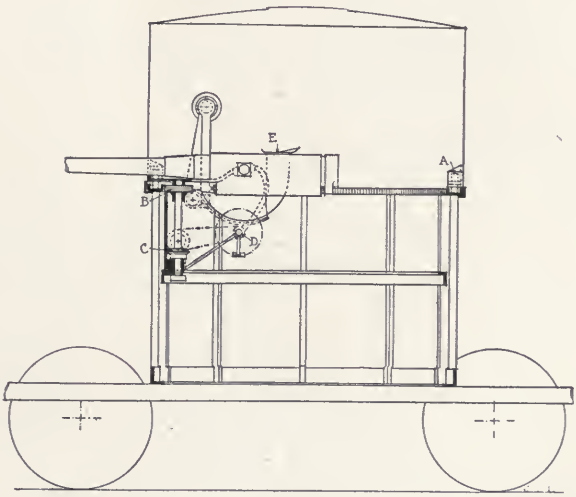
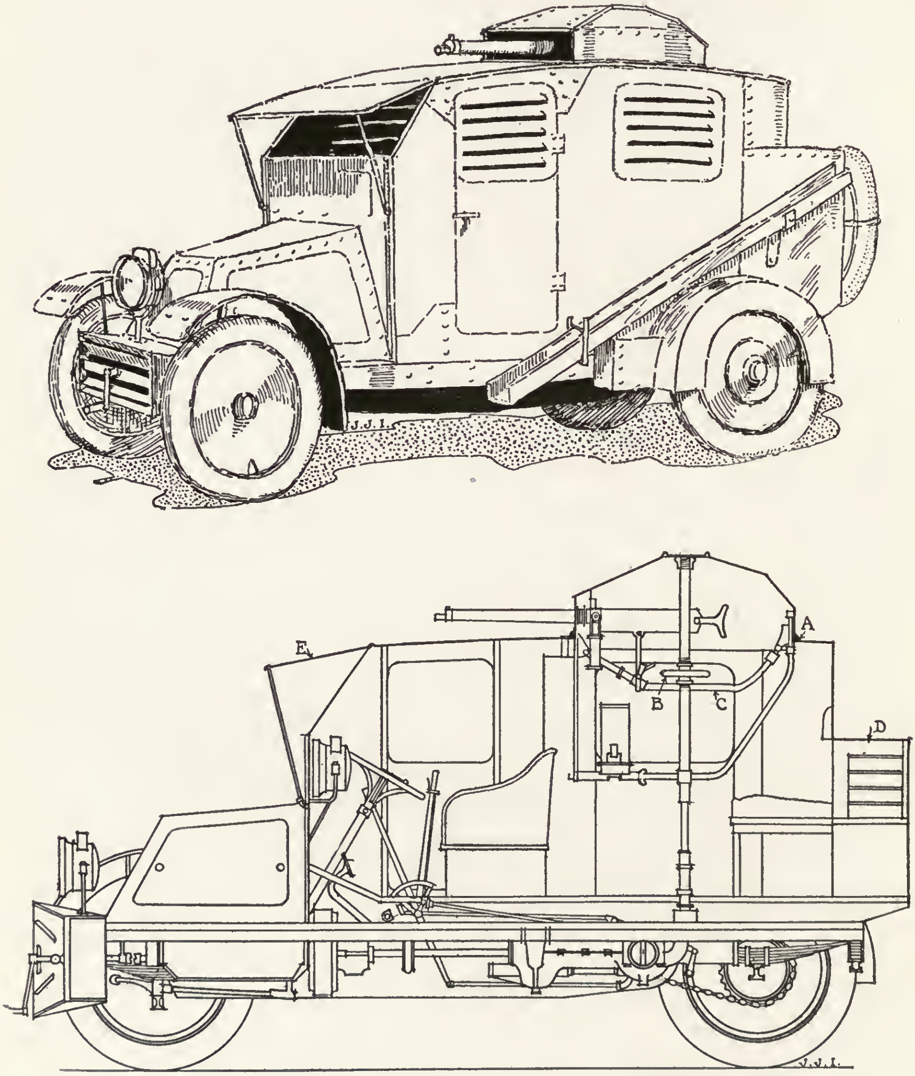


FIG. 1—SECTIONAL VIEW OF SCHNEIDER ARMORED CAR

An Italian artillery major, de Sauteiron, has produced an automobile battery consisting of four machine guns, two mounted on each side. The sides of the vehicle can be swung out to bring all the guns into line.

Strange as it may appear to Americans accustomed to self-starters on every form of automobile, not one car is, I believe, similarly equipped. Yet a moment's reflection will show the desirability, if not absolute necessity, of such a fitting. Several extremely narrow escapes have occurred already through one of the crew having to restart the motor when the car was under fire. It is to be hoped that all armored automobiles will, in future, possess engine starters.



FIGS. 2 AND 3.—EXTERIOR AND SECTIONAL VIEWS OF THE CHARRON ARMORED CAR. A. RUBBER RING FOR CLAMPING TURRET WHEN FIRING. B. HANDWHEEL FOR ELEVATING OR DEPRESSING CUPOLA. C. CROSS-BAR ON WHICH GUN IS MOUNTED. D. AMMUNITION CHAMBER. E. SHIELD

Chapter XV.

WAR USES OF THE MOTORCYCLE

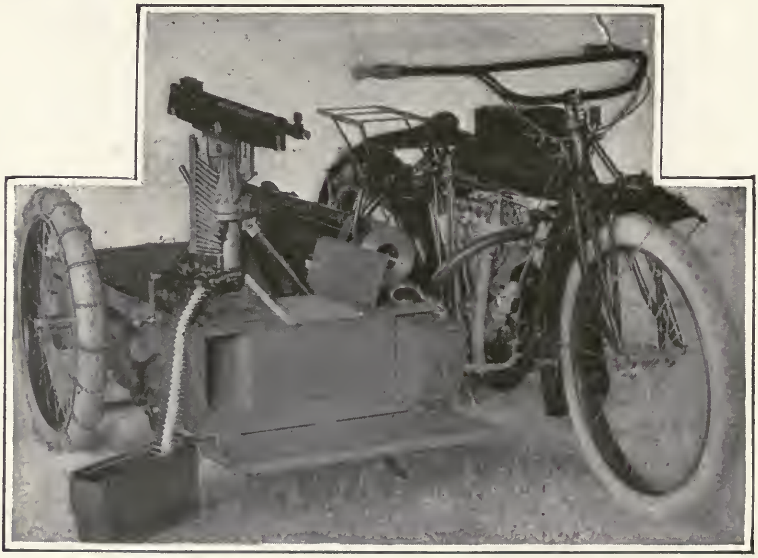
The Cycle Ambulance and Motor Machine Gun Made Possible by the Sidecar

WHEN one speaks of military dirigibles involuntarily the mind turns to Germany, the home of the Zeppelin. When the military aeroplane is referred to one thinks of France, which has done more than any other nation for the development of the "heavier-than-air" machine, although the invention belongs to America. When the military motorcycle is mentioned, the mind turns instinctively to England, which undoubtedly is the real home of the two-wheeled motor carriage, although the invention belongs to France. Yet all the warring nations except Serbia possess dirigibles, all of them possess aeroplanes and all of them possess motorcycles. In fact, there are probably many more German and French motorcycles in war service than English; for at the outbreak of the conflict all the continental nations concerned commandeered every motor vehicle of whatever type. In England, on the other hand, while there was no confiscation of power vehicles, large numbers of motorcycles were offered voluntarily to the government. Soon after war was declared there was a great meeting of motorcyclists at Wimbledon Common, who gathered together to offer their services to the army. Although the work of the motorcyclists is by no means as conspicuous as that of other branches of the service, there is no doubt that they have proved invaluable to the respective colors they were

FRENCH MOTORCYCLE SCOUT WITH HIS DOG. THE DOG CARRIES MESSAGES TO HEADQUARTERS serving. We find them doing all the work that used to be done by the mounted courier, and much more besides. They carry messages between one end of a column and another. They act as police on the roads behind the battle line. They serve as guides for motor trucks and serve as scouts for automobile convoys, examining the roads to see that bridges are in good condition and that there are no impassable obstacles. They even do much reconnoitering which was formerly done by the cavalry only. In all such work their enormous speed as compared with that of a horse is of tremendous importance. The only drawback is that they cannot run freely across country or over roads that are in very bad repair or obstructed by fallen trees or telegraph poles.

The motorcycle sidecar which England claims as its own invention, has already proved of inestimable value for military purposes. One of our photographs shows a motorcycle scout belonging to the French army in Belgium. This motorcyclist uses a sidecar as a luggage carrier and also for the purpose of transporting a fellow-soldier or officer when conditions demand it, but chiefly to carry a dog that accompanies him on all his expeditions. Once in a while, when he has an important message to send back to headquarters, but does not wish to interrupt his reconnoitering, he writes the message on a

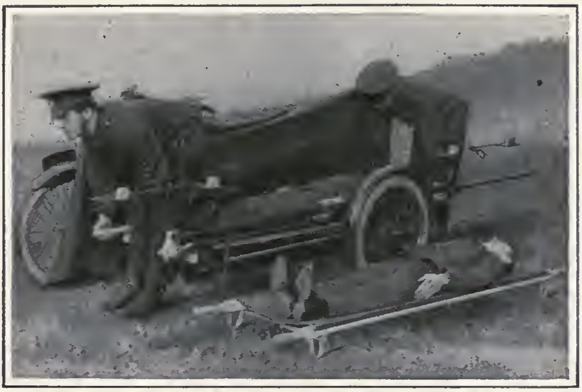
BRITISH SIDECAR FITTED WITH A LEWIS MACHINE GUN



SIDECAR OF AMERICAN DESIGN CARRYING A COLT AUTOMATIC slip of paper which is fastened to the dog's collar, and the dog is sent to headquarters, while the scout proceeds on his way.

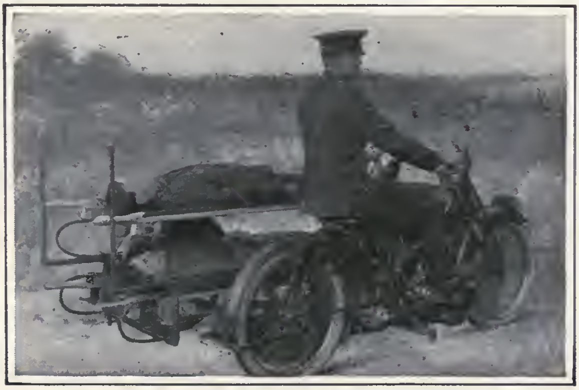
The sidecar has made it possible to convert the motorcycle into a fighting machine. Several machines have recently been introduced in war which are equipped with automatic guns. One of our photographs shows an American motorcycle sidecar built especially for fighting purposes, on which a Colt automatic gun of rifle caliber is mounted. Provision is made for carrying two passengers, so that it is possible to operate the gun while the machine is in motion. Of course, this greatly increases its field of usefulness. The gun has a firing capacity of 450 or more shots per minute and, if desired, may be detached from the special mount on the machine and used on a portable tripod which is collapsible and carried on the sidecar. The machine is equipped with a 15 horse-power twin-cylinder motor and has a two-speed gear, the low-speed permitting it to be used for cross-country work, if necessary. On the road it will run up to a speed of 40 miles per hour, and it has a radius of 75 miles on a tankful of gasoline.

Another of our photographs shows the first London machine-gun battery, equipped with a Lewis gun that is operated from a sidecar. Other English armed motorcycles are provided with bullet-proof steel guards to protect the man in the sidecar and also vital parts of the driver of the machine. A shield is attached to the handle-bar and has a bullet-proof guard that extends well over the front wheel to protect the tire from puncture.



PLACING THE WOUNDED IN THE MOTORCYCLE AMBULANCE

The British Red Cross Society recently adopted a motorcycle ambulance sidecar for service on the Continent. Two photographs of this car are shown herewith. The machine is of standard 8 horse-power type with semi-automatic lubrication and magneto ignition. The speed gear is of the three-speed countershaft type. The ambulance portion is of an entirely original design. It is constructed of tubular framework and so arranged that comfortable accommodation is found for two recumbent figures upon standard regulation army stretchers, these being supported on long, easy



THE SIDECAR AMBULANCE HASTENING TO THE HOSPITAL springs which run from end to end. From the bottom springs a cradle passes across from one side spring to the other, at each side, and these are slotted to take the feet of the stretcher. Rubber blocks are fixed so that the wood of the stretcher does not rest upon the metal cradle. The upper springs have metal attachments which pass similarly from one side spring to the other, and these are made to swing around on a pivot so as to allow the bearer of the bottom stretcher to walk right through the sidecar. Tubular stanchions are fitted at the five extreme corners of the framework, and these carry a waterproof cover, or awning, which is held in position by two buttons. The rear outside stanchion is made to swing down, so that there is no undue lift while placing the side stretcher in position. Among the several salient features of the motorcycle ambulance, its extreme mobility is prominent, as the machine can turn in 9 feet, as against 36 feet required by a motorcar ambulance. It can travel wherever a motorcar can travel, and to a great number of places that a motorcar ambulance could not go. Due to its lightness, this machine has two distinct advantages: In the first place, it can, with the assistance of rider and attendant, surmount obstacles which would stop any ordinary motorcar ambulance; second, it is much less likely to become bogged; but even in such an eventuality the machine can easily be pushed out by the rider and attendant. There is an economy in fuel consumption, as, during trials recently carried out by the British military authorities in the Tyneside district, an average of 55 to 65 miles per gallon (American) has been obtained, as against 12 to 17 miles, which is the average with standard motorcar ambulances. As will be gathered from the illustrations, the machine can be loaded and unloaded in the minimum of time, and the whole arrangement contributes to the comfort of the wounded passengers.

AT THE TOP OF AN OBSERVATION MAST

Chapter XVI.

A MODERN MILITARY CAMP

Various Methods of Building Temporary, Permanent or Winter Shelters

A MODERN military camp is far more substantial in character, far more ingeniously planned than the layman realizes. It may be only temporary, in which case it is constructed by the troops in the field themselves, or it may be of a fairly permanent character, in which case it may be built both by soldiers and civilians under the guidance of the engineer corps, or as they are known in Europe, "pioneers." The simplest of all camps are those which are used simply for bivouacking, and the most elaborate are those in which huts and barracks are used in order to provide some measure of protection against the weather.

Obviously the most useful protection against weather is the well-known army tent. In erecting tents, the general direction of the wind prevailing about a camp is ascertained, and the tents are pitched in lines parallel with the wind's travel. In order to shield the troops from wet and cold soil, a wooden floor is ordinarily provided, the necessary material being found either on the camping ground itself or being carried along from the last camp.

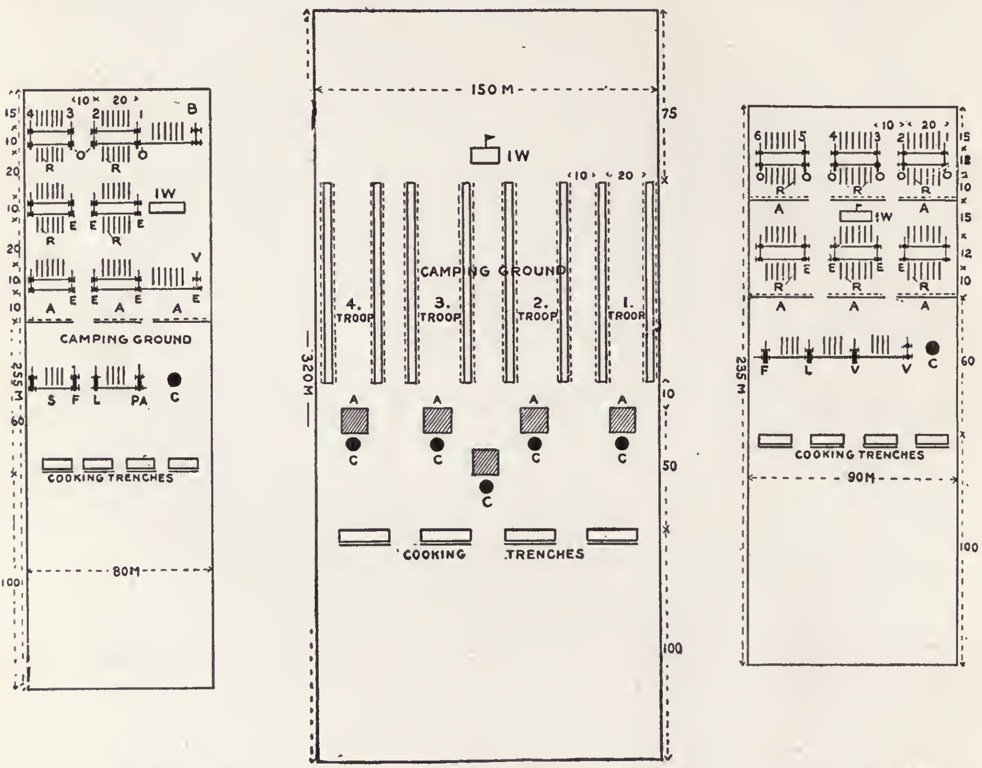
Circular wind screens, surrounded by a ditch, are to be found in many military camps as a protection against storms. These screens are built by driving in piles to a height of three feet, the piles being connected by ropes of straw or grass. Against this straw, branches or the like are piled so as to make a wall, which is held in place by a layer of earth at its foot (Fig. 1). If long poles can be obtained and much covering straw, panels from seven to eight feet can be tied together and supported by poles, as a protection against the wind (Fig. 2).

Camp huts are most easily made by tilting two wind screens against each other in the manner shown in Fig. 2, the angle at the ridge being 90 degrees. Assuming that the height of the ridge from the ground is 9 feet 4 inches, the interior will have a breadth of 16 feet 5 inches, or room enough for two rows of cots and an aisle a yard broad. The beams are of the type shown in Fig. 6. Boards may be laid upon the beams and covered with tar paper. One gable end is closed and the other provided with a door. In order to keep the hut dry, draining ditches are dug all around it, into which the rain flows. Around the bottom of the hut earth is packed so as to keep out drafts. Such huts are usually not less than 20 feet long (with accommodations for twenty men) and not more than 33 feet long (with accommodations for thirty-two men). The cots may be built in at the same time as the huts themselves. In the Austro-Hungarian army a round hut of straw (Fig. 3) has been adopted.

Winter huts are of various types, but their construction is much the same as that of the ordinary hut, with the exception that stronger beams and heavy sloping roofing is employed. The latter is particularly necessary because a layer of earth overlies the entire roof. Such huts are built in an excavation not more than 2½ feet deep on suitable beams. An iron stove serves to heat the interior, or a stove made of bricks, turf, or the like. If stove piping cannot be readily obtained, old vegetable and meat cans are fashioned into a pipe. When the hut is built in a deeper excavation, a sloping roof is employed as shown in Fig. 4, composed of several layers of earth and wood. This heavy roofing is necessary to protect the men within the hut from shell and shrapnel fire.

Instead of huts, barracks may be constructed with vertical side walls. They are built with buried posts or stanchions. Joists or joined boards may be used for the posts. The walls are boarded up both from without and within, and the hollow space between is front to form a windshield. If there are no buildings near containing kitchens which can be used, hearths are built of brick or of limestone and lime mortar. Three masons can build such a hearth in one day with six hundred bricks and cover the whole with a protective roof. For a single company (squadron or battery) three caldrons of 175 quarts capacity each will be required.

Field ovens can be built if necessary by the field bakery column, in order to provide the troops with bread. For this purpose the iron



PLAN OF A GERMAN CAMP.—A. BAGGAGE AND EQUIPMENT. B. SENTRY. C. OFFICERS. E. AMMUNITION CAISSONS. F. FODDER. L. PROVISIONS. I W. GUARDS. O. GUNS. P A. BAGGAGE WAGONS. R. STALLS. S. BLACKSMITHS. V. SUPPLIES

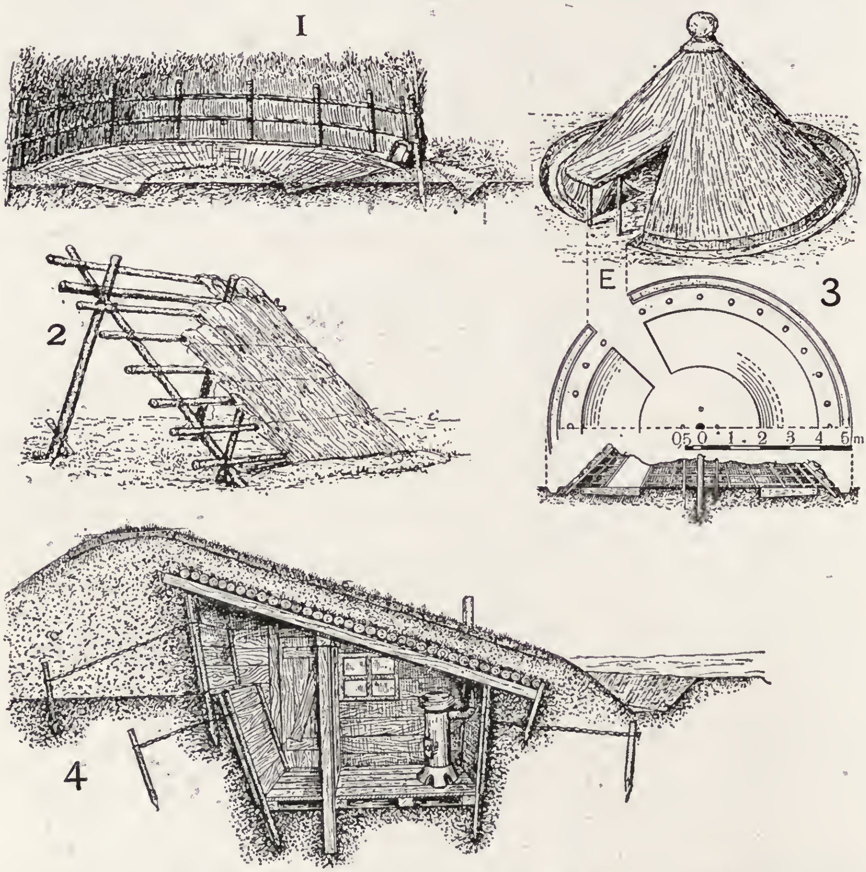
filled with turf, moss, earth and the like, as a protection against heat or cold. Window openings may be provided as may appear necessary. In winter the entire structure is jacketed with earth up to the gable walls. Stables may be joined to the barracks. They are either of the sloping roof or the gable roof type and are big enough to house horses, the attendants to the horses, as well as harness, fodder, and the like.

For cooking, trenches 1½ to 2 feet in depth and 3¼ feet wide at the top are used. In one side wall five holes are dug, as shown in Fig. 7. The excavated earth is thrown up in framing which the field bakery column always carries with it is employed. Mortar, sand, and bricks must be obtained on the spot. In the Prussian army the iron framing of the oven is built in with the brick and cannot be removed except by breaking the masonry away. In other armies it may serve simply as false work to be removed after the oven is completed; but in this case it is harder to build the oven. The hearth is always first constructed, with an easy rise toward the rear. Stone, sand, etc., are used in the foundation, and a vault of brick completes the masonry. At the rear end a chim-

GENERAL VIEW OF A GERMAN MILITARY CAMP. SMALL VIEWS ABOVE ILLUSTRATE THE CONSTRUCTION OF A WELL (FIG. 5) A PERMANENT CAMP HUT OF WOOD (FIG. 6), AND THE COOKING ARRANGEMENTS (FIG. 7).

ney is built and the forward end draft holes and other convenient openings are provided. A protecting roof covers the hole. The oven is completely protected by clay, stones, gravel and the like.

The water supply of a camp is a matter of great importance. Only running water is used. In the German army the upstream water is used for drinking purposes and the downstream water for watering horses and for bathing. Suitable signs notify the men which water is safe to drink and which may be used only for bathing. In shallow or narrow streams, basins are dug or small dams built so as to form a reservoir of ample dimensions. Stepping stones are provided to keep the water clear, as well as board protection to prevent the banks from crumbling. Basins are dug for watering horses; troughs are provided only in case of necessity, and are then propped on posts and filled by means of pumps. Pipes may be driven if water lies at a reasonable depth; in other words, not more than 20 feet. Depending upon their size, these pipes will deliver from 4 to 22 gallons of water per minute. If water lies very near the surface a hole is dug and a cask, the bottom of which has been knocked out, is placed in the hole to form a basin. If the water lies at a greater depth, the basin may be formed of box sections, driven in one on top of the other, in position (Fig. 5). If the depth is greater than 3 meters, a kind of shaft must be made, the wooden sections being driven in one after the other, the opening at the top being greater than that at the bottom. The water is then raised by means of a suction pump. A plentiful supply of water is one of the greatest luxuries an army in the field can enjoy.



EXAMPLES OF STRUCTURES USED IN PERMANENT CAMPS. FIG. 1.—SCREENS FOR PROTECTION AGAINST WIND. FIG. 2.—ANOTHER STYLE OF WIND SCREEN, THAT CAN BE CONVERTED INTO A SHELTER. FIG. 3.—ELEVATION AND PLAN OF ROUND STRAW HUT, ADOPTED BY AUSTRIANS. FIG. 4.—SUNKEN WINTER HUT, USUALLY CONSTRUCTED IN INTRENCHMENTS. (ILLUSTRATIONS FROM HANDBUCH FUER HEER UND FLOTTE).

Chapter XVII.

TRENCH WARFARE

Ten Hours of Trench Digging for Ten Minutes of Rifle Fire

BY CAPT. W. D. A. ANDERSON CORPS OF ENGINEERS, U. S. ARMY

THE wonderful accuracy and power of modern artillery has driven armies underground as the only salvation from annihilation. At the same time the enormous numbers of men engaged extend the flanks so far that turning movements are often impossible and battles must be decided by frontal operations.

In the wars up to the Russo-Japanese war in 1904-1905 the campaigns consisted largely in maneuvering the armies so as to threaten the enemy's flank. Now the important advantages are gained by maneuvering the heavy artillery so as to bring a preponderance of fire to bear upon a definite length of the enemy's front.

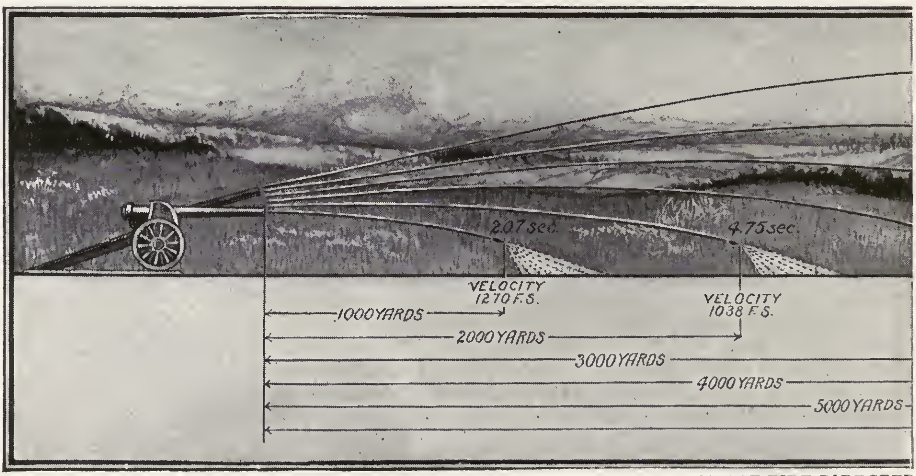
The shattering power of high explosive shells can reduce to a rubble mound any structure on which they are brought to bear. Consequently the military engineer recognizes this physical limitation of the defense and adjusts his structures by utilizing mounds of sand or earth for parapets. The energy of the shell is largely used up in raising a cloud of earth, most of which falls back in place.

Photo by Branger

FRENCH INFANTRY MARCHING TO THE FIRING LINE

After a bombardment a line of field fortifications looks more like a spoil bank than a defensive work, but its resisting power may be little diminished. The very irregularity aids in rendering the exact trench line less conspicuous.

Prolonged bombardment will in time destroy any trench, but an active defense can offset this by continuous extension and reconstruction of the lines of trenches. While the artillery of the defense counter-batters the attacking artillery, the soldiers of the line wield their picks and shovels to repair the trenches. Instead of the dash and glory of historical warfare, the soldier of to-day has the prosaic task of devoting over ten hours to trench work for every ten minutes spent in firing his rifle.



SHEAF FIRE DIRECTED

The principle of trench warfare consists in providing a number of lines of trenches so that if one is captured the next succeeding line can be held. By delaying the enemy at each successive trench time is gained to bring up reinforcements of men and artillery.

The artillery is depended upon for bombardment and for action against groups. Its long range and accuracy permit the batteries to be placed on the reverse slopes of hills from one to six miles in rear of the advanced lines. Here the guns are safe from observation except by aeroplane scouts, and the gun crews are further protected by parapets. So important is concealment that even in these protected locations the guns are screened by being placed in woods or orchards or by being covered with branches or with hay.

CONCEALED ARTILLERY EMPLACEMENT.

The man at the gun does not see his target. The observation of the objective of fire and of the effect of shots is carried out at a distant point. Information is telephoned in to the battery and calculation is made of the change in azimuth or elevation needed to correct the landing point of the shots. In this way the objective of the gunfire may be changed from point to point as the progress of the action dictates.

The close contact is maintained by the infantry, who depend upon the firing trenches for their effective work. These are deep narrow trenches with a steep revetted bank on the side toward the enemy. (See Chapter II, pages 7-20.) A bench is provided against this bank, or interior slope, so that men standing on the firing bench will be conveniently placed for firing over the parapet. A large stock of cartridges is placed on a bench cut in the parapet so that each man may continue his firing without changing position.

FIRING TRENCH, SIMPLE TYPE.

To give the man in the firing trench a still better chance to stop an attacking force the ground in front is covered with obstacles that will delay the enemy without affording any protection. Any device is used, but the best of all is barbed wire. It cannot be shot away, even if it coils up and entangles the feet. As chance offers, barbed wire is criss-crossed between the posts until a formidable entanglement is obtained.

The trench guard must be close at hand, ready to man the firing trenches on a moment's notice. At the same time they cannot stay in the trenches during bombardment, as the protection is so slight that the losses would be excessive. This object is secured by having a cover trench close by from which entrance is obtained into shelter.

Where a ravine or reverse hill slope is near enough, the cover trench consists merely of the line of entrances into the bombproofs. In these cellars, or bombproofs, the trench guard sleep, eat, and live during their 48-hour tour at the front. New detachments are then brought up to the front line, while the old guard goes back to the reserve for four days' rest.

Numerous passages are provided for the quick rush of the soldiers from the cover trenches to the firing trenches. If these were direct, the enemy's shrapnel might rake them and prevent the arrival of reinforcements. To prevent this the communicating trenches twist and turn so that every part of the trench is protected by the turn next ahead.

Not only must these zigzag communicating trenches be dug between the advanced trenches, but even far to the rear. Modern artillery can in less than one minute get the range and hit an exposed target two miles away. Communicating trenches must be provided from the first line all the way back until the hills or folds in the ground will protect the rest of the route. Thus, for a zone of approximately a mile along the battle front, every move must be made in deep trenches.

The firing trenches at the front are not necessarily continuous. They are required only to oppose an advance of the enemy along gulleys or valleys or through woods. The open spaces are fully covered by artillery and machine-gun fire. The connecting trenches, however, fill in the gaps so as to make a practically continuous line.

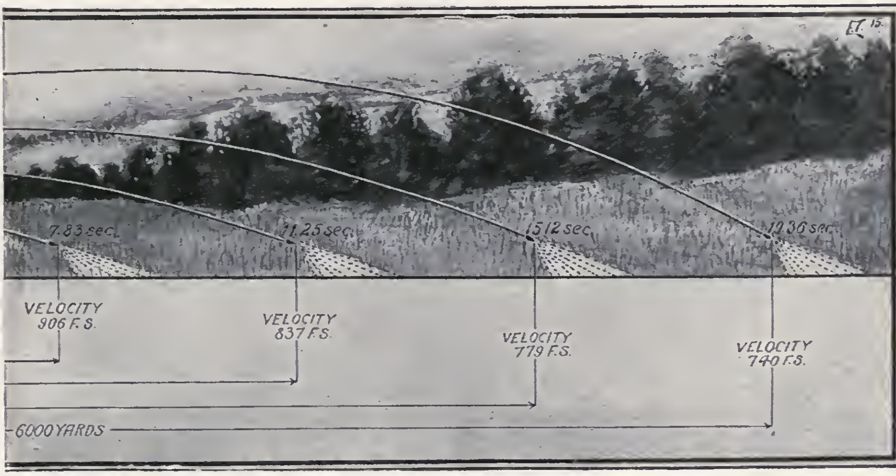
Everywhere provision is made for protection against enfilading fire. The communicating trenches are zigzagged, or are defiladed by roofing them over with logs and mounds of earth at short intervals. The firing trenches are also defiladed by offsets, or traverses, at intervals of about twelve yards. The traverses furnish raised mounds, or parapets, extending across the line of the trench and protect the soldiers from flank attack.

The above description covers only one firing line and its appurtenances. Reserve lines similar to these are dug in rear, at least two of them. As the sapping operations gain ground toward the enemy, new lines are constructed every hundred yards or so. If the enemy's lines are captured they are reconstructed for the use of the captors. At times these operations may lead to an army's having ten or more parallel lines of trenches along a short length of front.

After the simple lines of trenches are completed the troops are kept at work improving them. Deeper bombproof shelters are constructed and concrete is made use of for supporting and retaining walls. To take care of the ground water a complete drainage system is dug out with ditches or drain pipes leading to a natural outlet or to a sump from which the water is pumped away. After a few weeks occupation the line of entrenchments becomes a semi-permanent fortification, with underground chambers and communicating trenches.

DEFENSIVE TRENCH WARFARE.

In defensive tactics the trenches serve to strengthen a line so that the forces holding it can be reduced to a minimum. The troops thus released can then be concentrated at another point where an attack is to be made.



TOWARD TRENCHES

The line is held by maintaining a trench guard in the cover trenches of the advanced line. A few sentinels are placed in the firing trenches, but the main dependence for detecting an advance of the enemy's forces is placed on the concealed observation stations and on the aero service.

Photo by Branger

GERMAN INFANTRY MANNING A TRENCH

The trench guard furnishes only a delaying resistance while the forces in the rear are taking their positions. The main line of resistance is far enough back of the first line to give plenty of time for the warning and forwarding of reinforcements. The principal bodies of troops are kept back where they will not be subjected to bombardment.

Copyright by Underwood & Underwood

BRITISH MARINES FIGHTING FROM THE TRENCHES

The front line is then held by a line of sentinels, who are reinforced by the trench guard from the cover trenches. About 300 yards to the rear are supporting bodies who either reinforce the advance trench defenders or else hold a line to which the trench guard falls back. Still farther to the rear, in a central sheltered position, is maintained a large reserve which is charged with the duty of maintaining the fighting strength of a definite length of front, which for a European regiment of 3,000 men would be about half a mile.

This organization provides successive increases in the strength of the resistance to attack. The main object is to stop the enemy if possible or else to delay his forces until reinforcements can be brought up. Even where the attack is strong enough to break

AN OBSERVATION STATION OVERLOOKING THE SAND DUNES

TRENCH, WITH TRAVERSES, BORDERING A STREAM

Copyright by M. Branger

OUTPOST CONNECTED BY TELEPHONE WITH THE FIELD ARTILLERY

Copyright by M. Branger

A BRITISH FIRING TRENCH, SHOWING TRAVERSES through, the above tactics delay operations so much that troops can be rushed in from both sides to form a new line in rear of the weakened point.

TACTICS OF THE AGGRESSOR.

The aggressor in trench warfare has to use similar tactics for his infantry and must, above all, have a preponderance of artillery. Without the latter an advance would result only in slaughter.

The advance is prepared by placing the batteries of artillery in concealed positions from which their fire can be concentrated on the vicinity of the point selected for attack. Information is carefully gathered as to the location of the enemy's batteries and lines of trenches. At a prearranged signal the trenches and the ground in rear are bombarded with high explosive shells in order to drive out the defenders. Probable artillery locations and communicating trenches are raked with shrapnel fire. Close watch is kept of the effect of the fire and of any movements of the enemy that can by any possibility be detected.

The troops for the assault are meanwhile

Photo by Underwood & Underwood

BRITISH SOLDIERS EXPLAINING TO FRENCH OFFICERS THE OPERATION OF A TRENCH PUMP

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GERMAN TRENCH PROTECTED FROM SHELL FIRE BY WIRE COILS gathered in the most advanced trenches. When the enemy's infantry and artillery seem to be driven to cover the signal for the advance is given. The attackers scramble up keep up its fire. It must quickly locate and silence any hostile guns that open fire on the attacking troops. It must also cover with its fire all the ground in advance of its own

Photo by M. Branger

ENGLISH SOLDIERS BALING OUT ONE OF THEIR TRENCHES WITH LONGHANDLED SCOOPS

out of their trenches. Selected groups rush forward to cut the enemy's wire entanglements or to blow up the obstacles in front of his parapet. The rest follow close behind troops so as to prevent the enemy from moving up reinforcements. The expenditure of shells and shrapnel thus mounts up to enormous figures.

CAMPAGNE 1914-1915

2me Année. — N° 6 | LES TRANCHÉES | 10 Mars 1915

Secteur Les M...i.es [illegible]

LE POILU

Journal des Tranchées de Champagne

DIRECTION — le 108e Rég. Territorial d'Infanterie de campagne

PRIX DU N° 5 CENTIMES

Abonnement, un an.... 5 francs

Journal humoristique, littéraire, artistique
de la vie des Troglodytes
qui paraîtra quand il pourra et où il pourra
Défendu aux Embusqués

TABLEAU D'HONNEUR

du 108e Régiment d'Infanterie territorial de campagne

Le dimanche 21 février 1915, cérémonie émouvante par sa simplicité à X... Le lieutenant colonel C..., commandant le 108e territorial, a décoré sur le front, le *capitaine Braud*, nommé au grade de chevalier dans l'ordre de la Légion d'honneur, pour sa belle conduite, comme en témoigne l'ordre du régiment ci-après :

« *M. Braud Augustin*, capitaine au 108e régiment « territorial d'infanterie, a été nommé dans l'ordre de la « Légion d'honneur au grade de chevalier.

« Lors de l'attaque allemande du 17 décembre, ayant « reçu l'ordre du commandant du sous-secteur de coopérer avec sa compagnie aux opérations tendant à « enrayer cette attaque, a fait preuve pendant deux « jours de la plus grande bravoure, d'une [illegible] « fermeté et d'une entente parfaite de son métier. A « abordé, à plusieurs reprises, l'ennemi à la baïonnette « à la tête de ses hommes à qui il a su inspirer par son « attitude personnelle la plus grande confiance ».

LE POILU TROGLODYTE

Cette esquisse d'Histoire qui est venue au courant de ma plume, vous réjouira le cœur, j'espère, ô Poilus, comme mes gibernes essaient d'amuser votre esprit.

Je reviens maintenant à l'Histoire qui vous est personnelle, à celle que les historiens futurs qui voudront avoir des documents vécus sur la vie des Poilus troglodytes, seront obligés de venir cueillir dans le « Poilu », votre canard. Je n'exagère rien. Cette lettre qui vient du Canada et qui est publiée plus loin, est la preuve évidente de ce que j'avance.

Dans mes précédents articles, et par des exemples appropriés, j'ai pu montrer qu'en dehors du courage, qui est une des qualités essentielles de notre vieille race, ce qui caractérisait la guerre actuelle et semblait en quelque sorte nous faire connaître une race nouvelle, insoupçonnée, c'est le sang-froid, la tranquille assurance, la ténacité, la conscience du devoir, la patience, l'endurance de tous nos braves Poilus. J'avais ce vieux cliché qui tintait dans mes oreilles — *La Furia francese* — la grande épopée, les chevauchées à travers l'Europe. Il est vrai qu'on avait alors ce

Malgré les plus grandes précautions, quelques éboulements se produisent, des débris de paille s'y mélangent. Bref, par endroits, les boyaux sont plutôt congestionnés.

Un matin, le sergent Poilu S..., un loustic de la 1re compagnie du ... régiment d'infanterie active faisant sa ronde, fatigué de ne pouvoir obtenir plus de propreté, fit appeler le caporal de son escouade.

Vous allez prendre deux hommes de corvée avec vous, vous irez à l'ambulance de T... et vous donnerez ce bulletin au pharmacien.

Quelques instants après, le caporal partait avec deux jeunes Poilus — types classe 1914 — des collégiens, quoi ! Après de nombreux détours, ils arrivent à T... et se présentent au pharmacien de l'Ambulance. Le caporal remet le Bon que lui avait donné le sergent. Il était ainsi conçu :

« Bon pour 100 k. de sulfate de soude pour purger les boyaux de la marquise ».

Le pharmacien partit d'un éclat de rire, et sans se démonter, il remit aux trois bleus qui ne comprenaient pas la cause de cette hilarité

NEWSPAPER EDITED AND PRINTED IN THE TRENCHES

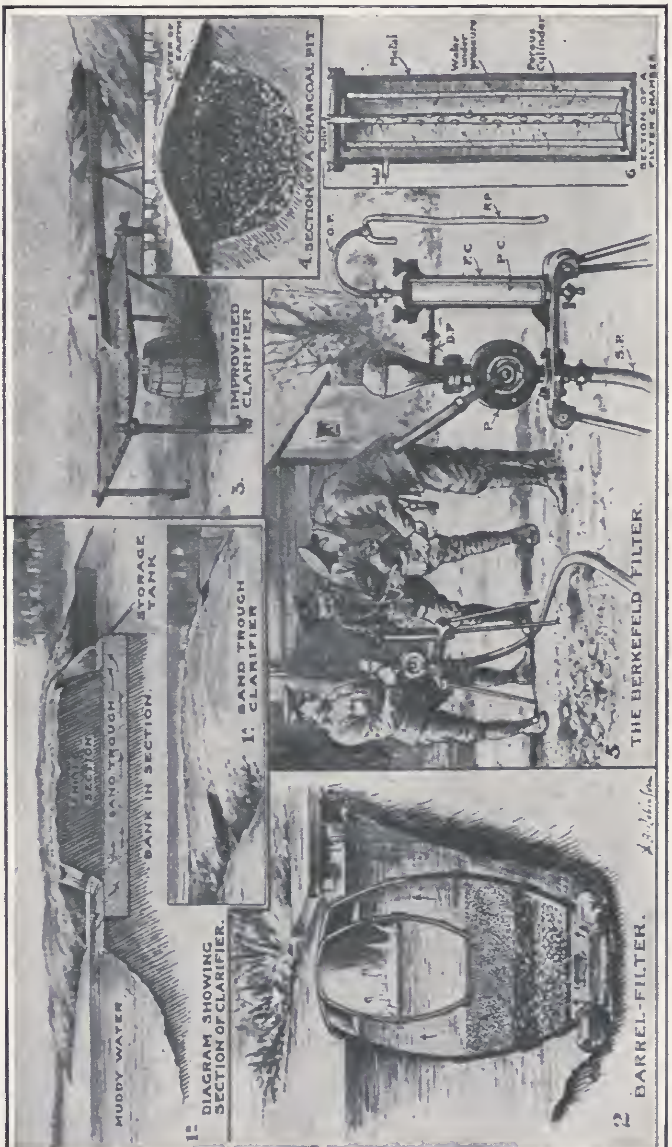
with bayonets fixed for the hand-to-hand struggle with the enemy's men that still remain in the conflict.

All the time the supporting artillery must

So accurate is the ballistic control that artillery fire is kept up over the heads of the attacking troops and the shell and shrapnel fuses can be cut to burst only 400 yards beyond them. This bombardment of the ground close in front keeps the enemy's riflemen under cover till the last minute and saves many lives for the attackers. Artillery thus becomes the indispensable arm of trench warfare. The artillery gains the dominance, while the infantry clinches the advantage.

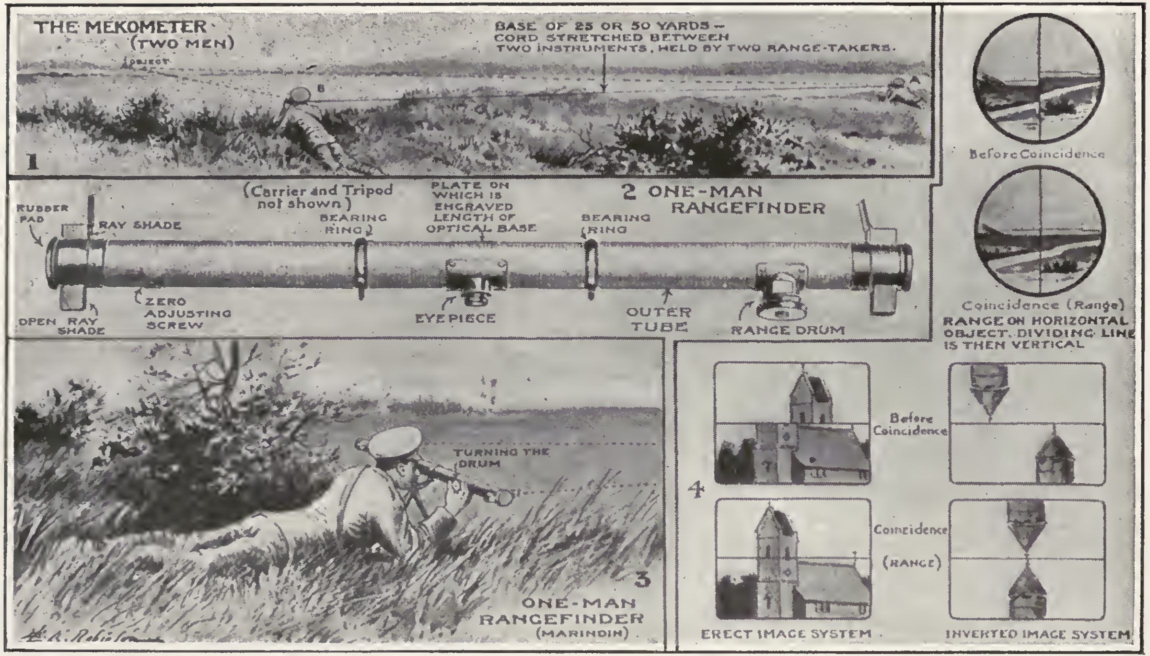
The above describes one incident of the fighting. It requires careful planning and preparation to assemble the troops and to provide the immense amount of munitions needed without betraying the project. From beginning to end the forces engaged must work together with perfect discipline. The final assault must nearly always be made at night to reduce the exposure and the consequent losses. The cost is great if successful, but is still greater if repulsed.

Every trench gained requires these tactics. Sometimes the assault carries several lines of trenches, but generally the defense stiffens so that only the advanced line is captured. The advantage must be gained one step at a time, each the preparation for the next. Only by a long series of small gains, each tending toward a general end, can an advance be gained that will have immediate strategic results.



Courtesy of the Illustrated War News

PURIFICATION OF WATER. MAKESHIFT CLARIFIERS AND PORTABLE FILTERS



Courtesy Illustrated War News

TYPES OF INSTRUMENTS WHOSE ACCURACY AND MANIPULATION MAY CAUSE VICTORY OR DEFEAT. AS EXPLAINED IN THE ARTICLE, FIG. 1 SHOWS A RANGE-FINDER KNOWN AS THE MEKOMETER, THAT NEEDS TWO MEN TO WORK IT. FIG. 2 SHOWS A ONE-MAN RANGE-FINDER; FIG. 3, THE SAME IN USE; AND THE SMALLER DIAGRAMS SHOW THE IMAGES SEEN RESPECTIVELY WHEN THE INSTRUMENT IS HELD HORIZONTALLY AND VERTICALLY. AN ARTILLERY RANGE-FINDER MUST BE A GOOD HORSEMAN, HAVE A GOOD EYE FOR COUNTRY, KEEN EYESIGHT, AND, ABOVE ALL, STEADY NERVES. ANY NERVOUSNESS WHILE TAKING A RANGE MAY EASILY GIVE AN ERROR OF A HUNDRED YARDS OR MORE, WHICH MIGHT MAKE THE DIFFERENCE BETWEEN VICTORY AND DEFEAT. THE ADVANTAGE IS WITH THE BATTERY WHICH DROPS A SHELL ON THE RIGHT SPOT AT THE CORRECT RANGE

Chapter XVIII.

"GETTING THE RANGE"

Instruments Which Make Gun Fire Effective at Distances Up to Ten Miles

CLOSE one eye, and then bring the tip of the index finger down upon any small object within reach and at about the level of the open eye. A man who has never tried this experiment will be astonished to find that his finger may overreach or fall short of the object by as much as an inch or more, and yet using both eyes, he could act with such accuracy as to bring two pinheads together at the very first attempt. This shows how much we depend upon triangulation for the judging of relative distances. With a camera one may gage distances up to one hundred feet or so by carefully noting the length of focus necessary to produce a sharp image on the ground glass. Similarly with the naked eye, we may estimate short distances by the change of focus in the eye itself; but for greater distances we have to utilize the principles of triangulation employed in range-finding.

A FIELD TELEMETER OR RANGE-FINDER AS USED BY OFFICERS OF THE AUSTRIAN ARMY TO STUDY THE POSITIONS OF THE RUSSIAN FORCES. THE OBSERVERS, CONCEALED BEHIND BREASTWORKS, ARE ENDEAVORING TO LOCATE AND DETERMINE THE RANGE OF THE HIDDEN BATTERIES OF THE ENEMY IN ORDER TO DIRECT THE FIRE OF THEIR OWN GUNS

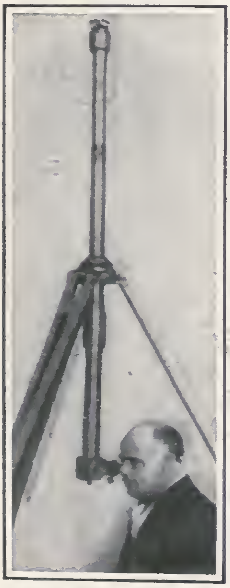
In a loose sense of the term we are all "cross-eyed" most of the time. In order to see an object, the eyes must converge or turn in so that the optical axes will cross upon it. The nearer the object, the more they turn in. It is only when "day-dreaming," or looking at an object an infinite distance away, that the optical axes are strictly parallel.

Harking back to our school days, we recall that the triangle is a figure with which much mathematical juggling may be done. It possesses three sides and three angles, and if any one side and any two of the other five elements be known, the whole triangle, no matter what its shape, can be reconstructed, and the size of every angle and side be determined. Whenever we look at an object we solve unconsciously a problem in trigonometry. A triangle is formed, with the eyes at two corners and the object at the third. The base of the triangle is the distance between the eyes, and the convergence of the eyes gives us two angles at each end of the base. No one bothers to find out the length of this base line or the value in degrees of the two angles, but by long practice everyone has acquired an ability to gage the tri-

THE PERISCOPE RAISES THE EYES FAR ABOVE THE SURROUNDING COUNTRY angle by unconsciously testing the muscular strength required to train the eyes upon the object. While few of us have learned how to gage actual distances, we can all sense the relative size of triangles with such precision that, for objects within a short range, we can tell to a sixty-fourth of an inch whether one object is nearer to us than another; because in looking from one object to the other there is an infinitesimal contraction of the angle of convergence. The actual change in this angle is measurable in seconds of arc, and yet we can feel and gage the slight tug of the muscles necessary to swing the eyes through this minute angle.

The reason the change of angle is so small is because the distance between the eyes is but one fifth of a foot. But what if we had a broader eye-base? If our eyes were set apart as far as an elephant's, how much more distinctly would distant objects stand out in relief? What if we used some artificial means of virtually spreading them apart a dozen feet or more? That is what

GERMAN OFFICERS WATCHING THE EFFECT OF THEIR GUN FIRE



THE WHOLE HORIZON IS VISIBLE WITH PANORAMIC PERISCOPE

Cuts pages 119-120 from Ueber Land und Meer

CLEVERLY DISGUISED PERISCOPE

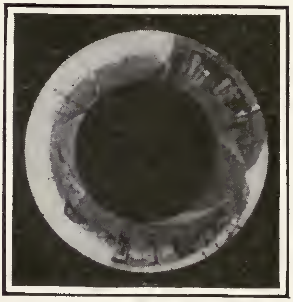
SCISSORS PERISCOPE WITH SHIELD FOR RIFLE FIRE the modern range-finder does, and it is also equipped with means for measuring the convergence necessary to train the gaze upon a distant target. With a base of fixed length and the measure of the two angles at the ends of the base known, it is then a simple matter to reconstruct the triangle formed

CIRCULAR LENS ON PANORAMIC TELESCOPE

between the range-finder and the object and to determine the distance of the object from the range-finder.

Fig. 1 shows a typical range-finder which will be seen to consist of two telescopes with a single eye-piece. In the illustration the eye-piece is shown at *A*, and it will be seen

which divert the rays entering the apertures of the range-finder, and send them at right angles into the objectives. Thus, an observer at *A* will see two images, one above the other, the upper image being that which he sees through the right-hand end of the range-finder, and the lower image that which comes



VIEW OF CITY IN PANORAMIC TELESCOPE

in at the left-hand end. The view will be something like that shown in Fig. 2, in which the upper half of the field of vision is out of register with the lower half. In order to bring the two images into coincidence, circular glass wedges *E* and E^1 are placed before the prisms *D* and D^1. By operating a

AN EXTEMPORIZED PERISCOPE. THE TRENCH PERISCOPE, A TWENTIETH CENTURY INNOVATION

that the telescopes run at right angles to the eye-piece in opposite directions, one of the objectives being indicated at *B* and the other at B^1, while the two crossed prisms *C* and C^1 turn the rays that enter the objective into the ocular *A*. At the ends of the range-finder tube are two pentagonal prisms, *D* and D^1,

thumb screw which is not shown in Fig. 1, because it lies above the plane of the section, the two circular wedges are simultaneously rotated, bending the rays that enter the range-finder until the two images seen in the ocular are brought into coincidence. A micrometer device measures the amount of rotation necessary to produce this result. But, instead of giving the measurement in degrees, it is calibrated to give the linear distance of the target from the range-finder. The calibration may be seen through the second eye-piece *F*, which, by means of a pair of prisms, is brought to bear upon the micrometer scale.

Of course, the longer the base line of the instrument the more efficient it is. Range-finders used on ships may use a base line a dozen or more feet in length, but for field service this would be entirely too bulky. The ordinary portable range-finder has a base between three and four feet long. In the case of fixed artillery in forts, ranges are found by placing observers a mile or more apart and connecting them by telephone or telegraph in such a way that they may make simultaneous observations from each end of this long base line and report to a common chart room where angles are worked out and the position of the target determined with a wonderful degree of accuracy.

Range-finding has been reduced to such a science that it is necessary to conceal batteries or guns. The battery must be kept out of sight, and it must fire at an enemy which also remains out of sight. The man who directs the firing may be at a great distance from his battery, located at some point of vantage, where he may obtain the range and signal it to his gunner. Knowing that at any moment he may become the target of the enemy's fire, and realizing the accuracy of modern artillery, it is very necessary for him to remain concealed. Some of the methods of concealment are shown in the accompanying photographs. A system similar to that of the submarine periscope is employed in the German army, so that a man hidden behind a natural breastwork may raise his artificial eyes far above him. Even the top of the periscope is frequently disguised by wisps of straw, so that it is next to impossible for the enemy, at the enormous range of modern fighting, to discover his whereabouts.

JAPANESE USING A RANGE-FINDER AT TSINGTAU

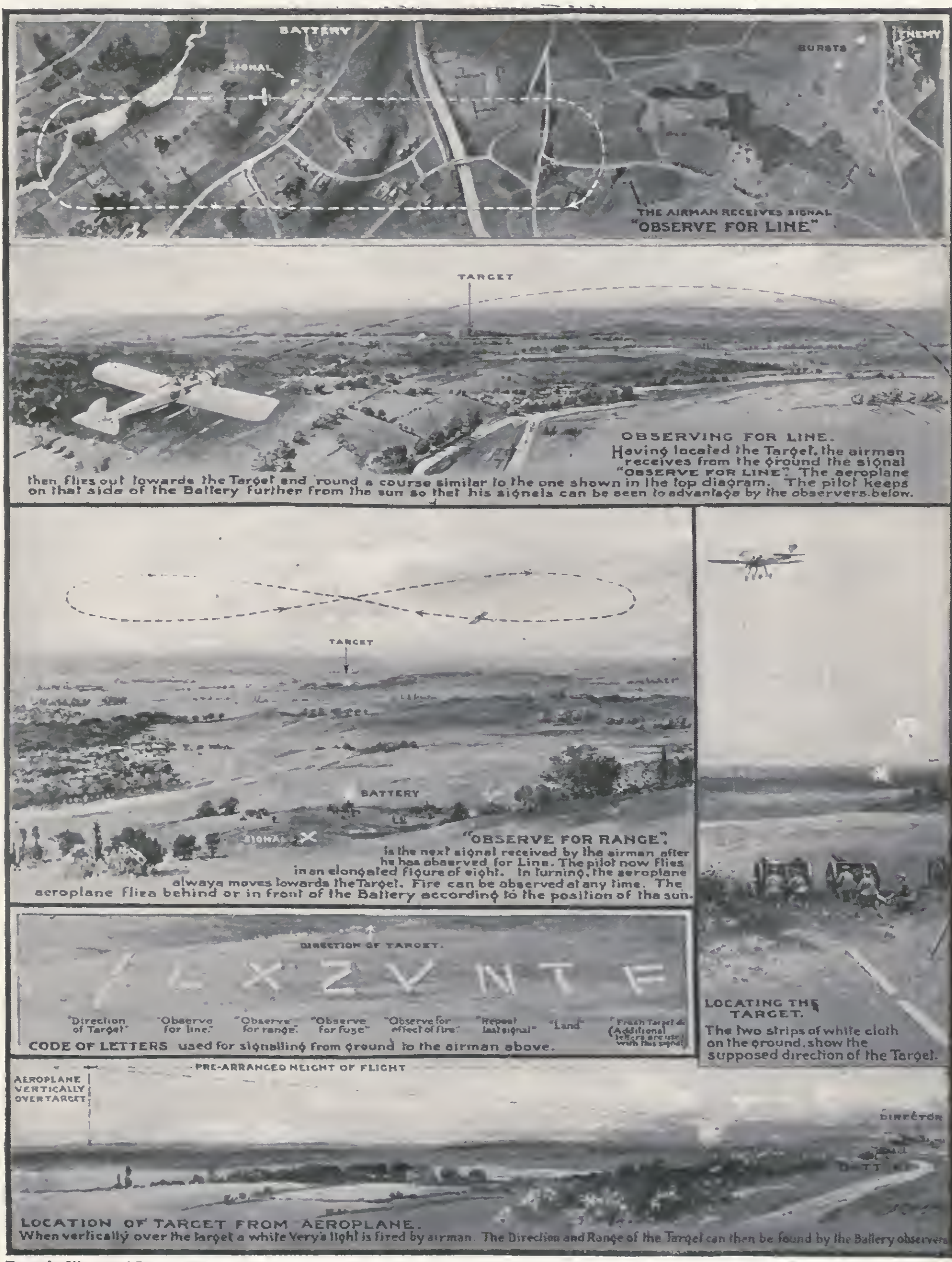
Not only is it necessary to foretell the range, but the observer must confirm his estimate by watching the actual effect of the fire of his guns. He may find that he has underestimated the distance of the target and must signal to have the guns elevated accordingly. For such purposes a range-finder is not required, but field glasses may be used; these, also, are arranged like the periscope of a submarine to protect the observer.

In the great European war the aeroplane has proved invaluable for locating the enemy and directing the fire of artillery. Herewith is a series of pictures illustrating how the man in the sky locates and signals the range to the man behind the gun. The aviator rises to a prearranged height and, maintaining that altitude, flies in the supposed direction of the enemy. As a guide, strips of white cloth are laid on the ground. Such a guide is shown in one of the illustrations, but it will be understood that this, as well as the code letters, are merely typical signals and do not represent any actually in use. After the airman has located the target, he sails right over it and signals by dropping a Very's light, using one or a number grouped in some prearranged combination. Two observers near the guns with instruments between them check the distances automatically, which they can do with considerable accuracy since the aeroplane's height above the ground is known. The firing can then begin. The direction or line of firing is checked by the airman, who steers in an elongated oval between the batteries and the enemy, signaling with Very's lights. Similarly he reports how the shells are bursting, whether short or beyond the target, or whether they are landing true.

The range-finder we have shown in Fig. 1 is merely typical of the kind usually employed. There are a great many modifications of it; too many to describe here. In some the upper half of image field is inverted, as shown in Fig. 3. This is claimed to give a better guide to perfect alinement of the two images. In other range-finders prisms are avoided and mirrors are used instead, so as to overcome distortions due to variations of color. Yellow rays predominate if the air is saturated with moisture, red if the air is dry, and blue or blue-green on a dull, cloudy day, and so the range-finder will be found to err in overestimating or underrating the distances, according to the state of the weather. These, however, are refinements which only concern the man who has actually to use these instruments.

PERISCOPE FIELD-GLASSES CONCEALED BY A WISP OF STRAW

There are some range-finders based on entirely different principles from the one we have illustrated in Fig. 1. Figs. 4 and 5, for instance, show a range-finder which depends upon a knowledge of dimensions of the target. If, for instance, we know the height of the stack of a battleship above water, we may readily determine the distance of this target from us by measuring the height of the image produced in our field glass. Fig. 5 illustrates the principles of the device. Here we have two triangles meeting at the object glass *G* of the telescope, the line *H*, *I* being the known height of the target and H', I' the height of its image in the telescope. The two triangles are similar, hence one is as much larger than the other as H, I is larger than H', I'. The method of measuring H', I' is shown in Fig. 4.



From the Illustrated London News

HOW THE TARGET IS FOUND AND THE RANGE IS CHECKED BY AIRMEN

Attached to the eye-piece of the telescope is a device containing a pair of disk prisms or wedge-shaped plates of glass, which may be adjusted by means of a micrometer screw to elevate a part of the image. When, as in Fig. 4, the elevation is sufficient to bring the water-line of the part seen through the prisms to a level with the smokestack shown in the rest of the image field, the height of the image of the smokestack above the water is measured on the micrometer scale. But, instead of giving this height in fractions of an inch, the device may be set for a unit height, when the scale will give the actual distance of the object. In this case, for instance, the height of the smokestack may be 25 yards above the water, and the observer may so readily change the dimensions of his ship and thus deceive the observer. However, this device may be used in conjunction with an ordinary range-finder, so that once the distance of the ship has been discovered, this simple instrument will show whether it is moving farther away or toward the observer

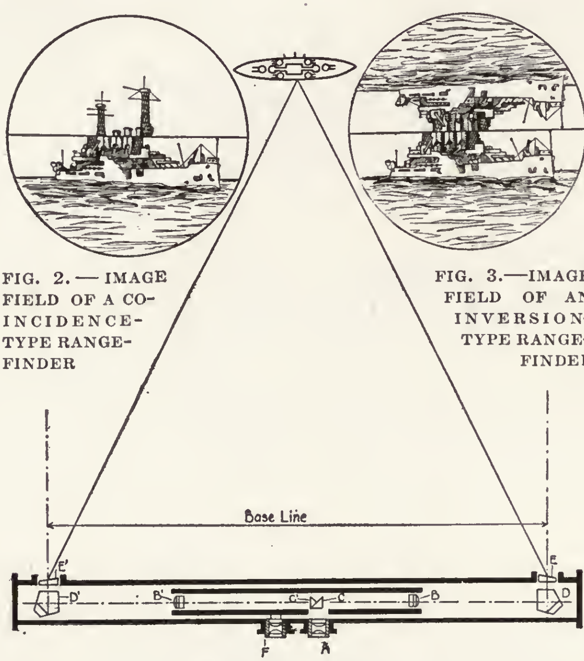


FIG. 2.—IMAGE FIELD OF A COINCIDENCE-TYPE RANGE-FINDER

FIG. 3.—IMAGE FIELD OF AN INVERSION-TYPE RANGE-FINDER

FIG. 1.—DIAGRAMMATIC VIEW OF A TYPICAL RANGE-FINDER

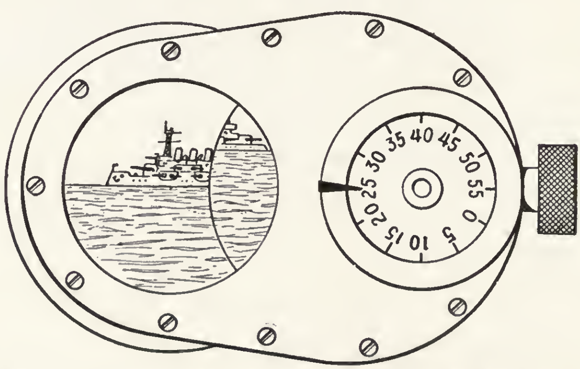


FIG. 4.—INSTRUMENT FOR MEASURING THE IMAGE OF AN OBJECT OF KNOWN HEIGHT

may know that for such a height each mark represents a hundred yards. As the observer found it necessary to turn the scale until 25 came opposite the marker, he knows at once that the battleship is 2,500 yards away.

It is seldom that one can depend upon an instrument of this sort, because the enemy and at what rate. For this reason it has been termed a "range-keeper."

Another range-finding device depends upon the known height of the observer above water level. This instrument, of course, can be used only on the sea, or in taking observations from the land on objects at sea. As is commonly known, the horizon lies always practically at the level of the eye, so that a line running from the eye to the horizon is practically a horizontal line. A truly horizontal line may be obtained by taking observations on the horizon fore and aft, at the same time, with a double telescope, and correcting the instrument accordingly. Now, if an observer is situated twenty-five yards above the sea and wishes to discover the range of an object between him and the horizontal plane, he may measure the angle through which he must depress the axis of one of his telescopes to train it upon the object, while the other remains fixed upon the apparent horizon. As is shown in the insert in Fig. 6, the apparent horizon or truly horizontal line is indicated by the line *KL* and *l* is the angle it makes with the object located at *M*. The observer knows his height above water level, which is *LN*, and drawing a line from *M* to *N*, we have a right-angled triangle *LMN*, in which the line *MN*, being also horizontal, is parallel to the line *KL*. Now, the angle *l* must equal the angle *m*, as our geometries taught us along ago, and we have, thus, a triangle in which one side *LM* and two angles *m* and *n* are known. With this knowledge we can easily estimate the length of the side *LM* or *MN* and determine the distance of the target *M* from the top or the bottom of the tower. The advantage of this system, of course, lies in the fact that it gives the observer a broad base line to work with, and thus enables him to determine the position of the target with greater accuracy.

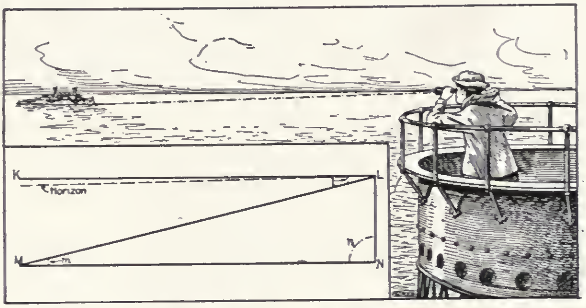
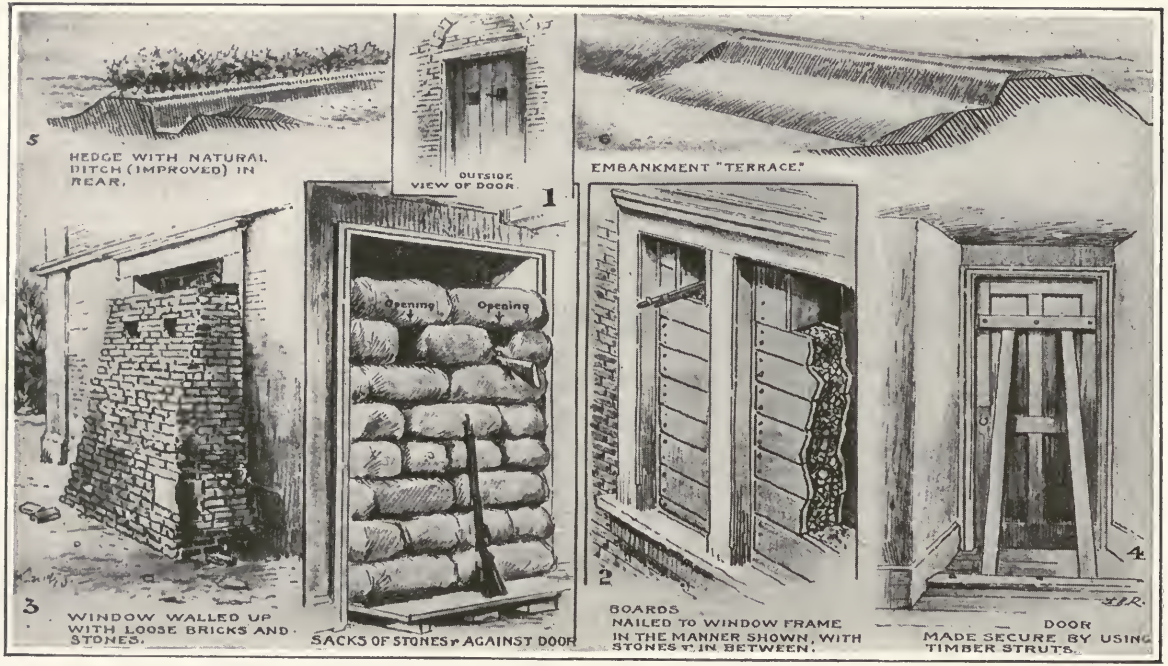


FIG. 6.—RANGE FINDING IN WHICH THE OBSERVER'S HEIGHT ABOVE THE SEA SERVES AS A BASE LINE.



Courtesy Illustrated War News

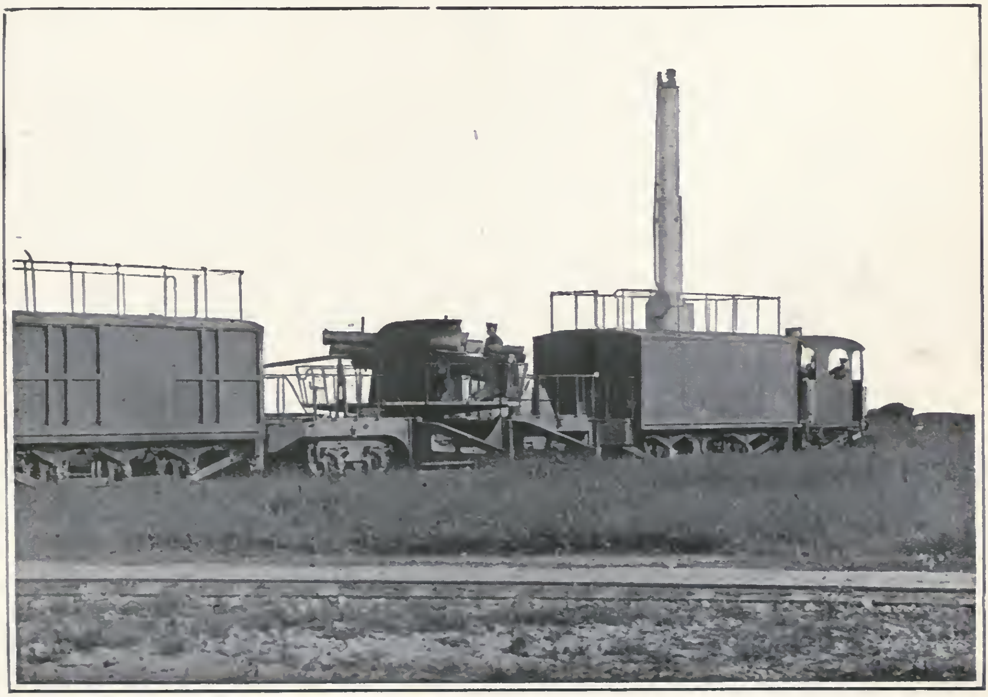
IMPROVISED DEFENSES, AND DEVICES USED FOR THE IMPROVEMENT OF EXISTING COVER. THE TAKING OF COVER IS ONE OF THE ARTS OF MODERN WARFARE, AND IT FOLLOWS THAT THE IMPROVEMENT OF EXISTING DEFENSES, NATURAL OR ARTIFICIAL, IS A MATTER OF EQUAL IMPORTANCE IN THE OPERATION OF TROOPS. THE NATURE OF SUCH DEFENSES, OF COURSE, VARIES TO AN ALMOST UNLIMITED EXTENT ACCORDING TO THE CHARACTER OF THE LOCALITY AND THE KIND OF MATERIALS AVAILABLE FOR CONSTRUCTING THEM. THE ILLUSTRATIONS SHOW A NUMBER OF TYPICAL METHODS BY WHICH HOUSES, WALLS, HEDGES, EMBANKMENTS AND SO ON CAN BE PUT INTO A STRONGER STATE OF DEFENSE FOR THE USE OF INFANTRY

Chapter XIX.

A FORT THAT TRAVELS ON WHEELS

Schneider Mobile Batteries for Coast Defense

MOBILE batteries running on rails are well qualified to defend a long line of coast. Their use renders it possible to do away with batteries which it would be otherwise necessary to provide for the defense of areas included between the principal defensive fortifications. By reason of their great mobility, these batteries can be rapidly moved to points where it is necessary to reinforce the defense, to enter immediately into action, or to withdraw, either because they may be required elsewhere or to escape a well-directed fire.



THE COMPLETE SCHNEIDER COAST DEFENSE TRAIN BATTERY. IN THE CENTER IS THE AMMUNITION CAR; ON EACH SIDE ARE THE TWO GUNS; AND TO THE RIGHT IS THE OBSERVATION CAR

The temporary consolidation of a certain number of guns will constitute a kind of movable fort, powerful and very economical. The mobility of the batteries will be a protecting element far more efficacious than the ramparts of permanent forts, upon which, because of the advanced position of the outworks, the fire of an enemy can be concentrated.

In addition to these various advantages, mobile batteries present other merits, the principal ones of which are:

(*a*) Since the mobile batteries can take the place of fixed coast batteries of the same offensive power, but of much more costly construction, there is great economy in the preparation of the defense. It is necessary merely to provide a railway.

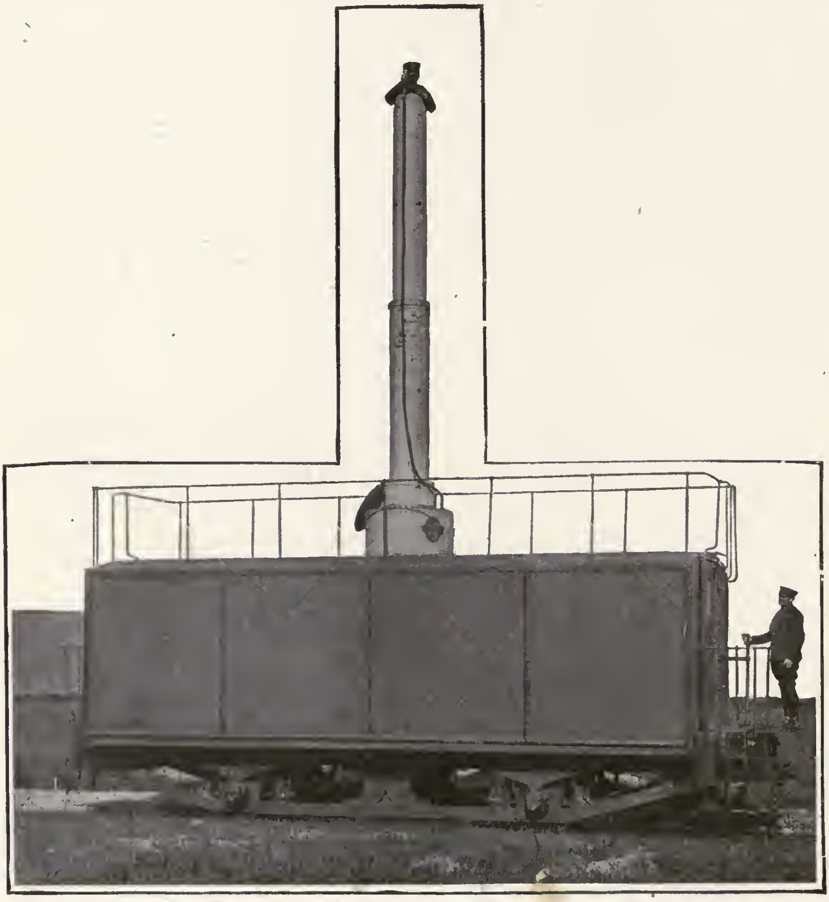
(*b*) Complete secrecy of the plan of defense, since the placing of a battery in position is not betrayed by preliminary work.

(*c*) A better utilization and economy of material, since the guns will not be uselessly stationed in fixed positions in permanent work.

(*d*) The material can be more easily kept in condition; for in time of peace the batteries can be stored under cover and sheltered from intemperate weather.

(*e*) It will be unnecessary to establish strategic roads for conveying siege or field artillery material on wheels.

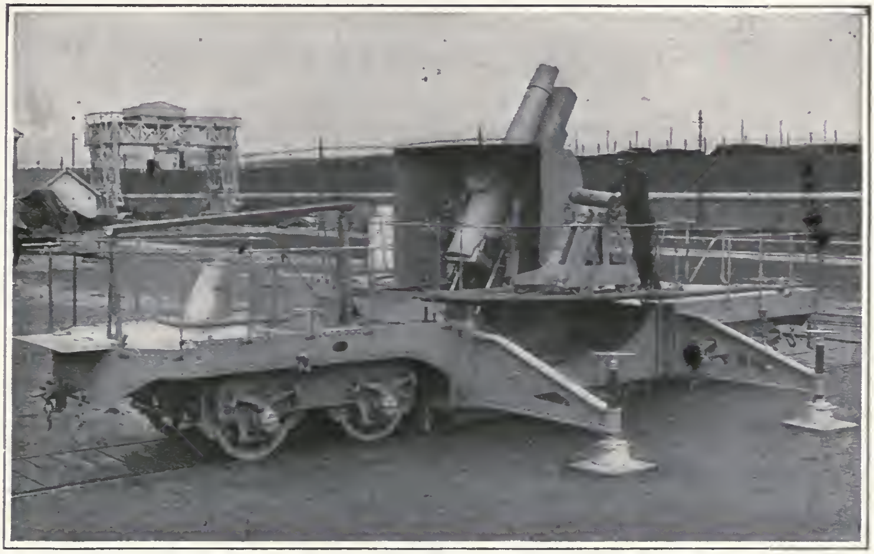
(*f*) The railway can be employed for other purposes than those of the artillery. Thus, in time of war it can be used for the rapid transportation of infantry and the conveying of the necessary ammunition to the defending batteries; and in time of peace for the economical development of the coast by the transportation of merchandise and passengers. The system herewith illustrated has been developed by Schneider & Co., the well-known makers of armor and guns.



OBSERVATION CAR WITH FIRE-CONTROL OFFICER AT THE TOP OF TELESCOPIC MAST. NOTE TELEPHONE CONNECTION

The mobile battery consists of two massive steel cars, each carrying an 8-inch rapid-fire gun, an ammunition car, and an observation car, the whole constituting a train of four cars drawn by a locomotive on an ordinary railway. The gun car is provided with two bogie trucks and a sheet-steel platform, lower in the middle than at the ends, in which lower part the 8-inch piece is carried on a central swivel-mount. The gun and its carriage are similar to other modern coast-defense weapons designed by Schneider. The body of the car, the frame, and the brakes are all similar to the corresponding parts on the ammunition car.

The observatory consists of two movable tubes, telescoping one within the other, and of a short, fixed section of tube carried on the car itself, and extending down to the frame. The fixed tube section serves to guide the movable sections. The movable tubes are telescoped into the fixed tubes when the train is traveling to its destination. The smaller movable tube has an observation platform at



EIGHT-INCH RAPID-FIRE GUN ON CAR WITH STEADYING ARMS SWUNG OUT INTO POSITION

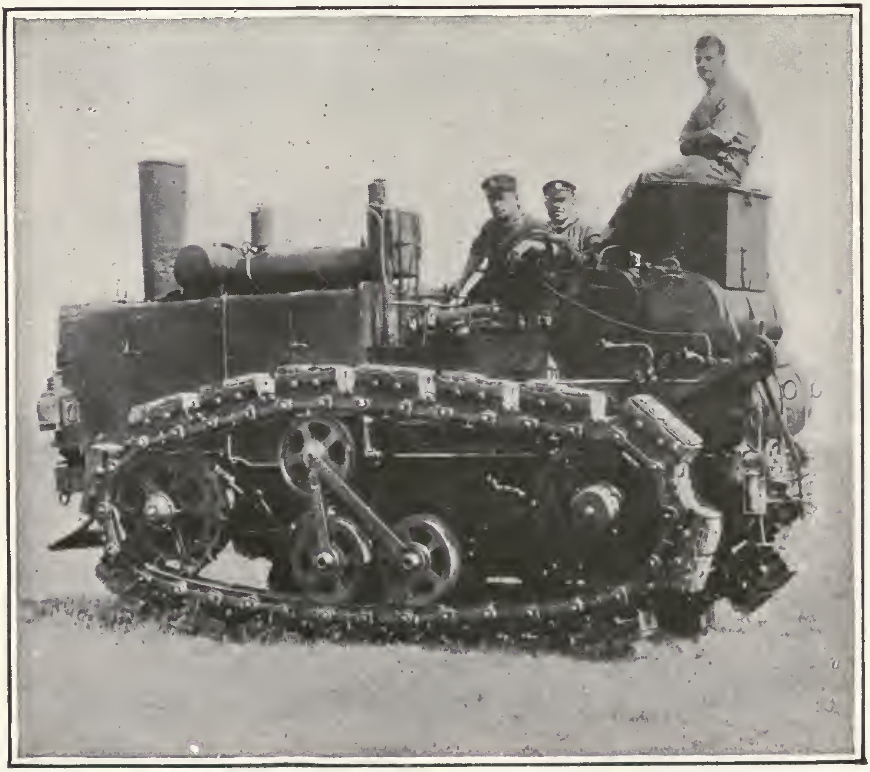
INTERIOR OF AMMUNITION CAR; CRANE PICKING UP SHELL FROM THE SHELL RACK its upper end. The tower is operated by means of a hand-operated hoisting apparatus within the car.

The gun has a caliber of 8 inches. Weight of projectile is 220 pounds; initial velocity, 1,400 foot-seconds; total length of the gun barrel, 11 feet; maximum elevation, 60 degrees; maximum depression minus five degrees; arc of fire, 360 degrees; weight of the gun without breech blocks, 3,560 kilogrammes; weight of the breech block is 140 kilogrammes; weight of the entire gun mounting and car, 1,145 kilogrammes. The hydraulic recoil brake is so constructed that the recoil can be readily taken up by the truck and the rails of the track. The mechanism for returning the gun to battery is sufficiently powerful to bring the piece into position, even when the gun is trained at the maximum angle of fire. The side members of the platform carry two articulated swinging supports, the outer ends of which carry screw-adjusted base plates, which are employed when the gun is swung around with its longitudinal axis at right angles to the length of the car. Ammunition is served to the gun by means of a small carriage which runs on a circular rail surrounding the piece.

The ammunition car is placed between the two gun cars in the train, so as to supply both pieces with projectiles. The projectiles are stored in racks arranged within the car in a horizontal position. The car is armored with plates one inch in thickness.

The observation car is usually coupled directly to the locomotive. From this position the commanding officer can place his guns in the most favorable positions, or to select a more advantageous point of observation.

The observatory at full extension provides an excellent platform for spotting the fall of the shots.



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BRITISH CATERPILLAR TRACTOR. THE WARRING NATIONS HAVE FOUND THE CATERPILLAR AND PED-RAIL TYPE OF TRACTOR INDISPENSABLE FOR HAULING ARTILLERY AND EQUIPMENT OVER UNEVEN GROUND. THIS PICTURE SHOWS A MACHINE USED BY THE BRITISH ARMY. INTERMEDIATE OF THE MAIN SPROCKET WHEELS ARE IDLERS ADAPTED TO TAKE UP SLACK AND PROVIDE BETTER TRACTION

Chapter XX.

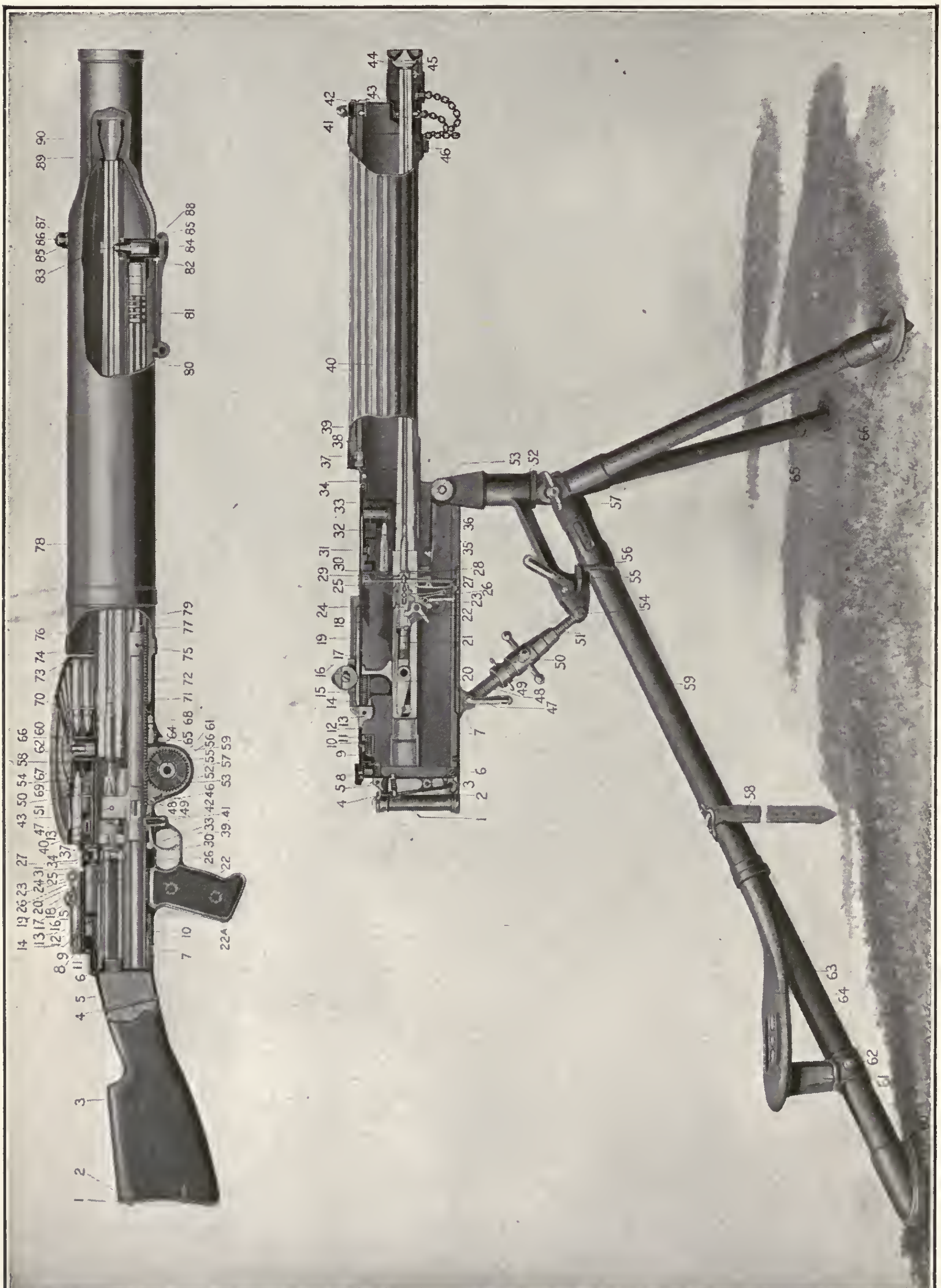
RAPID FIRE MACHINE GUNS

The Leaden Torrent is a Great Repeller of Charges

WHILE the idea of a rapid fire gun is old, its practical realization had to await the coming of the metallic cartridge. The machine has now become one of the most deadly weapons, for it has proved invaluable for repelling a charge, in defending trenches, either by direct or enfilade fire, and when mounted on a motor vehicle it is indispensable in a foray or a reconnaissance in force within the hostile territory. These machine guns, of which there are many different makes, each country having developed

THE LEWIS GUN IN ACTION

some special style, all have a single barrel, which is in some cases kept cool by a water jacket, in others by air radiation. In many ridge belt. This band usually carries two hundred and fifty cartridges, which are automatically fed into the gun barrel, one at a



DETAILS OF THE LEWIS (UPPER) AND MAXIM (LOWER) RAPID FIRE MACHINE GUNS. DEVICES THAT CAN POUR FORTH A LEADEN TORRENT AT THE RATE OF A THOUSAND BULLETS A MINUTE, MAKING THE ADVANCE OF TROOPS A PRACTICAL IMPOSSIBILITY

cases the ammunition is fed to the gun by means of a belt which carries the cartridges separately in loops, like the ordinary cart- time as the belt passes through the breech of the gun. In some machines the cartridges are fed from a magazine placed upon the breech of the gun, and which can be quickly replaced as fast as its contents are exhausted. Among the prominent English automatic machine guns now being used in the war are the Maxim, Lewis, and Vickers, the two former of which are shown in the accompanying illustrations; while the American Colt is also extensively used. The Maxim gun shown has the belt feed, and a water-cooling jacket, while the Lewis has a magazine feed, and is air-cooled. When in use machine guns are generally mounted on a light metal tripod, which can be readily folded up for transportation; and the entire outfit can be carried on the backs of horses, or even of men, for even the heaviest weigh only about sixty-eight pounds complete. Their lightness and mobility are of inestimable value.

The Lewis Light Magazine Gun

ALTHOUGH the modern machine gun is a most valuable and efficient weapon it still falls short of present military requirements; for army experts are demanding an arm that shall have all the characteristics of the machine gun, and the portability and simplicity in handling of an ordinary rifle. As an approximation to this demand, and a forecast of what the gun of the future will be, the Lewis gun is shown, for in it we have a weapon that can be fired from the shoulder, like a service rifle, although it would require a strong man to use it in this way. This gun is supplied with ammunition from a rotating drum magazine that holds about fifty cartridges which can be discharged in four seconds, a fresh magazine being substituted in two seconds, and the speed of fire can be regulated as desired between 350 and 750 shots a minute. Underneath the rifle barrel is located a cylinder that contains a piston connected with the operating mechanism of the arm; and near the forward end of the barrel there is an opening into the operating cylinder, in front of the piston. When the gun is fired the gases of the explosion, under high pressure, are admitted to the cylinder when the bullet passes the gas port in the barrel, and this pressure continues until the bullet leaves the muzzle, when the gas pressure is released. The gas pressure drives the piston in the operating cylinder backward, to perform the operations of ejecting the empty cartridge, inserting a fresh cartridge and setting the firing pin ready to fire another shot. The piston also partly winds a coiled spring, which acts to close the breech and return the various parts to the firing position after the operating piston has completed its action. By means of a valve at the gas port the speed of firing can be easily regulated.

An important feature of the gun is the cooling device, which consists of a series of deep, longitudinal ribs of aluminium fixed to the barrel. These are inclosed by a light sheet metal case, open at the rear, and projecting beyond the muzzle of the barrel by a contracted sleeve. The bullet passing through this sleeve when fired induces a draught of air which carries off the heat generated by the burning powder.

When firing this gun, if the trigger is pressed once, and then quickly released, only a single shot is delivered; but if the trigger is held back the mechanism will continue to operate until the magazine is empty, when it will stop, in the firing position, ready to resume as soon as a filled magazine is put on, and the trigger pulled again. For general use a light portable support is recommended, but, as has been said, it is possible for a strong man to use it like an ordinary rifle. Although the Lewis gun is largely manufactured in England, and before the war in Belgium, the inventor is an American, and an officer in the United States Army.

When a weapon of this kind is used it would be necessary to have one man to handle the gun and one or more men to carry ammunition; but this would far surpass individual rifle fire.

List of Parts of the Lewis Gun

1. Butt plate.
2. Butt plate screws.
3. Butt.
4. Butt tang screw.
5. Butt tang.
6. Feed cover latch.
7. Butt latch, securing butt to receiver.
8. Back sight bed spring.
9. Back sight bed spring screw.
10. Butt latch spring.
11. Back sight bed.
12. Feed cover latch pin.
13. Feed cover.
14. Back sight leaf.
15. Back sight thumb piece.
16. Back sight slide catch.
17. Back sight fine adj. worm.
18. Back sight fine adj. worm axis pin.
19. Back sight slide catch spring
20. Back sight slide.
22. Firing hand grip.
22a. Guard side rivets.
23. Back sight axis pin washer.

24. Back sight axis pin.
25. Back sight axis washer fixing pin.
26. Receiver.
27. Magazine pawls spring.
30. Trigger.
31. Feed operating stud.
33. Trigger pin.
34. Feed operating arm.
37. Bolt that closes breech and takes shock of discharge.
39. Guard.
40. Cartridge guide spring.
41. Sear spring.
42. Sear.
43. Magazine pan.
46. Gear stop.
47. Striker fixing pin.
48. Gear stop pin.
49. Gear stop spring.
50. Striker.
51. Cartridge spacer.
52. Gear operated by main spring.
53. Main spring casing.
54. Magazine top plate rivets.
55. Main spring which closes breech and returns parts to firing position.
56. Collet pin.
57. Main spring collet.
58. Magazine center.
59. Main spring rivets.
60. Magazine latch spring.
61. Gear casing.
62. Magazine latch.
64. Gear casing side piece.
65. Gear case hinge pin.
66. Feed operating arm latch.
67. Magazine top plate.
68. Receiver lock pin.
69. Cartridge spacer rivets.
70. Interior cartridge separators.
71. Radiator casing rear, locking piece.
72. Rack, actuated by piston and main spring.
72. Radiator casing rear, platform.
74. Radiator casing rear.
75. Piston connecting pin.
76. Barrel.
77. Gas cylinder.
78. Radiator for cooling barrel.
79. Piston operated by gases of exploding cartridge that ejects empty shell and resets firing pin.
80. Regulator key stud.
81. Gas regulator key.
82. Gas chamber.
83. Gas port.
84. Gas regulator.
85. Clamp ring.
86. Fore sight.
87. Clamp ring positioning screw.
88. Clamp ring screw.
89. Barrel mouth piece.
90. Radiator casing front.

The Maxim Machine Gun and Its Construction

THE basic idea of a multiple, or rapid fire gun, of the class now generally known as machine guns, is probably as old as the history of guns themselves. There is an old Chinese double-barreled gun in existence, which according to the inscription, was made in 1607, each barrel of which is provided with three vent holes so spaced that there is room for a charge of powder and a bullet between each vent. By this arrangement three shots could be rapidly discharged from each barrel, thus constituting a true rapid fire gun. Since the time of this weapon many devices having the same object have been designed; but the first weapon that proved actually practical was the multi-barreled gun invented in America during the civil war by Dr. Gatling. This gun was operated by hand power and was capable, in its improved form, of firing over a thousand shots a minute. It may be remarked that the original French mitrailleuse was never very successful.

The modern machine gun has but a single barrel, and is, in its most improved form, entirely automatic in its action; that is, after the first shot has been fired it will continue to fire at a very rapid rate, all of the necessary operations of loading and firing being worked by either the recoil or by the pressure of the exploding gases within the barrel. While the guns of the semi-automatic type have been made in fairly large sizes, the true machine gun is an automatic gun built to take only the regular service rifle cartridge used by the troops; and these guns operate at speeds of from 400 to about 1,000 shots a minute, depending largely on the size of the charge of explosive in the cartridge.

Parts of Maxim Automatic Machine Gun With Tripod

PARTS OF GUN AS ENUMERATED ON THE ACCOMPANYING DRAWING.

1. Handle block.
2. Firing trigger.
3. Trigger pin.
4. Tripper spring.
5. Safety catch to prevent accidental discharge.
6. Handle block pin.
7. Trigger bar.
8. Cover catch.
9. Cover catch spring piston.
10. Cover catch spring.
11. Cover catch guide.
12. Outside plate, left.
13. Sight rack.
14. Sight spring piston.
15. Sight spring.
16. Rear sight, complete.
17. Upper guide block.
18. Cover.
19. Recoil plate, left.
20. Crank.
21. Crosshead.
22. Tumbler.
23. Hand sear.
24. Firing pin.
25. Lock frame.
26. Main spring.
27. Lock frame fillerpiece.
28. Tail spring.
29. Gib spring.
30. Carrier.
31. Feed box slide.
32. Feed box.
33. Barrel.
34. Trunnion block.
35. Bottom plate.
36. Ejector tube spring.
37. Rear plug.
38. Inside slide.
39. Outside slide.
40. Water jacket for cooling barrel.
41. Front sight, complete.
42. Front plug.
43. Water jacket cap.
44. Nozzle.
45. Barrel disk.
46. Water plug for emptying.

PARTS OF TRIPOD.

47. Upper elevating pin.
48. Outer elevating screw.
49. Check nut.
50. Elevating nut.
51. Inner elevating screw.
52. Top carriage.
53. Trunnion pin.
54. Lower elevating pin.
55. Traversing clamp.
56. Traversing guide.
57. Wing nut to control line of sight.
58. Strap for binding tripod legs (when on the march).
59. Outer trail tube.
60. Trail shoe.
61. Seat support.
62. Seat bracket.
63. Inner trail tube.
64. Seat for operator.
65. Front legs.
66. Front shoes to support and prevent movement of tripod.

The New Vickers Light Automatic Rifle=caliber Gun

RECENTLY an improved type of the familiar Vickers light automatic rifle caliber gun has made its appearance, and commands attention owing to its greater mobility and ingenious tripod. In the main the principle of the gun remains the same as the service Vickers weapon of this type. The chief alteration is in the inversion of the lock, and the trigger bar is taken to the top of the casing, which is reduced in depth and which requires the crank to revolve in the opposite direction.

An appreciable reduction in weight has been also effected, for whereas the older weapon ready for use weighed 68¾ pounds, the new gun weighs only 36 pounds. This lessening of weight has been obtained by the use of high-class steel instead of gun-metal in the construction of all the parts, with the exception of some of the details of the water jackets, such as the water tubes, which are made of brass. Moreover, owing to the lightness of the recoiling parts, no muzzle attachment is required, so that no time is wasted in cleaning.

The inverted lock is of an improved type, the details having been simplified so that it can be stripped and assembled without using any tools beyond an ordinary punch. It is arranged so as to give an extra forward movement after the cartridge is placed in the chamber, whereby the shell charge is supported firmly at the instant of explosion, thus minimizing any tendency to break or to separate during firing.

VICKERS AUTOMATIC RIFLE-CALIBER GUN ON ADJUSTABLE TRIPOD. SEAT BEING USED AS KNEE PAD

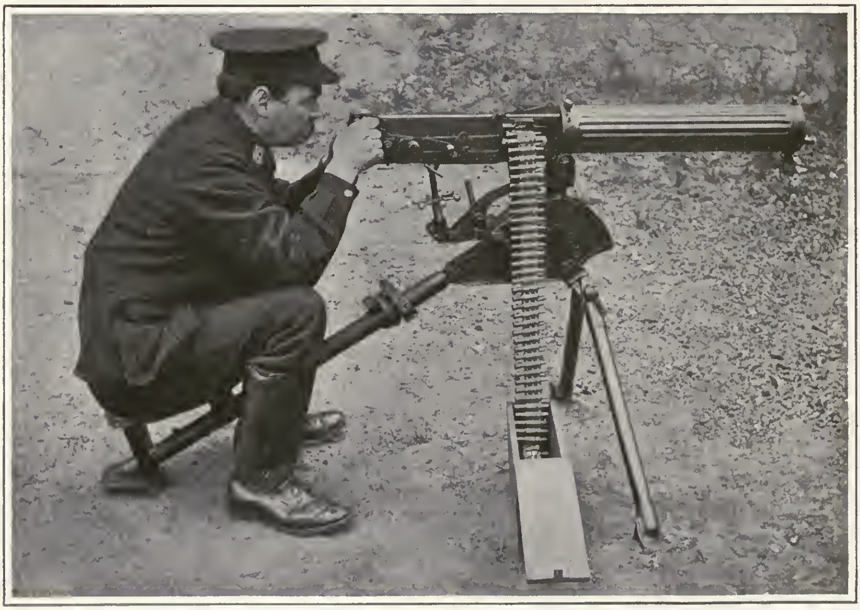
The most important feature is the adjustable tripod which enables the gun to be raised or lowered to suit any height of protection, either on a level surface or a sloping bank, and in such a way that the angle at which the gun is laid is not altered. The mounting can also be used as a parapet mounting with the training pivot vertical.

When it is desired to alter the height of the gun all that is required is to raise the rear leg of the tripod and to turn the adjusting handle until the desired height has been attained. The line of sight can be varied by sixteen inches, ranging from a minimum of 16 inches to a maximum of 32 inches, off the ground. About sixteen turns of the handle are required to raise the mounting from the lowest to the highest position.

No matter what may be the position of the gun it can be trained about the vertical pivot are provided which can be moved on the training arc and secured in any position. The maximum angle of training is 30 degrees on either side of the center.

The mounting is constructed with a top

LOWEST FIRING POSITION WITH ADJUSTABLE TRIPOD. GUN 16 INCHES ABOVE GROUND. ANGLE ELEVATION DOES NOT ALTER IN TRAINING. SEAT BEING USED AS ELBOW REST



HIGHEST FIRING POSITION OF THE ADJUSTABLE TRIPOD. GUN 32 INCHES ABOVE GROUND. ANGLE OF ELEVATION DOES NOT ALTER IN TRAINING. SEAT BEING USED FOR SITTING POSITION

without altering the angle of elevation. The angles of training are marked off on the training arc, and in order to limit the training between any desired points, two stops carriage consisting of cross head, elevating gear, training arc and training socket, which is movable on guides on the top of the adjustable tripod consisting of casing with adjusting gear, front legs, rear leg or trail and seat.

The front legs are attached to a Y-piece pivoted in the front bearing, which receives its movement when the adjusting nut is raised or lowered. On each side of the Y-piece is a bolt with an eccentric clamp for use in attaching the front leg, and above and radial from the bolt is a toothed segment adapted for engaging the teeth formed at the top of the front leg. By means of this arrangement the mounting can be adapted to uneven ground. The slope of the ground on which the gun may be adapted with the training pivot vertical varies from 5 degrees descending to 60 degrees ascending.

The front legs are made of steel tubing fitted with shoes to prevent their digging into the ground, and at the upper end with a link having a longitudinal slot so that they may be withdrawn from the teeth in the Y-piece or folded conveniently to the side of the tripod for the purpose of transport. The rear leg or trail is made of steel tubing with a fitting at the top end which hinges in the rear bearing, and which receives its movement from the adjusting nut. The lower end is provided with a trail shoe which has a deep flange to prevent it from slipping along the ground.

The seat is made of thin steel plates flanged and pressed into shape. It serves as a seat for the higher firing positions, and, being carried on hinged brackets and a sliding sleeve, can be pushed down flat on the trail to form a kneeling pad for the intermediate firing positions. The upper part of the seat is made in halves, which are hinged in front and which can be swung around horizontally to form elbow rests for the lower firing positions. The seat is locked in its different positions by a sliding bolt which has two projections engaging the seat flanges when the halves are together, and a projection moving in slots in the seat hinge when the halves are forward and forming elbow rests. When in this position a projecting piece in front from a washer secured to one-half of the seat hinge prevents the rear end from being raised, and the sliding sleeve is held from moving.

The illustrations show the tripod in use and also the adaptability of the weapon to uneven ground. When the gun is being used from behind a protection or embankment, the area exposed on the other side is extremely small.

Photo by Branger

THIS IS NOT A SIMPLE PEASANT'S HUT OR A MOUNTAIN CAMP, BUT THE INTERIOR OF A TRENCH IN THE VOSGES, MADE COMFORTABLE BY ALPINE CHASSEURS OF THE FRENCH ARMY

THE FILTER PRESS IS LARGELY USED IN THE MANUFACTURE OF EXPLOSIVES

Chapter XXI.

THE EUROPEAN INFANTRYMAN'S RIFLE

Comparisons of Mausers, Mannlichers, Lee-Enfields and other Weapons used in the War

BY EDWARD C. CROSSMAN

BRITISH RIFLES.

THE British were caught in bad shape when the great European war broke out. They have clung to the old Lee action, taken up in 1889, and with many changes have used it ever since despite its weakness and the advent of better rifles. Evidently the hope of an automatic military rifle prevented them from disarming their troops of the old Lee and re-arming them with a better rifle, like the Ross or Mauser.

They now use the short Lee-Enfield in the regular army, a rifle using chargers of five cartridges something like the clip of the Mauser, for refilling the Mauser magazine. Only the British rifle, having a protruding box magazine, holds ten cartridges or two clips at a time, against the five of nearly all other rifles like the Mauser and its American brother, the new Springfield—a Mauser with some changes.

Unhappily the territorials, or "militia," as we would call them, have the older long rifle, giving different shooting, and of course a nuisance were two forces of the two branches fighting on the same line. Both rifles are inferior in strength and simplicity to the Mauser. The British had an experimental rifle finished and a few ready for experimental issue when the war broke out—a Mauser firing the 0.280 cartridge much like the Ross.

Worse still, the British have a mixed lot of ammunition, and this might cause bad mixups in giving sight settings and calculating the fire of troops.

Very evidently the British have been badly blistered by the work of the despised German sharpshooters, and they lay most of the efficiency of these men to their telescopic rifle sights.

A number of men in every German company of infantry are supplied with the fine prismatic telescopic rifle sights, and with these to aid them in picking up and aligning the rifles upon almost hidden foes, they do murderous work in their sniping.

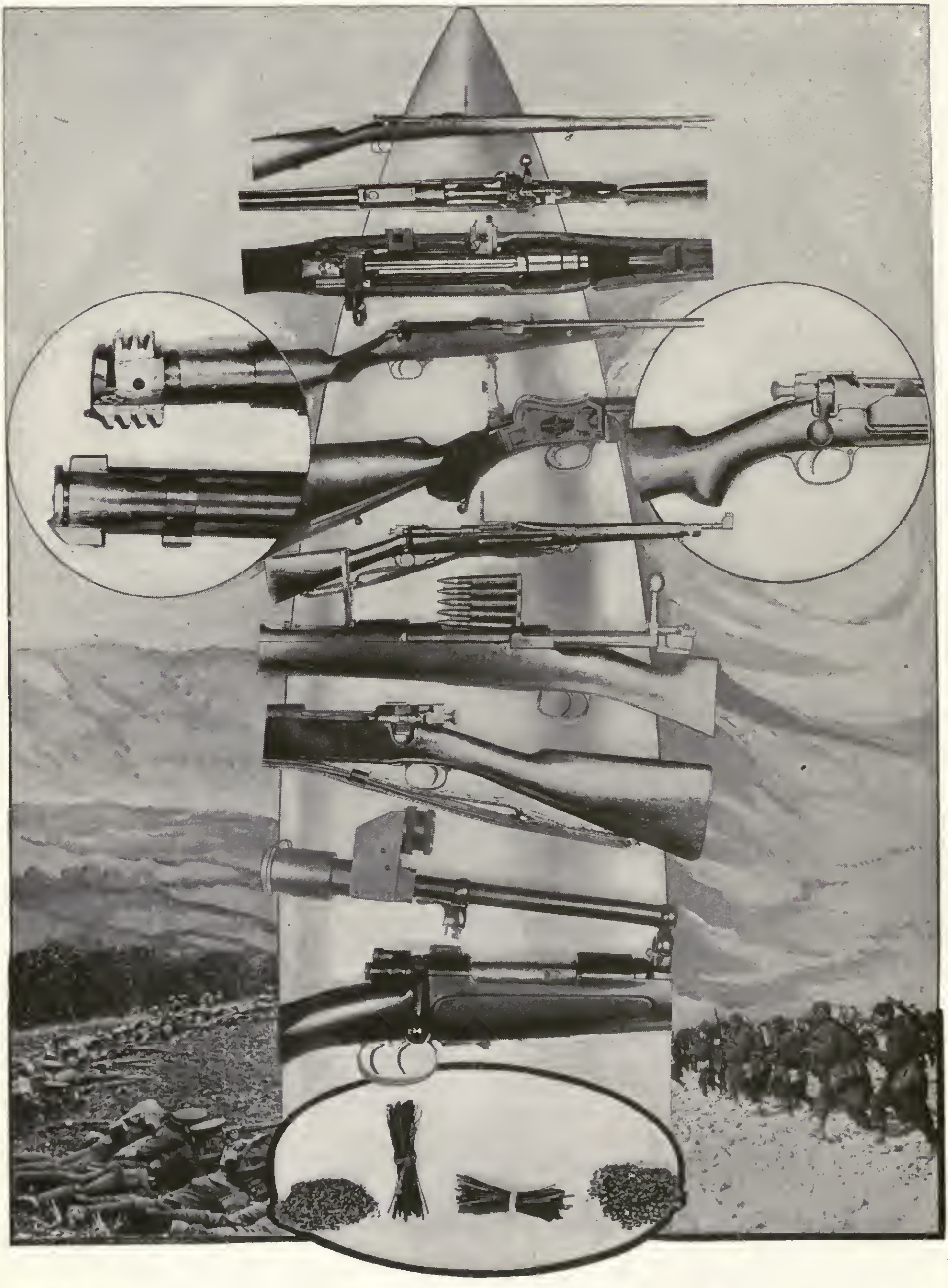
The British have finally resolved to meet them at their own game, and have placed large orders in America for telescopic rifle sights, depending mostly upon the makers of the telescope sight for the American army. In our own service the two best shots in each company of infantry are armed with rifles equipped with fine prismatic telescope sights, for just this sniping work.

On a well-lighted and defined objective the telescope rifle sight offers no advantage to the man with normal eyesight, but in picking out a partly hidden or badly lighted mark, the telescope sight gives the rifleman the same advantage that a fine prismatic field glass gives the person using it. It is necessary merely to find the mark in the field of the glass, touch it with the needle point in the telescope field and squeeze the trigger.

The telescope mounted on the American service rifle, although not yet perfect, is probably the most carefully designed telescopic sight ever made. Short and compact, it is furnished with graduated elevating and traversing disks for the finest adjustments in range and windage. No other instrument of its sort approaches it, save the sighting telescopes used on field guns.

THE FRENCH "LEBEL"—AN AMUSING RIFLE.

The French use a rifle, the Lebel, that looks like the old wrecks sold in department and army sale stores, and labeled Veterli or something similar to it. It has a tubular magazine in the forestock like an American re-



THE EUROPEAN INFANTRYMAN'S RIFLE. FROM TOP TO BOTTOM.—THE MAUSER, THE SPRINGFIELD, CANADIAN ROSS WITH TELESCOPIC SIGHT, CANADIAN SERVICE RIFLE WITH SPORTING STOCK, FULL PISTOL GRIP ON U. S. SERVICE RIFLE (KRAG). IN CIRCLE TO RIGHT, MARTINI SINGLE SHOT RIFLE. IN CIRCLE TO LEFT, BOLTS OF RIFLES SHOWING THE BOLT IS KEPT FROM BLOWING OUT. AMERICAN SPRINGFIELD A MODIFIED MAUSER. MAUSER OPEN SHOWING CARTRIDGE CLIP, BOLT AND MECHANISM. AMERICAN SPRINGFIELD, TELESCOPIC SIGHT ON SPORTING MAUSER. IN OVAL AT BOTTOM FOUR TYPES OF PROPELLANT SMOKELESS POWDERS.

peating rifle, the receiver is nickel-plated, and, all in all, it is the most amusing looking rifle of the whole collection. Its whole get-up looks crude and child-like. Add to this a fearfully long triangular bayonet, such as the American army discarded twenty years ago, give the soldier carrying it a long blue coat like an overcoat and a pair of red trousers, and you've got a picture to make the gods weak from laughter.

The cartridge is quite interesting, with its solid copper-zinc alloy bullet. Not satisfied with the virtues of the sharp point, the French went still farther, and put on a tapering stern on their bullet; so it is a true boat-shaped bullet, instead of being cut off square behind like all other bullets. Thus, the bullet is given a streamline form, which even German ballistic experts admit cuts down air resistance. It weighs 170 grains and it leaves the rifle with a speed of 2,400 foot-seconds. It is quite as good as the English cartridge. The magazine is loaded, not with clips or chargers like the rifles of the others, but by the slow process of cramming in one shell after another into a tubular magazine like an American Winchester's.

THE RUSSIANS AND THEIR MODIFIED MAUSER.

The Russians use a modified Mauser, with ammunition of the old blunt nose type like the British Mark VI, velocity 2,000 foot-seconds. The bayonet, a triangular one, is always fixed, is very hard to remove, and has no scabbard. It is carried on the rifle at all times—a very clumsy, crude and senseless scheme.

The Belgians use the Mauser, with ammunition of the older blunt nose type, clip-loading, like the rifles of all the nations save France. In this system a clip or charger of five cartridges is pushed into a slot at the top of the magazine entrance. A push of the thumb drives all five out of the clip, down into the magazine, and the clip is thrown away. The caliber, like that of the Russian and French rifles, is practically 0.30.

The Turks use the Mauser, of 0.30 caliber, and use to some extent the newer pointed bullets in this rifle.

The Austrians and the Germans are the best equipped of any of the nations in the rifle line. The Austrians use the Mannlicher, firing pointed bullets with a velocity of nearly 2,800 foot-seconds.

THE NEW GERMAN MAUSER—THE BEST IN EUROPE.

The Germans use the latest type of Mauser, from which the American new Springfield was taken. The rifle, a clip-loader, weighs nine pounds. It fires spitzer bullets of 154 grains weight, with a velocity of over 2,900 foot-seconds. The rifle in its simple sight-setting arrangement, its finish, its accuracy, and the high speed of its bullet is superior to the rifle of any other nation among those fighting. It has a long sword bayonet, usually carried in a scabbard at the soldier's belt. With its long barrel and long bayonet, it gives a stabbing length of 5 feet 9 inches with the bayonet on, beating the others save the long bayonet of the Frenchman.

The German soldier has eight inches the better of the argument over the British soldier when it comes to crossing bayonets, and the extra eight inches easily turns the battle in favor of the longer, if both men are of equal skill.

The Canadians, in spite of being part of the forces of the British Empire, cast out the ancient and honorable Lee nearly ten years ago, taking the Ross, a rifle made by Sir Charles Ross of Scotland, in Quebec. Their present rifle, practically the rifle that sells on the American market for sporting use, fires the regulation 0.303 British army cartridge instead of the much better Ross product, the 0.280.

This Ross is a straight pull rifle; that is, by an arrangement primarily like the familiar spiral screw-driver, the bolt with the locking lugs is revolved by pulling straight back on a bolt handle and separate sleeve, unlocking the bolt without the usual half turn of a bolt handle, as on the Mauser, Krag, new Springfield, and Lee-Enfield.

THE RIFLES OF AUSTRIA, BULGARIA AND GREECE.

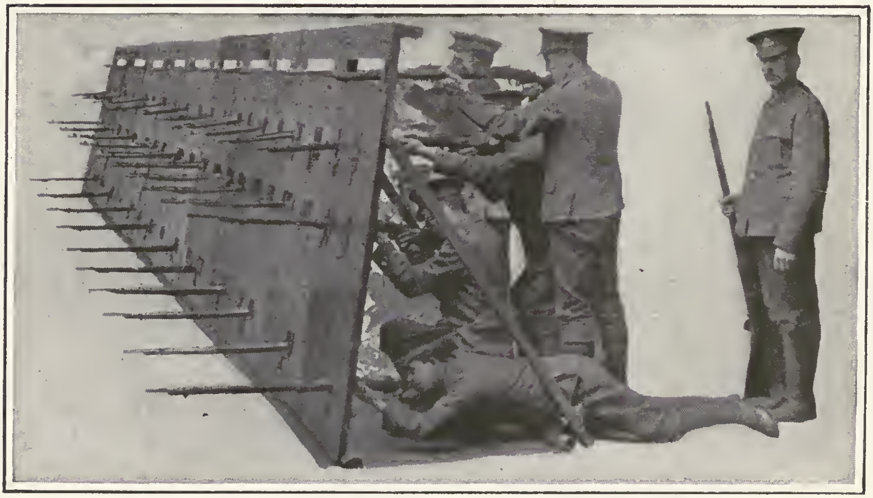
The same principle is used in the Mannlicher straight pull of Austria, Bulgaria, and Greece. This type of rifle action is very fast, a snap back and forth of the wrist being sufficient to operate it, but it is more tiring for a long series of shots because of throwing the strain on only one set of muscles.

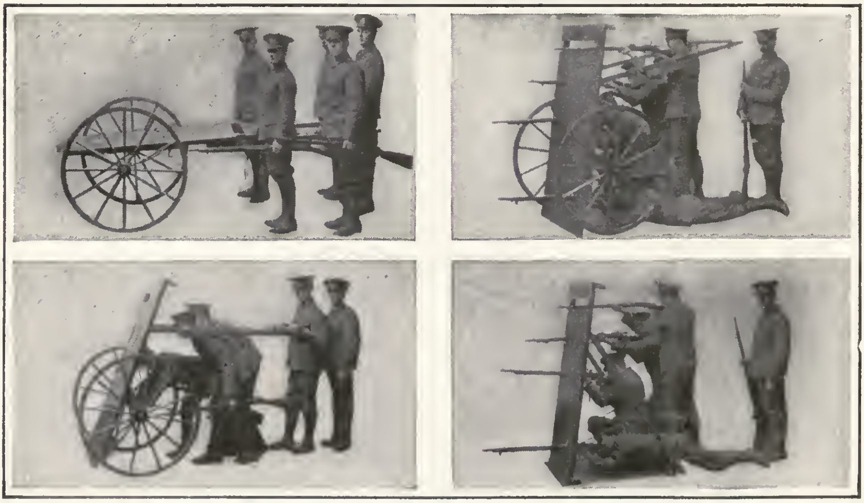
All the other rifles use what is called the turn-bolt, a long cylindrical bolt containing striker and main spring, carrying an extractor on the head, and having two steel lugs to lock against the explosion, working back and forth in grooves cut in the receiver. The bolt is locked by turning it a quarter round to the right, revolving the lugs in behind shoulders in the frame; it is unlocked in the reverse direction, hence the name turn-bolt, as opposed to the straight pull rifles of Austria, Greece, Bulgaria, Switzerland, and Canada.

The chief virtues of these rifles are the strength, the simplicity, and the impossibility of jamming the mechanism for more than a moment. All the essential parts can be removed for cleaning without tools.

This is true in the highest degree with the German Mauser, in the lowest with the French Lebel and the straight pull Mannlichers.

With these magazine rifles, fitted with magazines for charger loading, and having a wonderfully high rate of sustained fire, the problem is to keep the men supplied with ammunition for an all-day's hot battle. The Japanese troops went into some of the battles near the Yalu and later, carrying 350 rounds of ammunition per man. Yet some of the soldiers were out of cartridges by noon. The weight of 350 rounds of the Japanese 0.256 cartridge is, of course, 350 times the weight of each cartridge, this being 350 grains. Each soldier was therefore carrying, besides his regular pack and rifle, 17½ pounds of cartridges.





Courtesy of London Illustrated News

BULLET-PROOF SHIELD ON WHEELS FOR ATTACK OR DEFENSE. AN ARMORED SHIELD BEHIND WHICH MEN MAY ADVANCE OR MAY BARRICADE A ROAD, OR THE LIKE, WAS SUBMITTED RECENTLY TO THE BRITISH WAR OFFICE. THE SMALL PICTURES SHOW VARIOUS USES OF THE DEVICE. IT MAY BE TRANSPORTED LIKE A TWO-WHEELED CART, CARRYING ON THE SHIELD PLATE A SUPPLY OF AMMUNITION. IT MAY BE USED AS A TEMPORARY BARRICADE OR AS AN ADVANCING OR RETIRING SHIELD, OR THE WHEELS AND SPRINGS MAY BE REMOVED TO FORM A FIXED BARRICADE. TEN SUCH SHIELDS PLACED SIDE BY SIDE FORM A 30-FOOT BARRICADE

Chapter XXII.

HOW RIFLE BULLETS FLY

French and Swiss Bullets of Stream-line Shape to Reduce Air Resistance

BY EDWARD C. CROSSMAN

WHEN the powder charge of a military rifle like the German Mauser is ignited, it drives from the muzzle of the rifle a little 30-caliber, 150-grain bullet at the rate of practically 3,000 feet per second. This does not mean that it flies the first 3,000 feet in one second, because the instant it is clear of the terrific blast of powder gases that follow it, it commences to fight the resistance of the air just as a steamer fights the resistance of the water through which she ploughs.

Our bullet gets down the first three or four hundred yards with the average speed of 2,500 feet per second, or at the rate of 1,700 miles an hour. A steamer travels little more than 20 miles per hour, even though she be of the Atlantic greyhound type. So the bullet is experiencing the same pressure from the air as if it were standing still and had a gale of 1,700 miles an hour blowing against it. A gale of 140 miles an hour, one twelfth of this 1,700-mile rate, will blow down buildings.

So, while the air is considerably less dense than water, the speed of the rifle bullet is so terrific that its ability to slip through the air is just as important as is the ability of the boat to slip through the water. The two differ in this—that while the steamer and the sailing vessel have their propelling power always working within or against the sails of the boat, and so propelling it at a uniform rate, the bullet has its impulse all given at the very start, and no further help along its course can be handed it. It is like a ship that is sent plunging down a very long and steep set of ways into the water. The moment the momentum received from the slide is lost through the resistance of the water, the ship stops.

So important is this air resistance to the flight of the bullet, and so well is it understood in these modern days, that modern bullets have long sharp points like well-sharpened lead pencils to overcome this resistance from the comparatively dense medium—the air. No bicycle rider needs to be told how much this enters into even the progress of low speed objects. Drop the wind shield on a motorcar traveling 30 miles an hour, and without touching throttle or spark the car travels 34 or 35 miles an hour instead of 30. Make this speed 1,700 miles an hour, and although our bullet is a tiny, heavy object with but a third of an inch diameter to offer to the air, the slightest change in its form means a huge change.

But for this resistance of the air we would have only the problem of gravity to consider. The instant the bullet departs from the bore of the rifle it becomes liable to the laws of gravity, just as much as the apple that fell from the boughs of the tree before the eyes of the suddenly enlightened scientist.

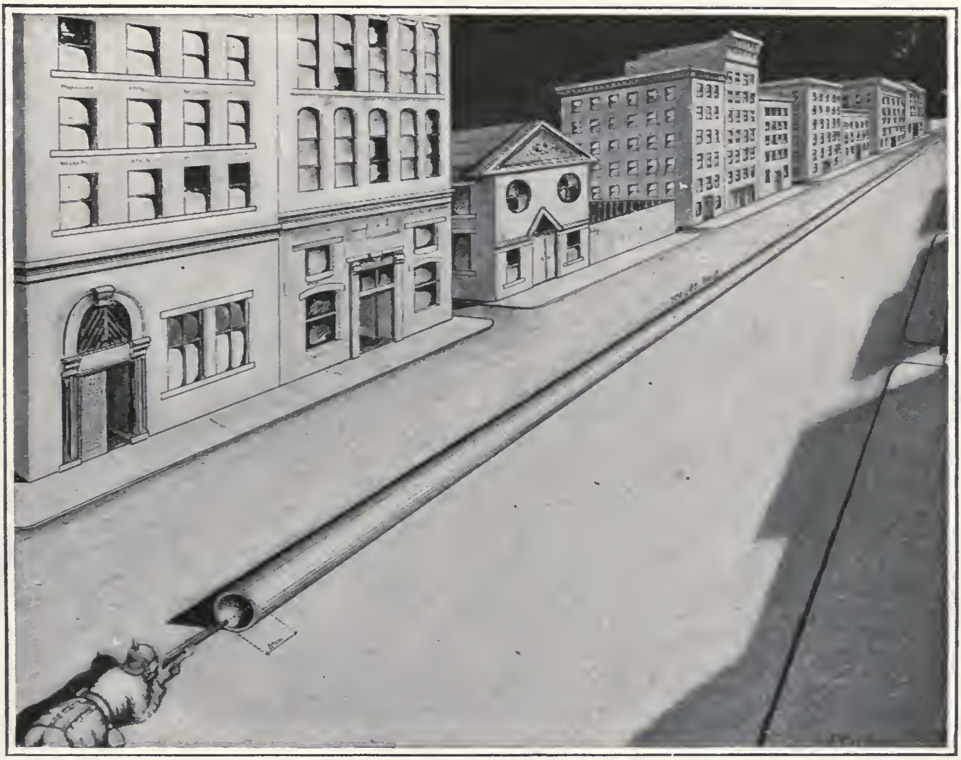
If, as has to be the case, the bullet is projected out on a line rising above the horizontal or a straight line to the mark, then it commences to fall from its projected line at the rate of 16 feet the first second of its travel, 48 feet the next second, and so on, with the rate of fall constantly increasing. The speed of the bullet does not alter this fact; it merely gets the bullet to the mark before much time has elapsed, and therefore before it has fallen far from its projected line of flight.

Were it not for our air resistance, hitting objects a distance from the rifle would be simple, and we could adjust our rifle sights merely to overcome gravity according to the formulæ used for the fall of objects in *vacuo*. If our rifle had a muzzle velocity of 2,700 feet per second and our mark stood 2,700 feet away, then our bullet would take just one second to get out here. As our bullet would fall just 16 feet in this second, we would have to aim our rifle just 16 feet higher than our mark, so the falling bullet would strike it after coming back to the line of the sight to the mark. And so our bullet projected out on a line with a spot 16 feet above our mark, would gradually fall away from this line under the pull of gravity until at the mark, one second's time from the muzzle, it would have returned again to the line of sight and would hit the mark.

This is the principle of sighting a rifle—to actually point the muzzle at a spot as much higher than the mark as our bullet will fall in the time it takes to pass over the distance. By the use of an elevating rear sight we are enabled to do this and still aim the sights themselves at the mark. Here, of course, the line of the sights and the line of the barrel do not coincide, the sight pointing at the mark, the barrel pointing far higher. But, while the rifle has to be pointed as much higher than the mark as the bullet will fall in the time it takes to travel the distance, we cannot figure the time taken by any such simple means as taking for granted the fact that the bullet flies over the distance with all its muzzle velocity. It does not, and our friend the air is behind the trouble.

TO LAND IN THESE TRENCHES AT THE RANGE OF 1,000 YARDS, THE GERMAN MAUSER IS ACTUALLY POINTED AT THE TOP OF THE TREE, 40 FEET ABOVE THE GROUND, ALTHOUGH THE SIGHTS ARE ALINED ON THE TRENCHES. THE 0.450.70 SPRINGFIELD OF INDIAN FIGHTING DAYS WOULD HAVE TO BE POINTED 175 FEET ABOVE THE LINE OF TRENCHES TO REACH THEM.

A bullet with the muzzle speed of 2,700 feet per second does not travel 2,700 feet down the range in one second. A bullet with the sharp needle point of the U. S. Army bullet or of the German Mauser bullet, with this 2,700 feet per second muzzle velocity, requires 1.6 seconds—practically 1⅔ seconds—to cover the first 2,700 feet. The extra two thirds second is due to head resistance. Instead of arriving at the mark 2,700 feet away with all its original speed left, our bullet arrives with just 1,140 feet per second speed left. That is, its speed when it reaches the mark, if retained from then on, would take it over 1,140 feet in one second. Of course, it is not retained, but continues to drop. Hence, instead of so adjusting our sights as to make the line of the barrel point at a spot 16 feet higher than the thing we desire to hit, because of the one second we supposed our bullet would take, we have to adjust our sights to make the barrel point at a spot about 30 feet higher than the mark, because, with the constant slowing down of the bullet from the air, it takes 1.6 seconds to make the trip. Thus, the effect of the air in the first place is to make the flight of the bullet a very curved flight, and because of this high curve it has to describe to overcome the influence of gravity during this 1.6 seconds, it would completely miss a man half way out to the mark, even if the rifle were aimed dead at him, with the sights set for 900 yards or 2,700 feet, and in a strong wind the deviation would be still greater. Naturally enough, the faster the bullet starts from the muzzle of the rifle, and the better shaped it is to overcome the resistance of the air, the less time it requires to get over a given range. The less time it requires, the less it falls under the pull of gravity and the less it has to rise in its flight. And, rising but little, it is more likely to hit men along the line of its flight even though the sights are not set for the right distance, and the bullet be sent out for a range much farther on. In one case its path is that of the very swiftly thrown baseball, in the other its path is the half-brick slowly describing a parabola through the air. The baseball would not miss anything along the line of its flight by rising over it, the half-brick would not hit anything until it had fallen back toward earth.



GERMANY DRIVES ITS BULLET A DISTANCE EQUAL TO FIVE CITY BLOCKS, OR 500 YARDS, WITHOUT THE LINE OF FLIGHT BEING HIGH ENOUGH TO TOUCH THE TOP OF A 26-INCH PIPE. ITS TRAJECTORY IS "FLAT"

This flat flight, termed a "flat trajectory," in military and ballistic parlance, is the most sought-for attribute of a military rifle. It means that if the range is misjudged, or if the soldiers forget to set their sights correctly, the chance for hitting the enemy is far greater. As judging a range, particularly if the enemy or our own men are on the move, is very difficult, the flat trajectory is most important.

Where one bullet, like that from the old black powder Springfield, might rise 10 feet in its flight, a modern bullet will rise but a third of this. The modern bullet would hit a man anywhere in its path; the old bullet would miss him save where it rose from the line of sight and returned to it. The modern bullet travels at terrific speed, nearly 3,000 feet per second; the old bullet traveled at low speed, not more than 1,200 feet per second.

just as the designer of a yacht studies every line and curve to aid in minimizing the water resistance, the bullet designer pares off the point of the bullet and gives it a lean entry to help it slip through the dense medium, air, at high speed.

Up to 1905, bullets for military rifles had blunt bows, almost canal-boat shape. They were as little adapted to slipping through the air as boats so shaped are adapted to slipping through the water. Since 1905 most of the civilized nations have adopted the sharp-pointed bullet, so-called spitzer. So efficient has this been in overcoming air resistance that the bullet designers were enabled to reduce the weight of our army bullet from 220 grains to 150, without in the least taking away from the ability of the missile to overcome the resistance of the air. With the bullet so lightened, they were further enabled to drive it at the rate of 2,700 feet per second instead of 2,000 feet per second, without adding to the recoil of the rifle, and they thus cut down the weight of the cartridge the soldier had to carry some 70 grains, or one pound for each 100 cartridges.

IF THE GERMAN RIFLE IS SIGHTED FOR 1,000 YARDS, AND AIMED EVEN CLEAR DOWN AT THE FEET OF THE HORSE OF A CAVALRYMAN, THE BULLET WILL GO CLEAR OVER HIS HEAD IF HE IS ANYWHERE FROM 300 TO 800 YARDS AWAY FROM THE RIFLE. IN SPITE OF ITS HIGH VELOCITY, THE TRAJECTORY OR FLIGHT OF THE BULLET IS NO LONGER FLAT. IT RISES ONLY 20 INCHES IN FLYING 500 YARDS; IT RISES 13 FEET IN TRAVELING 1,000 YARDS. THE ANSWER IS CHIEFLY AIR RESISTANCE

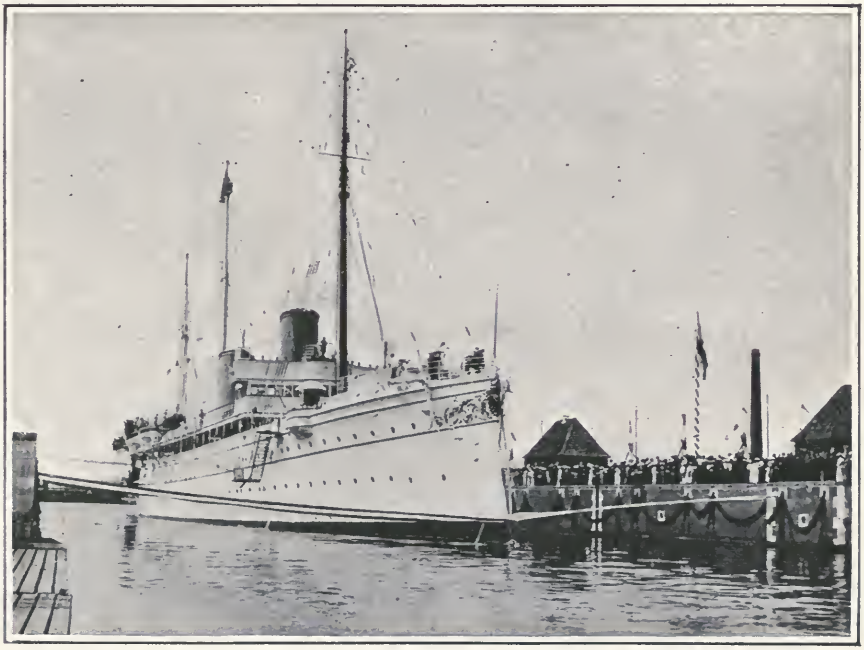
Another consideration in being able to overcome air resistance and land a bullet at a certain spot with a considerable amount of its speed left is the fact that a bullet losing in speed loses frightfully in power. The United States 150-grain sharp-pointed bullet gets out to 900 yards with 1,140 foot-seconds left. It has the blow of 433 foot-pounds in energy. If it got there with all its 2,700 foot-seconds left, it would hit a blow of 2,430 foot-pounds. The difference between the energy of 433 foot-pounds and 2,430 foot-pounds has been taken from the bullet by its work of overcoming the resistance of the air in traveling little more than a half mile. So,

So important is the small matter of the sharp point on the bullet that adding it amounted to 70 grains out of the 220 grains in ability to drive through the air. If the present 150-grain American bullet were reshaped to the old blunt point used on the Krag-Jorgensen and on the bullets from the Russian army rifle of to-day and then were fired with the same muzzle speed, it would require 2 seconds to make the trip over 2,700 feet instead of 1.6 seconds, it would get there with only 900 feet per second speed left instead of 1,140 feet per second, it would have the punch of only 270 foot-pounds instead of 433, and it would have to rise in its flight 16 feet above the line of sight instead of 10.5 feet. And all of this is chargeable merely to cutting off the sharp point and making it the blunt point formerly used, and found on most American big game shooting bullets.

But the Americans and the Germans and the British have failed to go the logical limit in shaping bullets for flight through the air, and the Swiss have done this with their neighbors, the French. Both the Swiss and the French service bullets are purely boat-shaped, the bows long and tapering, and the sterns, instead of being cut off square like the United States bullet, taper back precisely like the stern of a racing yacht, to a diameter about two thirds the full width of the bullet. By this means the back-drag of the air, the vacuum that forms from the high speed of the bullet, is cut down and so is increased the ability of the bullet to hold its speed. There is startlingly little resemblance between the long, graceful, sharp-bowed and taper-stern French and Swiss bullets and the huge, stubby, blunt-nose, square-stern bullets used not many years ago.

Reconstruction of the Kiel Canal

IN 1895, after eight years of hard work, the great canal running from the mouth of the Elbe, in the North Sea, to the Fjord of Kiel, in the Baltic, a distance of about sixty miles, was thrown open to commerce. It had a normal width of 72 feet at the bottom and 220 at the water level, with a depth of 29½ feet. Although a sea-level canal, twin locks were built at each end, those at the western entrance to take care of the large tide variations, and those at the eastern end to take care of variations of water level, in the practically tideless Baltic, due to gales. The locks were 492 feet long, 82 feet wide, and 32 feet deep. The locks at Kiel remained open most of the time, while those at the mouth of the Elbe did not need to be used at certain tides.



THE "HOHENZOLLERN" BREAKING A RIBBON OF BLACK, WHITE AND RED, AT THE OPENING OF THE NEW KIEL CANAL LOCKS

The canal proved wonderfully valuable to commerce, because it saved the long, hazardous trip around the stormy coasts of Denmark. But its strategic value to the German navy was of even greater importance, as has been demonstrated in the present war.

Although the locks, when built, were large enough to take almost all vessels, they were outgrown in time, even by warships, and finally it was decided to reconstruct the canal, making it broader and providing locks that could take the largest vessel afloat, with plenty of room to spare. This work was completed in time to be of incalculable value to Germany in the present war.

The normal width of the canal is now 335 feet at the surface and 144 at the bottom, with a depth of 36 feet. New twin locks have been built alongside the old ones at each end. They have an available length of 1,082.6 feet and width of 147.6 feet. Intermediate gates may be used to cut off a chamber 328 feet long. The locks at Panama, it will be recalled, are only 1,000 feet long by 110 feet wide.

The work of reconstructing the canal cost $55,000,000. The new locks were formally opened by the Kaiser, recently, in the manner shown in the accompanying illustration. The royal yacht "Hohenzollern" may be seen breaking a ribbon of black, white, and red stretched across one of the new locks.

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ONE OF THE FRENCH GUNS IN THE ACT OF FIRING. THE GUN CREW ARE HOLDING THEIR HANDS TO THEIR EARS. A SPECIAL TRACK MUST BE LAID FOR TRANSPORTATION OF THE GUN

Chapter XXIII.

THE BULLETS OF THE NATIONS

How the Shape of a Bullet Affects its Flight

BACK in 1905 the Germans, prying around, as usual, in rifle experiments, re-discovered the ballistic fact that if you sharpen the bow of a bullet it cuts down air resistance, as sharpening the bow of a canal boat to a yacht bow cuts down the resistance of the water. Back in the 50's Col. Jacobs, a British officer stationed in India, had discovered this, had proved it, and had called the attention of the world to the fact, For a half century mathematical gentlemen, such as Bashford, had laid down the law that the point of a bullet made no difference in the flight of a bullet. It does make little difference in the ultimate range, but this is not considered in designing a fighting rifle.

The Germans found that so much did a sharpened point cut down the terrific resistance of the air, that they could shave down their army bullet from 215 grains to 154 grains and still overcome air resistance, and retain the same proportion of the original speed imparted by the rifle as with the old heavy bullet.

This meant, in turn, that they would greatly increase the velocity—the speed—of the bullet, which, in turn, meant that the flight of the bullet would be much flatter, and *ergo*, over fighting ranges, the chances of hitting men anywhere along the field were much increased. Errors in judging range were much less costly, because the bullet did not rise high enough to miss, anyhow. Setting sights or changing sights for changes in range were obviated, because so flat flew the new bullet that for 500 yards or more a man kneeling would be hit anywhere from the muzzle to the 500-yard mark were the rifle sighted for 500 yards.

In other words, the new cartridge—the "S" bullet, it is called by the Germans—gave a danger space of more than 500 yards—500 yards of space from the muzzle of the rifle over which the bullet nowhere got up high enough to go over a kneeling man. This is the result of a flat trajectory or bullet flight, and this in turn comes from a high muzzle velocity, and this in turn can be had only from a light bullet. And light bullets are of no use if they fall off quickly from air resistance, and only the sharp point confers comparative immunity from this terrific resistance through which the bullet has to force its way.

Such is the reason for the sharp pointed bullet used by the Germans, the French, the Austrians, the British, the Canadians, and probably the Russians to some extent. The Germans termed it a "*Spitzgeschoss*," merely a pointed bullet. It is sometimes termed a "spitz" bullet, with a queer hybrid of German and English in the term, and English-speaking people usually term it a "spitzer," a sort of slangy corruption of the original word.

The United States promptly took it up, calling in its new rifles, the new Springfield, and rechambering the barrels to fire the new ball. The change in this rifle threw out the old blunt nose bullet of 220 grains and with a muzzle speed of 2,200 foot-seconds and substituted a spitzer of 150 grains with a velocity of 2,700 foot-seconds. The bullet is pointed like a neatly sharpened pencil.

The extreme range of the two sorts of bullets is 5,200 yards for the present spitzer, 4,200 yards for the old blunt nose bullet used in the Springfield.

But let me pause here and spear a fallacy common among the uninformed. The extreme range of a rifle—the distance to which it will carry when pointed at an angle of 45 degrees from the horizontal—has absolutely no bearing on its virtues. It is a by-product, not a virtue, not sought for by rifle designers, not cared for by military men, and absolutely not considered. The ballistician in military walks of life cares not whether the bullet finally winds up 4,200 yards or 4,200 rods from the muzzle if the rifle is fired at an angle of 45. A rifle is no more to be judged by its extreme range than a horse is to be judged by the number of hairs in his eyebrow. Extreme range, we have said, is a by-product; nobody cares what it is, because it is not used, nor is half of it ever used.

Fifteen hundred yards is extreme range for the military rifle in actual use, but very uncommon. A thousand yards sometimes sees the ball open, but often the fighting hardly begins at this distance.

The thing for which all ballisticians strive is a rifle that shoots very flat over fighting ranges which lie under 1,000 yards, to obviate sight changes, and to minimize the cost of errors in range judgment. After that the range of the bullet is immaterial; infantry fire is not even remotely effective—worth the ammunition—at ranges half as far as the rifle would carry. Therefore, the surest way to prove that you don't know the first principles of the military rifle is to begin to talk about its range. The two favorite questions of the proletariat—"How many does she hold? How far will she shoot?" The man that knows what is needed asks, "How fast can the magazine be recharged? How flat does she shoot?"

Now, the harmless little sharp pointed bullet, that promised to ooze through parties on the other side of the argument so gently that they would hardly mind it, turned out to be a little devil. Its evil disposition varies with the rifles in which it is used, due probably to difference of balance of bullet, etc.

In the American Springfield it does just the opposite to what it promises. Because the weight is far back, because of its high speed, and because it is very easily upset, it proceeds to spin widely on its tail when it hits tissue, if not to travel sideways like a hog to battle.

It rips and slashes and knocks things out of time by the shock it imparts. Once in a long while it behaves like a civilized bullet, but not often. It is very freakish in its travel. Stewart Edward White records one bullet that struck a beast in the right shoulder, went through to the left, broke it, traveled down the left leg, came out on the side toward Mr. White, and hit the ground half way between him and the animal! So the poor soldier may be shot in the watch pocket and have the bullet emerge under his left toe.

So knowing that the Germans, and the French, and the British, and the Canadians—and possibly the Belgians to some extent—all use the spitzer bullet, you can see that the Germans, not reading English shooting literature, might suspect from the effects on their men that the foe were shooting little buzz-saws, not bullets.

Europeans have known for some time of the effect of these sharp pointed bullets; the Germans should, too. Queerly enough, the German spitzer bullet does not seem to give this slashing, ripping effect; the British report the same effects as those from the older type of blunt nose bullet, clean-cut holes.

Years ago the Russian Red Cross Society asked the Russian Minister of War to inquire into the effects of the pointed bullets, then used for the first time by the Germans and Austrians. The Red Cross people alleged that these bullets had been proved to be unstable, to tip on entering the body, and to keyhole—travel sideways. So the evil effect of the spitzer was a matter of public knowledge years ago, and it seems that the German bullet was not immune except in their protestations.

So, except for the looks of the thing, if the British choose to use their old Mark IV., hollow point, Zulu-killing bullet instead of their Mark VII. spitzer, they will be doing the foe a kindness—by departing from the rules of the convention.

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UNEXPLODED GERMAN SHELLS FOUND AFTER THE BATTLE OF MARNE

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SEARCHING COTTON FOR CONCEALED ARMS, WITH X-RAYS

Photo by Branger

BELGIAN RIFLEMEN DEFENDING THE APPROACH TO A VILLAGE

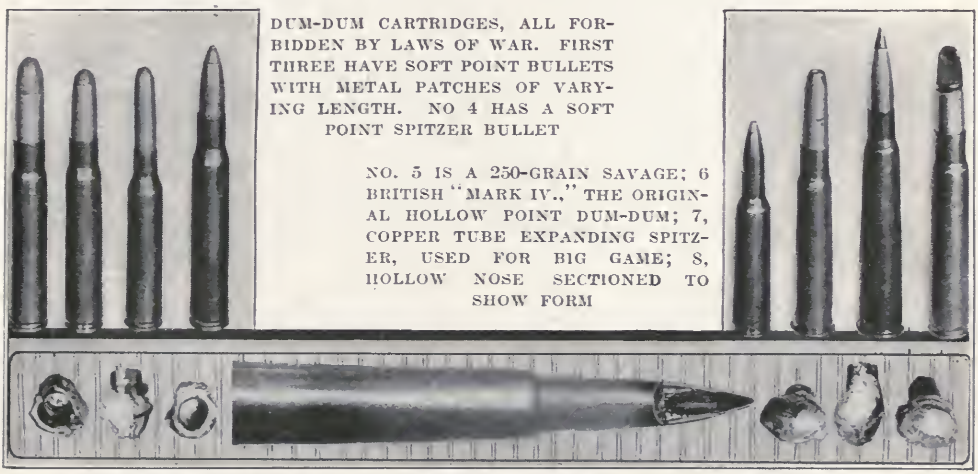
Chapter XXIV.

"DUM-DUM" BULLETS

BY EDWARD C. CROSSMAN

THE dum-dum charges in the European war take us back to the days of the Spanish war, when the same accusations were made. As a matter of fact, Spanish 7-millimeter cartridges could be produced with the point of the bullet sawed criss-cross with a hacksaw, but at that we doubt its being any more deadly than the ordinary bullet.

With the exception of the French, the belligerents in the European war use smokeless nigh-velocity rifles of small bore and, of course, firing jacketed bullets. These bullets are constructed of a lead core, with a tough jacket or skin over the outside, closed everywhere except at the base where the core is inserted. This very tough skin is made either of sheet steel, nickeled to prevent rust, or else of an alloy of copper and nickel of about the proportion of 20 per cent nickel to 80 per cent copper, and being thus merely German silver. Sawing the point off a sharp point bullet of this construction does not cause the bullet to break up in tissue, unless the cut is made far down the bullet.



DUM-DUM CARTRIDGES, ALL FORBIDDEN BY LAWS OF WAR. FIRST THREE HAVE SOFT POINT BULLETS WITH METAL PATCHES OF VARYING LENGTH. NO 4 HAS A SOFT POINT SPITZER BULLET

NO. 5 IS A 250-GRAIN SAVAGE; 6 BRITISH "MARK IV.," THE ORIGINAL HOLLOW POINT DUM-DUM; 7, COPPER TUBE EXPANDING SPITZER, USED FOR BIG GAME; 8, HOLLOW NOSE SECTIONED TO SHOW FORM

DUM-DUM BULLETS AFTER FIRING — EXPANDING SPITZER BULLET SECTIONED TO SHOW HOLLOW COPPER JACKET THAT MAKES IT BREAK UP — DUM-DUM BULLETS AFTER FIRING

All the nations engaged use practically the 0.30 caliber, although, of course, the cartridges vary considerably. No, they are not 30-30's, nor any relation to 30-30's, the 0.30-30 being an American game-shooting cartridge of considerably less power than a military cartridge.

Now early in the small bore, jacket bullet game, the British found themselves in difficulties with some hill tribe or other. These Afghans or similar East Indian Apache, were accustomed to rush British camps by the light of the stars, or sometimes by daylight, and brandish knives as large as *machetes* and as sharp as razors.

The first thing the British discovered about their new small bore acquisition in place of the good old 0.45 caliber Martini-Henry, was that the new rifle would not stop an Afghan or other hill person, who really intended to keep coming. Several British soldiers were killed by hill men who, according to all the laws of warfare, should have been very, very dead. Drilling them with the 0.303 seemed merely to exasperate them. Therefore, in their hill arsenal of Dum-Dum, the British proceeded to evolve a new bullet for making good men out of hill men. They took the 0.303 bullet and removed some jacket from the point, exposing the leaden core. Then they tried it on some more hill men. The British troops reported that it was fine. No word was ever received from the parties on the other side. Thus arose the first soft point, metal-patched bullet, and on it was saddled the name of "Dum-Dum" from the little, obscure Indian arsenal that produced it. And so, every bullet from a small bore rifle, doctored up in any way at all, was yclept "Dum-Dum," although it might use some other system for procuring expansion of the bullet. Also any wound that was unseemly large was promptly charged up to a dum-dum bullet, although it might just as well have come from a bullet ricocheting from rocky ground, or in these modern days from a sharp point bullet in its original tumbling act.

"THE CALM BEFORE THE STORM"

The British proceeded to change this dum-dum bullet around a bit, making it hollow nose, instead of exposing so much lead, but still designing it to expand and break up on impact. It was officially recognized and named, as we remember, the Mark IV., the British so naming every separate cartridge and rifle they ever produced.

They found it just as pleasing in Africa. They laid out Dervishes with it, and they stopped Matabeles and other members of the Zulu nation. With the last, particularly the ordinary bullets proved ineffective. When an impi started for the British line, the members thereof kept on coming until physically unable to move on. The regular bullets were inadequate. We have before us a half dozen of the hollow nose bullets used by the British in the Matabele trouble.

At The Hague or Geneva Convention, we forget which, the British, with other civilized nations, signed compacts forbidding the use of expansive or explosive bullets.

But the French, against whom the dum-dum charge was brought, have a clear case of alibi.

Exposing the lead of a patched bullet or giving it a hollow nose tends to make the jacket peel back and split up in ribbons, allow the lead to fly off in small bits, and the main body of it to flatten out or mushroom.

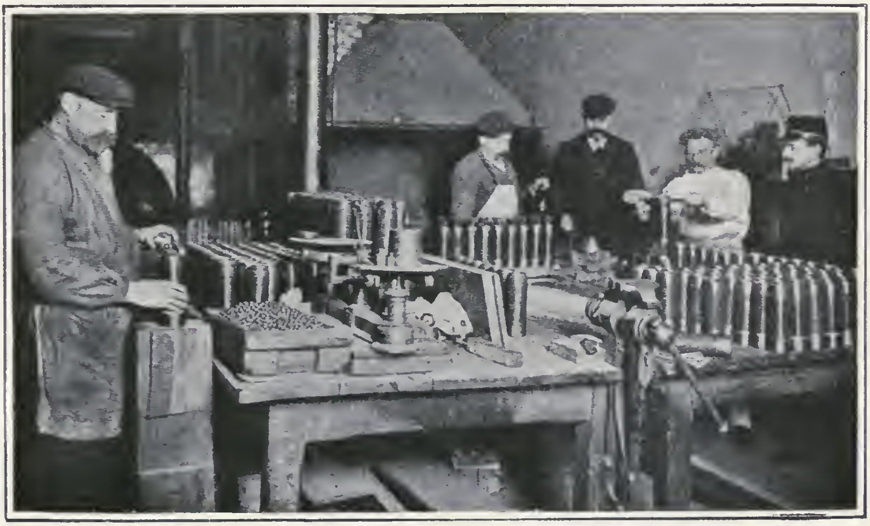
But the French use exclusively a bullet formed of solid copper-zinc alloy, no jacket, no lead, no soft metal to smear around regardless of what one does to the bullet. It could "dum-dum" about as easily as a piece of heavy copper wire. The German charges were disproved the instant we saw at whose door they had been laid. The French soldiers —some of them—in their ignorance might have sawed at the points of the bullets or cut them through, or otherwise fussed around with them. Instances of the sort are common in every army, including our own. But, regardless of the intent of the few scattered fools that might have done this, the effect was *nil*, because you cannot do anything to a copper-zinc bullet to make it more deadly.

Also, Germans protested because the French cartridges were poisoned. They found a ring of black stuff around the neck of each cartridge. This black stuff turned out to be a waterproofing.

As a matter of fact, consider the manifest stupidity, not to say childishness and lack of sportsmanship that lies back of all this dum-dum folly. Altering a bullet on a wholesale scale would result in inaccuracy, altered ballistics of the rifle, chances for trouble if the bullet broke up in the barrel as happens if the point of a solid jacket bullet is sawed off, and general trouble all round, not to mention the small job of altering a few billion rounds of cartridges urgently needed on the firing line. And, were all this done, the net result would be a few men killed that otherwise might have lived, a few wounds of far nastier type, and a few less wounded for the surgeons to patch up.

When a man is hit by any modern or old style bullet he usually quits. The Russians quit before the tiny 0.25 caliber bullets of the Japs. The little 0.25 caliber bullets did just as effective work in the Balkans as the 0.30 caliber bullets. Once in a while a man might keep on fighting with a hole in him, but he is not worth while breaking all the laws of civilized fighting for, to say nothing of the trouble entailed in altering the bullets used.

Therefore, if you stop the advance of the enemy you've done all you can. The condition of his wounded does not interest the men on the other side. Nobody but a heathen would want to think of the wounded of the other side lying in agony from torn wounds of explosive bullets. Dum-dum bullets don't help to hit any more men, and it is hitting the men at all that is the difficult and the decisive thing in war.



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FILLING SHRAPNEL SHELLS WITH BULLETS

FIRING A VOLLEY OF HOWITZER GRENADES. RIFLE GRENADE AT LEFT

Chapter XXV.

GRENADES IN MODERN WARFARE

Hand Grenades

BY EDWARD C. CROSSMAN

BACK in the days of the muzzle-loading musket used by the armies of the world, it was not surprising to find the hand grenade in common use. With the gun as slow to load as a modern coast defense gun of largest size, of little power, inaccurate, and used in a manner that deprived it of half its possible usefulness, the hand grenade was an instrument that compared quite favorably with the musket.

In those days the hand grenade was merely a hollow iron shell, with a fuse that the grenadier lit from his always glowing match. Sometimes it was nicely timed, and when so timed it left a considerable gap in its immediate neighborhood. At other times its targets snuffed out its fuse, or else picked it up and hove it back to its senders. Inside the shell reposed a quarter or half pound of black powder, which is quite sufficient to dis-

WIRE NETTING AS A SHELTER FROM HAND GRENADES tribute jagged bits of the cast iron casing with considerable celerity.

In these days, however, of rifles sighted up to 2,500 yards and having the extreme range of 2½ miles; of clip loading magazines that enable an accurate and sustained fire of twenty-five or thirty shots a minute; of machine guns that chatter forth shots at the speed of an agitated pneumatic riveter on a steel-framed building, and of long-range field guns, the mere mention of a hand grenade is sufficient to provoke snickers among the listeners. The British "Musketry Regulations," containing a grave discussion of the hand grenade and how it is to be used, was as funny as "*Puck*" or "*Judge*" to those reading it, and not believing in the possibility that 2½-mile rifles could be brought down to the dull level of trench fighting at 50 yards range.

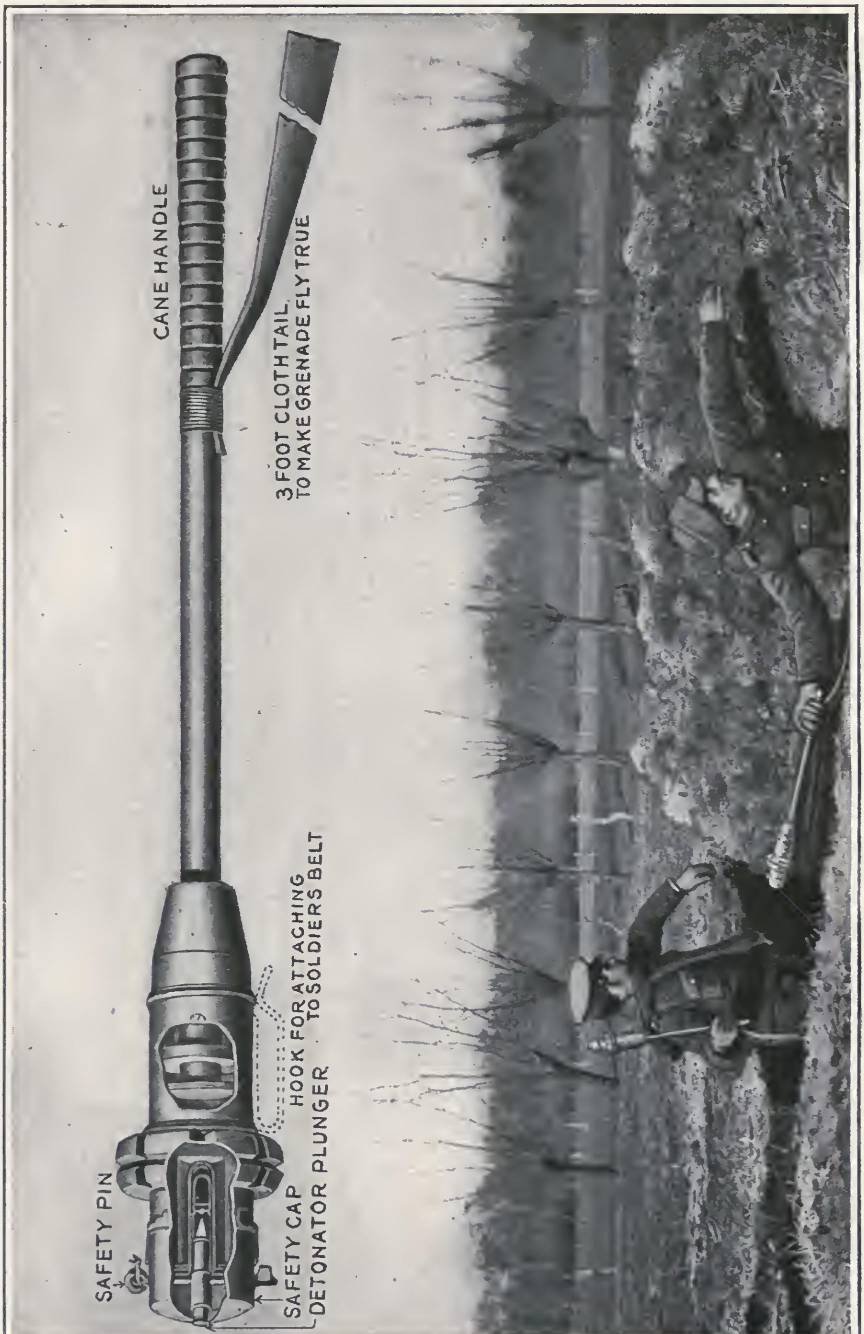
Now with the developments of the great European war, with enemies and the trenches at the distance of 50 yards or so, students of warfare have made some astonishing discoveries. One of them is that while a rifle of 2½-mile range won't hit a man with his head snugly down in a pit 50 yards away, a missile cannily tossed across the intervening space into the pit, may do with the aid of gravity just what the bullet failed to do.

The Teutons, with their usual love for thoroughness, evolved a short-barreled exaggerated howitzer of range *nil*, but of propelling power considerable. All they ask of this little gun is to heave a few hundredweight of high explosives into the air far enough for them to fall into the trenches of the other fellows a couple of hundred yards away, or even less. Here is the old hand grenade again, but of heavier weight, and with a little powder to do what the husky arm of the old grenadier used to do.

NET PROTECTION AGAINST HAND GRENADES

HAND GRENADES CAPTURED IN EAST PRUSSIA

The British hand grenade, a large number of which they had in service when the war broke out, consists first of a piece of cane with a metal head on it, containing the bursting charge of lyddite, and the detonator or exploding arrangement to act when the grenade strikes. The handle and head are 16 inches long over all. Attached to the end of the cane handle is a 3-foot bit of cloth, the tail, to make the grenade fly true and insure that it strikes head first, on its detonator, after which the cute little affair takes care of itself and those around it.



PRACTISING THROWING HAND GRENADES INTO THE ENEMY'S TRENCHES

The grenade, with its detonator and its safety devices to prevent premature discharge in carrying it, form quite a complicated and expensive bit of machinery. Normally the machine is carried by a hook, handle downward, at the soldier's belt. When the time seems ripe to use it, the soldier unhooks it from his belt, turns a cap at the head of the grenade until the word "remove," painted on the cap, is exposed and in line with arrows on the body of the grenade and then removes the safety cap. Then the detonator is placed into position on the side of the grenade and given a turn to lock into position in the studs provided for it.

The tail is then unwound from the handle, the cap is replaced and turned to fire position, the safety pin locking the detonator plunger is withdrawn, and the machine is ready to throw.

The soldier is instructed to throw it at an angle of not less than 35 degrees with the ground, both to give it the required range and to insure the machine hitting on its head and firing from the impact. It may be thrown under or over-handed. The soldier is told to be sure that the 3-foot tail does not become entangled with him or any other object as it leaves his hand.

FRENCH SOLDIERS THROWING HAND GRENADES INTO THE GERMAN TRENCHES

The bursting charge of lyddite is sufficient to blow the steel head into bits and kill the men standing close by it. The explosive is similar in its action to guncotton, but is made of carbolic acid and nitric acid, being of a form of the better known picric acid. The French "melinite" and the Japanese "shimose" are similar explosives under another name.

The grenade differs from the old type in that it is fitted up with percussion cap or detonator, sensitive to shock, to explode on impact with anything after it is set to "Fire," while the bursting charge, due to the great improvement in explosives, is five or six times as powerful, weight for weight, as the old-fashioned black powder formerly universally used in missiles of this character.

The trench fighting in Belgium and northern France has shown the full effectiveness of these miniature bombs, and it is not unlikely that the soldiers of the United States may find themselves drilling now and then in the gentle art of heaving an infernal machine full of high explosives across a few yards of ground, instead of learning how to hit things at 1,000 yards with the out-of-date rifle.

Fighting With Dynamite and Electricity

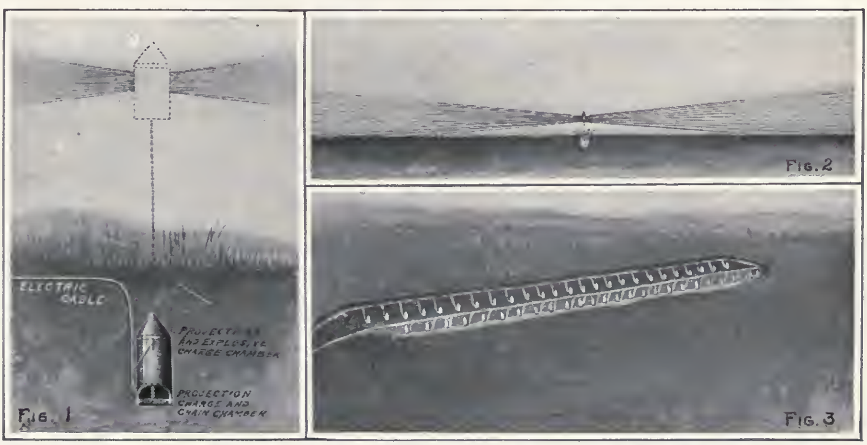
BY DR. ALFRED GRADENWITZ

A GLANCE at the history of recent strategy reveals a tendency noticeable in nearly all branches of human activity, viz., a gradual superseding of the individual by collective labor organized and controlled by a few superior minds. Individual strength and valor, once the greatest factor in warfare, has been reduced to a secondary *rôle.*

One of the latest stages in this development is the attempt to eliminate the personal element of the soldier entirely and to substitute for him a machine or automaton. Something of the sort has actually been attempted by a Norwegian engineer, N. W. Aasen, whose "mine grenades" work practically without the help of soldiers, spreading death and destruction everywhere. His contrivance is shown in the accompanying illustrations, Fig. 1 showing the grenade in position in the field, and Fig. 2 at the moment powerful explosive. The grenade consists of an iron cylinder with a conical point, which contains in its interior the projectiles and explosive charge as well as the mechanism causing the grenade to rise from the ground and eventually to explode. This mechanism can be set working only by the action of an electric current supplied to the grenade through a flexible cable.

At the bottom of the cylinder there is a small powder charge which is ignited by the electric current and which projects the shell

A BATTERY OF GRENADES EXPLODING



HOW THE AASEN GRENADES ARE USED IN WARFARE. 1. HOW THE MINE IS BURIED. DOTTED LINES SHOW THE EXPLODING POSITION. 2. TRAJECTORIES OF BULLETS AFTER EXPLOSION. 3. A BATTERY OF GRENADES

of explosion, representing the spreading of the projectiles. Fig. 3 shows a double shell barricade 1,200 yards long and 100 yards wide, made up of 50 mine grenades joined up in two sets, and which on exploding, sweep an area of 108,000 square yards.

Each grenade, inclusive of its accessories, weighs about 9 pounds, and contains 400 projectiles and about 12 ounces of an extremely body vertically through the superincumbent earth layers. The fuse which ignites the shell body is connected with a chain, the opposite end of which is fixed to the cylinder remaining in the ground. Explosion thus occurs at the very moment that the chain is tightened.

The grenade and cable are buried in the ground, so as to be entirely invisible to the enemy. When the grenade is to be fired, an electric current is sent through the cable, whereupon the grenade is projected upward to a predetermined height (generally three so as to sweep this in its entirety over an area of at least 960 square yards.

At a distance of 40 feet the projectiles will pierce a timber wall at least 4 inches thick,

BURSTING OF A MINE GRENADE. ELECTRICITY CAUSES THE BOMB TO BE PROJECTED UPWARD ABOUT THREE FEET WHEN IT EXPLODES CARRYING DEATH IN ITS WAKE

feet), where it explodes and simultaneously discharges the four hundred projectiles in a horizontal direction, radially from the center and parallel to the surface of the ground exerting mortal effects up to 96 yards. Hence this grenade partakes of the properties of the underground mine, explosive shell and shrapnel shell.

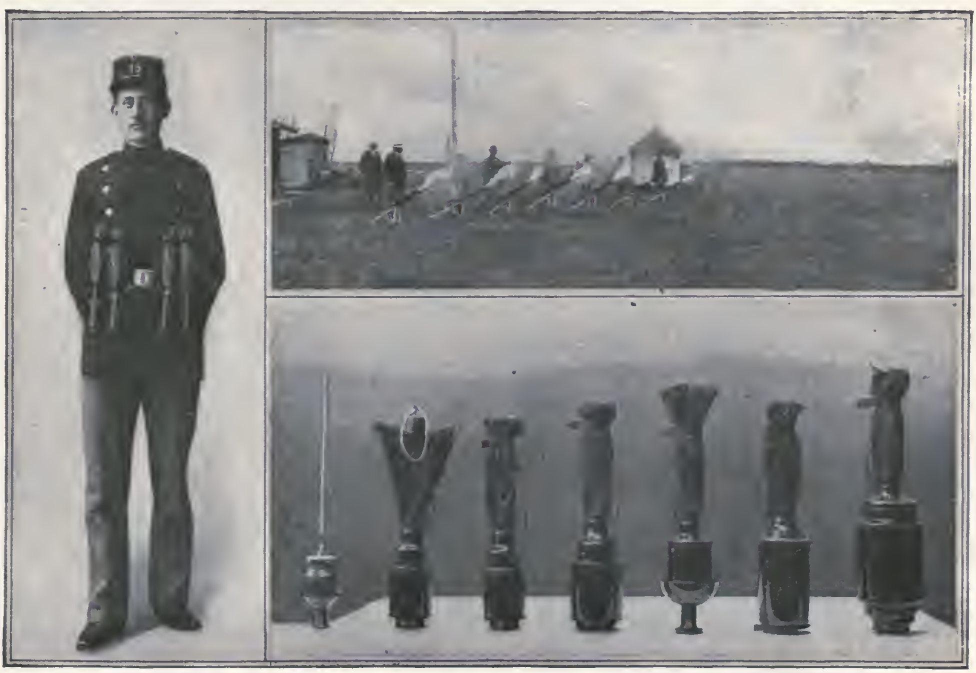
At the same time, however, it offers a number of conspicuous advantages. Since both the grenade and the cable are buried entirely in the ground, the mine field is hidden so completely as to make detection by the enemy altogether impossible. Moreover, the grenade, thanks to its special design, will always explode exactly at the height most advantageous for the explosive effects. Again, it invariably explodes with its longitudinal axis perpendicular to the ground, its four hundred projectiles being thrown out in all directions, parallel to the ground, so as always to insure maximum shooting effects. Very few projectiles will deviate from a horizontal direction. Finally, the grenade is, by a triple safeguard, fully protected against any premature explosion during transportation and while being handled and installed. It may even be fired on with rifle balls at short range, without being caused to explode.

Aasen grenades are inserted into holes dug in the ground with the spade or pick or with a special drill. In undermining a road the shells may be arranged alongside the wayside, 20 to 25 yards apart. Instead of connecting up all grenades of a given field in series and exploding them simultaneously, they may be arranged in several series, thus allowing a given mine field to be fired in several sections. The shells may also be provided in duplicate or in triplicate, so that after firing the first set, the fuses have only to be connected up to the next set of electric cables, in order again to establish the mine field.

Grenades once planted may remain in the ground for years without suffering any damage. If the mine field be tilled ground, it may even be used for agricultural purposes without incurring any danger. The fuse can be removed or inserted at any time.

The Aasen Hand, Rifle and Howitzer Grenades

HAND grenades were used to a large extent during the Russo-Japanese war, more particularly by both sides when fighting at close quarters during the assaults on the various forts at Port Arthur. The Japanese made them in the form of a small tin cylinder, about 8 inches long and 3 inches in diameter, filled with a high explosive and with about 7 inches of safety fuse projecting through a hole in the lid. This fuse being lighted before the grenade was thrown would allow about 9 seconds for the missile

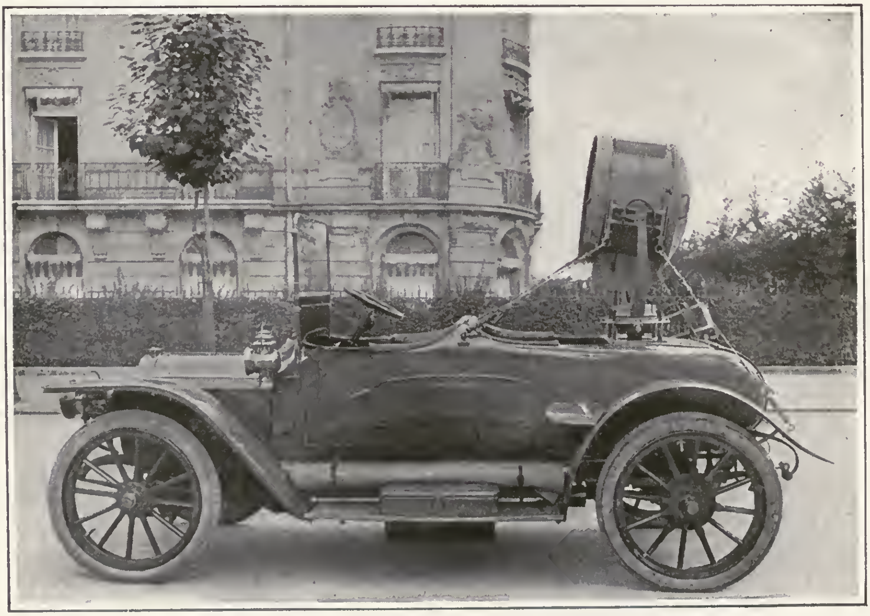


TYPES OF GRENADES USED IN MODERN WARFARE. 1. SOLDIER EQUIPPED WITH HAND-GRENADES. 2. A VOLLEY OF HOWITZER GRENADES. 3. SEVERAL TYPES OF GRENADES.

to reach its destination previous to exploding, but would not burn long enough to allow an enemy to pick it up when fallen and hurl it back before it had done its work. This was, in a manner, harking back to primitive methods, and any small closed tin receptacle would serve the same purpose if it were charged with gun-cotton or dynamite and a detonator and fuse attached in the usual way. The effect of these hand grenades when exploded in a confined space is sometimes very deadly. For instance, on one occasion a Russian guard of no less than seventeen men were killed inside a guard room by an improvised grenade, consisting of a fused slab of gun-cotton which was thrown through one of the windows.

So effective is this class of projectile when used under suitable conditions such as by storming parties on siege works or in small sorties by the besieged with the object of attacking sap-heads and approaches, that the Japanese found it necessary, when working in the trenches close to the enemy's line, to protect themselves by special wooden frames about 7 feet by 4 feet with stout wire netting projecting above the parapet. It is not to be wondered at therefore if inventors have endeavored of late years to produce grenades which while deadly to the enemy on explosion shall yet be capable of being safely handled by the thrower. The Aasen hand, rifle, and mine grenades are constructed to meet these conditions. Of the illustrations Fig. 1 shows the manner in which a soldier carries hand grenades on his person; Fig. 2 is a picture of a volley of howitzer grenades, in which case the grenades are discharged from a fixed stand with various degrees of inclination to the horizon; and Fig. 3 pictures several types of grenades. The Aasen mine grenade has already been described.

Volleys of rifle grenades were fired by 7 men from behind covers against a group of 80 double-figure targets of wood distributed under cover over an area of 900 square meters. Results of the first volley, as shown by numerals on the targets, 93 hits on 43 targets. After the third volley seventy-two targets showed 168 hits. The range varied between nine hundred and eighty-four and thirteen hundred and twelve feet.



AUTOMOBILE SEARCHLIGHT FOR THE FRENCH ARMY

Chapter XXVI.

THE USE OF POISONOUS GASES IN WARFARE

How Gases Are Generated and How Men May Protect Themselves from Them

BY JOHN B. C. KERSHAW, F. I. C.

THE earliest use of deleterious gases in siege warfare is recorded in the history of the Peloponnesian wars from 431 to 404 B. C.

Greek-fire, about which much was heard in the wars of the middle ages, was a liquid, the composition of which is now unknown, that was squirted through the air, and was used for setting fire to the buildings or places attacked. It was employed chiefly in sea-fights in order to set fire to the ships of the enemy, and it was used by the Byzantine Greeks at the sieges of Constantinople in the years 1261 and 1412.

FIG. 1.—RESPIRATOR CAPABLE OF BEING USED WITH ABSORBING CHEMICAL

Turning now to the application by the Germans of poisonous gases to trench warfare, we have the following official descriptions of the character and appearance of the gases, and of their effects:

Sir John French, in his report dated May 3rd, 1915, asserts that "the gases employed have been ejected from pipes laid in the trenches, and also produced by the explosion of shells especially manufactured for the purpose. The German troops, who attacked under cover of these gases, were provided with specially designed respirators.

"The effect of this poison is not merely disabling or even painlessly fatal; those of its victims who do not succumb on the field and who can be brought into the hospital suffer acutely, and in a large proportion of cases die a painful and lingering death.

"Those who survive are in little better case, as the injury to their lungs appears to be of a permanent character, and reduces them to a condition which points to their being invalids for life."

The following description, given by a British officer and published in the daily papers, shows the effects of the poison gases upon the men who survived them and were carried into the hospital:

FIG. 2.—TWO VIEWS OF A FRENCH TYPE OF FLANNEL MUZZLE

"When we got to the hospital we had no difficulty in finding out in which ward the men were, as the noise of the poor devils trying to get breath was sufficient to direct us. We were met by a doctor belonging to our division, who took us into the ward. There were about twenty of the worst cases

FIG. 3.—ITALIAN RESPIRATOR PROVIDED WITH EXIT VALVE FOR EXHALED AIR

in the ward on mattresses, all more or less in a sitting position propped up against the walls. Their faces, arms and hands were of a shiny gray-black color, with mouths open and lead-glazed eyes, all swaying slightly backward and forward trying to get their breath. It was the most appalling sight, all these poor black faces struggling, struggling for life."

Dr. J. S. Haldane, F.R.S., who was sent out to France to investigate the effects of these gases and to report upon the best methods of protection, states that:

"The symptoms and the other facts, so far ascertained, point to the use by the German troops of chlorine or bromine for purposes of asphyxiation. There are also facts pointing to the use in German shells of other irritant substances, though in some cases at least, these agents are not of the same brutally barbarous character as the gas used in the attack on the Canadians. The effects are not those of any of the ordinary products of combustion of explosives. On this point the symptoms described left not the slightest doubt in my mind."

The gases used in some attacks were a mixture of sulphurous acid and chlorine. The former is a dense white gas and the latter is green—both gases are heavier than air and would, therefore, creep along the ground —and they can be generated cheaply, in large quantities in the trenches, by comparatively simple means. Both gases are asphyxiating when breathed even in a dilute state—and when inhaled without much air dilution they would produce the effects upon the lungs that have been already described. As regards the methods of generating these gases, the sulphurous acid gas was probably made in the trenches by the simple expedient of throwing sulphur into open braziers containing charcoal or coke fires, while the chlorine was very probably brought to the trenches compressed under 5 atmospheres (or 76 pounds) into liquid form, in large steel cylinders similar to those used for compressed oxygen and hydrogen gases. Having brought a sufficient number of the cylinders of compressed chlorine to the trenches, it is merely necessary to insert a delivery pipe through the outer wall or parapet of the trench, to connect this to the cylinder, and then to wait for a favoring wind before turning on the gas tap, and

BRITISH SOLDIERS PREPARED TO WEATHER A GAS ATTACK allowing the gas to escape from the cylinder under its own pressure.

Since the liquefaction pressure of chlorine is so low, a very large number of gas cylinders would be required to transport a large volume of gas to the trenches where it was to be employed, but this would not prove an insuperable obstacle to an army well provided with motor transport.

Considering now the means of defense

SOLDIERS WEARING SMOKE HELMETS OR RESPIRATOR MUZZLES LIBERATE FROM THE TOP OF THE TRENCHES THE FUMES FROM TANKS OF POISONOUS GASES against sulphurous acid and chlorine gas, one must note first that neither gas is poisonous in the sense that carbon monoxide gas is poisonous, that is, neither gas forms a poisonous compound with the corpuscles of the blood. The gases are poisonous in the sense that they produce death by asphyxiation or by producing irritation and inflammation of the bronchial tubes and lung tissues, and if these gases are well diluted with air before they are inhaled, their permanent poisonous effect is greatly reduced.

These respirators, however, have not proved efficacious in warding off the evil effects of the gases when these latter have reached the trenches in a fairly condensed form, and Dr. Haldane has been sent out again to Flanders to experiment with various forms of larger respirators and head coverings of helmet shape, in which cotton wool or cotton waste soaked with chemical solutions can be employed.

A form of respirator which is capable of holding cotton wool or cotton waste, soaked with chemicals, is shown in Fig. 3. This form, it will be noticed, covers the nose and has an exit-valve for the exhaled air. It is patented by R. Spasciani of Milan, Italy, and has been sold in England for some time. Fig. 1 shows another form of respirator capable of being used with absorbing chemicals. The metal cover in this case is made of aluminium.

FRENCH SOLDIER PROTECTED AGAINST POISONOUS GASES

Turning now to the practical question of the means of defense against poisonous gases, these may be divided into two broad classes, according as they depend upon chemical or mechanical principles of removing the gases from the air.

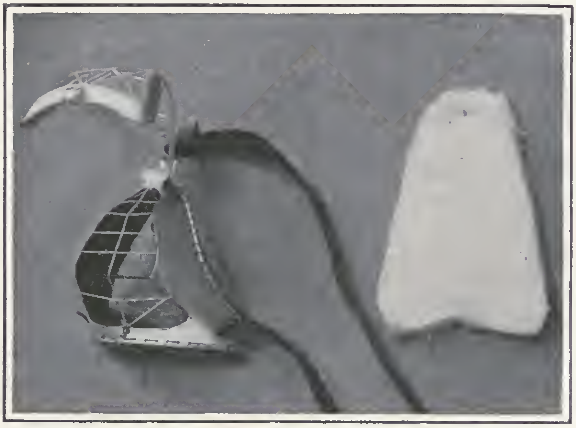
The first form of respirator supplied to the British troops in Flanders belongs to the former class and was based upon a pattern supplied by the Admiralty. Over a million of these respirators (made by voluntary labor), consisting of a covering for the mouth and nose of stockinette lined with cotton wool, were sent out toward the end of April, 1915.

In cases of gassing by chlorine, the inhalation of ammonia gas will be found to give great relief, since it combines with the gas that has entered the bronchial tubes and lungs, and removes the difficulty in breathing.

The suggestion that ammonia might be used in front of the trenches for combining with and condensing the whole of the noxious gases used in these attacks by the Germans is, however, impracticable, since the gas is very volatile and quickly disperses, also if used in condensed form in front of the trenches its effects upon the human breathing system would be nearly as severe as those of the chlorine and sulphurous acid gas.

The only practicable method of meeting these gas attacks, apart from the use of respirators charged with absorbing chemicals, such as bicarbonate of soda and similar alkaline salts, would appear to be that of creating a counter air current, which would either roll the gas back or would lift the clouds of poisonous vapor as it drifted clear over the trenches of the Allies. It might be possible with the aid of the army engineers to adapt the engines and propellers of aeroplanes for this work, or to arrange for gasoline operated air pumps to be stationed at certain points in the lines most subject to these gas attacks.

These anti-gas fans and pumps, of course, would have to be well hidden and protected from observation, otherwise they would soon be located and smashed by the enemies' fire. Placed in small "dug outs" at the rear of the first-line trenches and connected with these by underground ducts or flexible hose-pipe, they should, however, prove of great service in repelling attacks of poisonous vapor.



CONSTRUCTIONAL DETAILS OF THE GAS MASK

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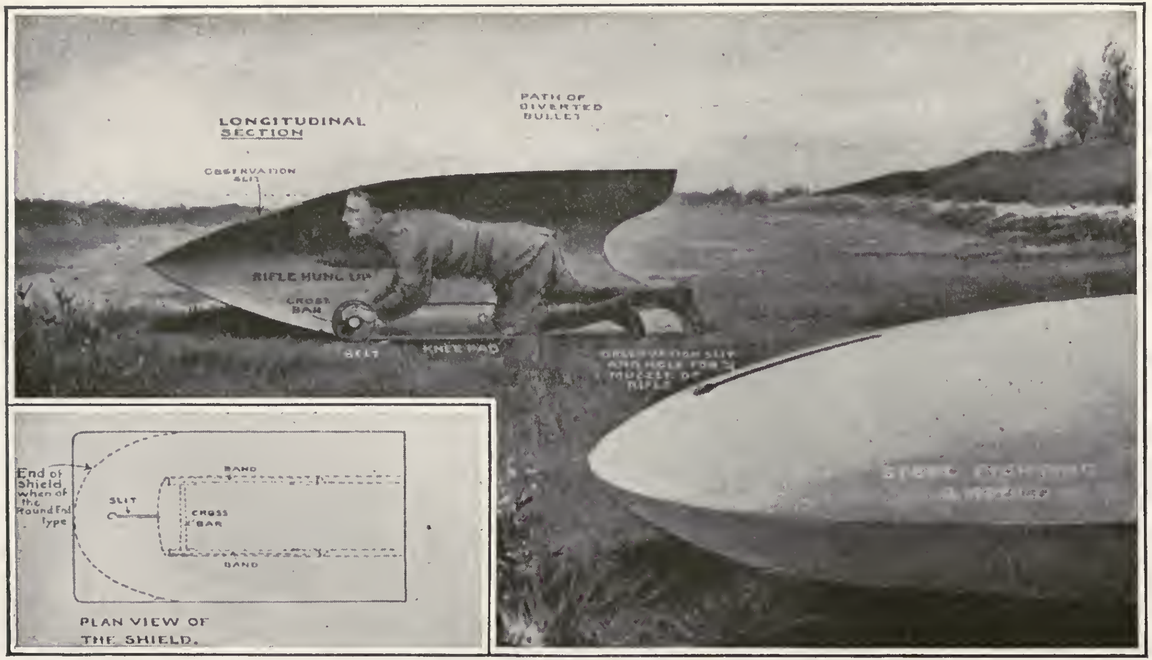
INCENDIARY BOMBS DROPPED FROM ZEPPELINS IN A RAID OVER THE TYNE, ENGLAND



Courtesy of Illustrated War News

WAR SHIELD TO PROTECT SOLDIERS WHEN ATTACKING AN INTRENCHED ENEMY. IT IS A SHIELD OF TEMPERED STEEL PLATES AND WEIGHS 209 POUNDS. THIS WEIGHT IS REDUCED WHEN THE FORWARD CORNERS ARE ROUNDED OFF. THE STEEL-PLATING IS ARRANGED AT A CONSIDERABLE ANGLE TO THE LINE OF FIRE. THE ADVANTAGE OF THIS IS THAT A GREATER EFFECTIVE SECTIONAL AREA IS PRESENTED TO THE LINE OF FIRE; ALSO THAT THE BULLET WILL GLANCE OFF THE PLATING. SUCH SHIELDS WILL ENABLE A TROOP TO APPROACH TO, AT LEAST, WITHIN TWENTY YARDS OF THE ENEMY'S TRENCH IN COMPARATIVE SAFETY. FROM THAT POINT OF ADVANCE, THEY CAN FIRE INTO THE ENEMY, OR, IF DESIRABLE, PUSH STILL CLOSER, OR QUIT THEIR SHIELDS AND RUSH THE SHORT REMAINING DISTANCE

Chapter XXVII.

MANUFACTURE OF SMOKELESS POWDER

Its Manufacture from a Cellulose Base

BY ROBERT G. SKERRETT

THE base of our smokeless powder is cellulose—that wonderful and yet indescribable form of matter. Cotton is one type of pure cellulose.

In 1832 Braconnot discovered that starch dissolved in nitric acid and when cleansed in water became an intense explosive. A little later, Pelouse obtained the same results by soaking cotton fabrics in that acid and then washing them in water. This was the first step in the evolution of smokeless powder. Because of the great violence and erratic behavior of the explosive thus discovered, it took years to develop it into a safe propellant. More than half a century ago, Austria, and later Prussia, used nitrocellulose in their ordnance, but its impetuous action could not then be properly curbed, and a series of accidents and unexpected explosions caused its abandonment. Years later, when the speedy torpedo boat and the rapid-fire gun arrived, French chemists, through stress of need, found ways to check the explosive violence of guncotton and to fashion it into a safe and practical propellant. We followed France, but our powder has been the immediate offspring of that produced by the great Russian chemist Mendeleff.

THE NITRATING HOUSE IS LIKE A GREAT, GLOOMY STEAM LAUNDRY—THE COTTON BEING DIGESTED IN CENTRIFUGAL WRINGERS LIKE THOSE IN WHICH CLOTHES ARE WASHED

THIS VIEW SHOWS THE IMPORTANT PROCESS OF WASHING THE COTTON IN THE ALKALINE BATH FOR THE PURPOSE OF REMOVING ALL TRACES OF OIL

It seems paradoxical that we should seek for a safer and less violent propellant than common gunpowder by adopting for a base an explosive well known to be more vigorous and more unruly. The secret discovered by the chemists proved nitrocellulose to be amenable to the influence of deterrent agents which subdue the suddenness of explosion, while the form of the grains regulates in a remarkable way the rapidity with which the granules burn and generate the propelling gases. Smokeless powder can now be made in grains of such size and such form that the conditions imposed by each caliber of gun can be met, and the muzzle velocity of the shot regulated with astonishing precision.

ONE OF THE MECHANICAL KNEADERS IN WHICH THE "PYRO" IS MIXED WITH ETHER-ALCOHOL SOLVENT, AND CONVERTED INTO "COLLOID, BEFORE PRESSING IT INTO SOLID CYLINDERS

Thus the task of the ordnance engineer is now quite opposite to that of former days. To-day the gun is designed to meet certain requirements, while the propellant is afterward made to suit the gun.

Now for the manner in which harmless cotton is transformed into a ballistic agent at the Naval Powder Factory, Indian Head, Md. No official secrets are betrayed, because the value of the process lies in the nice proportioning of the various ingredients combined with particular forms of grains. These niceties are the outcome of lessons learned after much experimenting, in which the variation of a tiny fraction of an inch may either make or mar the product.

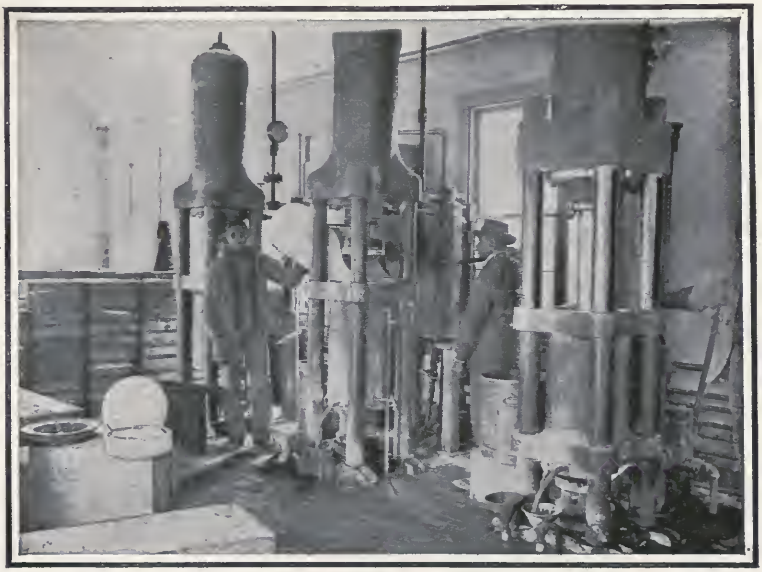
Cotton when steeped in nitric acid becomes soluble in a mixture of ether and alcohol if the percentage of nitration be less than 12.75, and is insoluble when the measure of acid is above this arbitrary dividing line. When below this percentage, nitrated cotton—which by nitration becomes an explosive—may be dissolved into a plastic substance; and when the ether-alcohol solvent has, in its turn, been evaporated, the cellulose becomes a hard, tough, translucent mass. Before hardening, however, the stuff is pressed into grains of various shapes which burn with a bright orange flame and without smoke. Our smokeless powder is a brother of collodion so useful in medicine and the art of photography; while celluloid, in its endless applications, is a first cousin, and lies just beyond the dividing line of those substances soluble in ether-alcohol.

THE "PYRO" IS PILED INTO OPEN TUBS, AND TRANSPORTED TO STEAMING TANKS, WHERE IT IS BOILED AND BOILED TO EXTRACT THE MAJOR PART OF THE CLINGING ACID

The cotton used may be either the blooms straight from the fields or the white mill waste. In either case, the cotton is cleansed by an alkaline bath, and then well dried in an atmosphere of 212 deg. Fahr. The workmen toil in this temperature, but the perfect dryness of the air explains why they are not boiled alive. The object of the drying is to make the cotton more absorptive in the acid, thus insuring more nearly perfect nitration. After the cotton has been dried, it is packed in air-tight canisters and sent to the nitrating house, where it is soaked for half an hour in a strong mixture of sulphuric and nitric acids. The reaction frees from the cotton a percentage of moisture which, if not withdrawn, would dilute the nitric acid and affect the character of the product. Sulphuric acid has a strong affinity for water, and it extracts the moisture—thus leaving the nitric acid unimpaired and capable of doing its full work upon the cotton.

The nitrating house is not unlike a big steam laundry in some ways—the cotton being digested in centrifugal wringers of a sort akin to those in which clothes are washed. The atmosphere is intensely acrid, and the stranger coughs in the biting air, to which the throats of the operatives seem to be indifferent. When the cotton has soaked sufficiently, it shows signs of heating by emitting a dense brownish smoke. It is then tumbled into vats of running water, and there "drowned" before being wrung out in another mechanical wringer. The cotton, before innocent, has become an explosive, in fact, is guncotton or pyro-cellulose. Its subsequent stability and value as a propellant now depend upon the thoroughness with which all traces of the transforming acid are extracted from the "pyro," as it is commonly called.

THE POWDER IS FORCED THROUGH MACARONI DIES IN THE FORM OF ENDLESS ROPE, PERFORATED FROM END TO END WITH A CONCENTRIC GROUP OF CIRCULAR PASSAGES



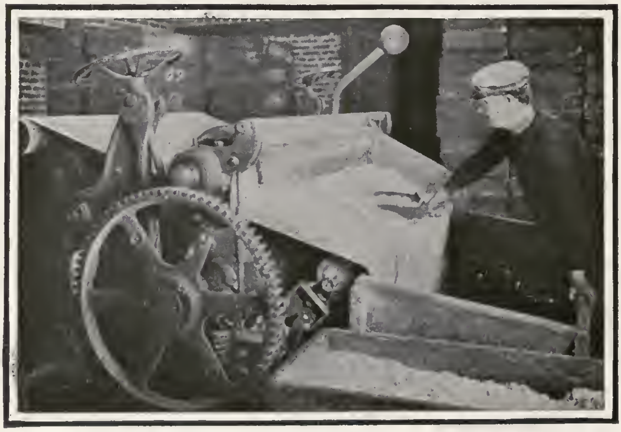
THE DEHYDRATING HOUSE, WHERE ALL BUT A VERY SMALL PERCENTAGE OF THE MOISTURE IS EXTRACTED BY PRESSURE AND FINALLY BY THE USE OF ALCOHOL TO DRIVE THE DAMPNESS BEFORE IT AND LEAVES ENOUGH OF THE SPIRITS BEHIND TO FORM THE NEEDFUL SOLVENT

To this end, the "pyro" is next put into open tubs, loaded upon a flat car, and carried to steaming tanks, where for two days it is boiled and boiled to extract the major part of the clinging acid. We know we are dealing now with an explosive by the sharp re-

IN THE DRYING HOUSE, WHERE THE POWDER GRAINS ARE STORED AWAY AND DRIED TO THE PROPER STAGE, BEFORE TESTING AND SEALING AWAY IN AIR-TIGHT TANKS

ports that come from under the car wheels as they pass anon over small bits of nitrated cotton. Next the stewed cotton is taken to the pulping house, where it is pulped and poached like the materials used in paper making. The water is changed often, and after twenty or thirty hours' working, the "pyro" is quite freed of the last trace of acid. These various operations do not undo the nitrating. The chemical metamorphosis accomplished in the cotton by the acid is permanent, and the boiling and washings serve only to remove spent and unabsorbed acid. The slimy pulp is now put through a "wet machine," coming from the rollers in flakes containing about 40 per cent of moisture. Thence it goes to the dehydrating house, where all but a small percentage of the moisture is extracted by successive applications of pressure, and, finally, by the use of alcohol, which drives the dampness before it, leaving just enough of the spirits behind to form the needful solvent when ether is added. The ether is poured in and the stuff is ground and mixed in a mechanical kneader. After half an hour's working, the material resembles damp cracker crumbs. Chemically, the "pyro" is now solvent and has undergone another change, requiring only the proper amount of pressure to produce homogeneity. The "colloid," for such it is, is then pressed into cakes weighing fifty pounds, which suggest soft rubber and are dully resonant. The stuff is no longer white, but looks like syrupy maple sugar. The amber-colored cakes are then subjected to a heavy pressure and the plastic stuff forced through steel collanders, whence it issues in cords like solid macaroni. Again, for the sake of more perfect union, these cords are pressed into a single compact cake, and then the plastic mass is placed within the cylinder of the powder press.

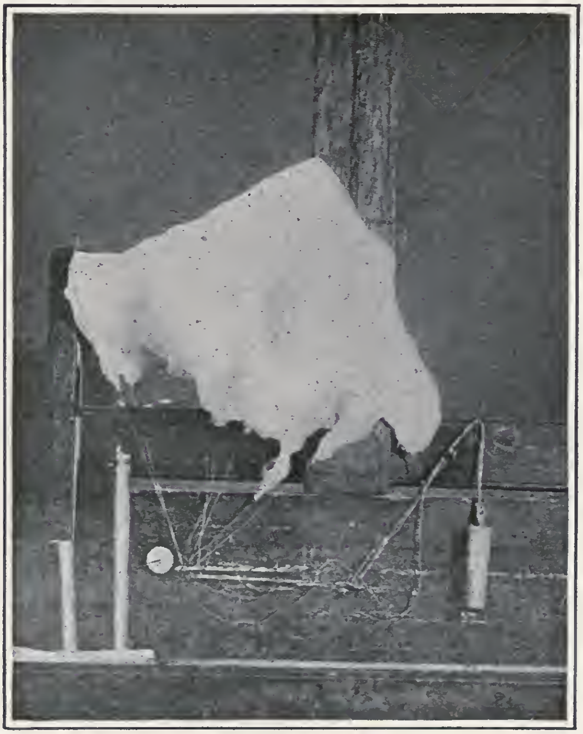
Under an impulse of from 4,000 to 6,000 pounds pressure to the square inch, varying with the size of grain, the powder issues through dies in the form of an endless snake of pale yellow, perforated from end to end with a concentric group of circular passages.



RUNNING THE FLUID PULP THROUGH THE "WET-MACHINE," WHENCE IT COMES FROM THE ROLLERS IN FLAKES CONTAINING ABOUT 40 PER CENT OF WATER

As the cord comes from the press it is cut into grains of uniform length, the size of these units and the number of perforations depending upon the caliber of the gun. The purpose of the small lengthwise passages is to insure a compensating burning surface, which increases directly as the external grain surface diminishes under the attack of the flame. This gives the powder its *progressive* burning quality, so needful in securing the desired ballistic results without undue stress upon the weapon.

The actual fashioning of the powder is now complete; but there are still things to be done before it is fit for issue to the service. As it was with the nitric acid, so too is it with the ether-alcohol solvent, the stability of the powder depending upon the degree to which this volatile is extracted. Some of this solvent is removed by distillation, and thousands of dollars worth of it are recovered annually and used again. The final stage of dryness is reached by storage in drying houses, the period varying from six weeks to six months, according to the size of the grain. Then, after being tested by actual firing, and mixed with grains of other groups to secure a desired average, the powder is put up in air-tight tanks ready for issue. The object of careful sealing is to arrest the escape of the remaining solvent, which acts as a deterrent and prevents the explosive from becoming too quick in its burning, thus serving to check the development of sudden and dangerously high pressures in the gun. Thus it is made ready to deal out death.



PARACHUTE CANDLES USED BY ZEPPELINS IN NIGHT ATTACKS

USING THE SEARCHLIGHT TO REPEL A NIGHT ATTACK

Chapter XXVIII.

NOCTURNAL WARFARE

Shells and Searchlights That Illuminate The Enemy

BY MAJOR H. BANNERMAN-PHILLIPS

AMONG the many nerve-trying developments of the art of war in recent times, night operations have assumed great prominence for various excellent reasons. To steal a march on an enemy and outmaneuver him; to avoid an unwelcome observation of his aerial scouts, planing at lofty altitudes, securely immune from the fire of terrestrial marksmen; to traverse ground which offers no cover from the views and fire of the enemy in daylight; to carry on an attack commenced before dark and convert it into a successful fight to a finish during the intervening period before the following dawn reveals one's dispositions, and, more important than all, to take the enemy by surprise, and thus enhance the chances of success tenfold, such are the grounds on which it may be found advisable to act by night rather than by day, although nocturnal operations are by no means so simple as those carried on in daylight, and should only be attempted by selected and seasoned troops who have had special and extended training for the express purpose in peace time. They involve a thorough reconnaissance of the ground even in the case of an ordinary night march, and to commit troops to a march or an assault on an enemy's position by night without such a precaution is to risk playing into the hands of the enemy. In the case of a march by night the route ought to be carefully gone over by the reconnoitering officers both by day and night, compass directions taken and landmarks noted, and unless one has actually carried out such a preliminary double reconnaissance and taken part in the subsequent operations, it is difficult to appreciate how much depends on the care with which this duty is performed. In the case of an advance across country with a view to attack by surprise, it is remarkable how obstacles which can be avoided or negotiated with ease in daylight may become veritable pitfalls by night, bringing confusion among the advancing troops and possibly noise which may reveal their presence and cause the failure of the whole operation.

In all cases secrecy as to previous intentions and concealment of the operation itself are of the utmost importance. By a well-planned strategical night march an enemy may be outflanked, or a position seized which would have been denied and defended by the adversary if he had realized that the movement was being made or that the attack was coming. A hostile army may thus be placed in such a position that the enemy is obliged to fight under unfavorable conditions, or a commander placed in an embarrassing position by some unforeseen development, may extricate himself by transferring his forces to a distance under cover of the darkness.

A night advance may be used to gain ground from which further progress will be made in daylight, the troops being deployed for attack at the outset and not in march order, and in such cases the attack would usually be made as soon as it is light.

An assault may be actually delivered during darkness, but the hazards of such a proceeding are so great that unless the conditions of a fire fight with the enemy have already proved adverse over the same ground in daylight, or are almost certain to be so, it is usually better to accept the proportion of losses by the enemy's fire which may be expected in a struggle for supremacy under normal conditions by day, trusting to gun and rifle for decision, than to endeavor to gain the point by the bayonet, the grenade, and hand-to-hand fighting, the only methods which can be relied upon in a nocturnal *mêlée*. In cases where a night assault is considered imperative everything is done to avoid alarming the enemy until the attack can close with him. Rifles are not loaded, though magazines are charged and cut-offs closed, the troops are given strict orders not to fire without a distinct order, bayonets alone to be used until daylight makes it possible to aim with effect; absolute silence to be maintained until the moment of assault, the advance to be carried out quietly and without rattling of accouterments. No smok-

By courtesy of the *Illustrated London News.*

SEARCHLIGHTS FIRED BY INFANTRYMEN. ILLUMINATING GRENADES DISCLOSING A CHARGE. AN ILLUMINATING GRENADE (HALE'S PATENT) IS FIRED FROM A RIFLE. FOUR OF THE GRENADES HAVE JUST BURST IN THE AIR AND THEIR LIGHTS, "HELD" BY PARACHUTES, ARE FALLING. THE THREE MEN IN THE RIGHT FOREGROUND HAVE ILLUMINATING GRENADES ON THEIR RIFLES, READY FOR FIRING. THE RIFLE IS NOT HELD AT THE SHOULDER, BUT ITS BUTT IS RESTED AGAINST THE GROUND; THIS BECAUSE THE RECOIL WOULD BE RATHER TOO MUCH FOR THE MAN'S SHOULDER.

ing is permitted, no matches to be struck. If men come across obstacles which cannot be easily crossed or cleared away, they must lie down until a passage can be made. If hos-

SEARCHLIGHTS ASSISTING IN DETECTING A RAID BY ARMORED MOTOR BOATS. FROM AN ORIGINAL PAINTING BY BEVERLY TOWLES.

tile scouts or patrols are encountered, an endeavor must be made to capture them without noise, or bayonet them in silence.

When all is said and done it should be extremely difficult, even with all these precautions, to surprise an enemy who in view of the various reasons for night operations will presumably be on the lookout for such methods of attack. Science will be pressed into the service of the defense and the occupants of a position will most certainly endeavor to turn the tables on their assailants, converting night into day at short notice by causing the latter to be exposed to one form or another of artificial light at the supreme moment, while they themselves remain covered by the darkness. Star-shells have been found exceedingly useful against savage enemies, but a better illuminant still is the parachute-light. This is fired from a gun like any other projectile, but of course with only a small charge of powder, and bursting above an enemy, develops into a parachute suspended in mid-air and showing a brilliant light which reveals during several minutes all that is going on beneath.

A civilized and well-equipped force is, of course, provided with searchlights of a portable description in addition to the star and parachute shells. These searchlights are especially useful to enable the artillery to play on the assaulting columns with telling effect, and without them the guns would be of little use in defense by night. They are posted, under the orders of the artillery commander, well to a flank of the guns of which they are to "make daylight," and protected from the enemy's fire by entrenchments, and are not turned on until the enemy has been reported as advancing to the attack. As a means of illuminating the immediate neighborhood of a position another form of parachute light, on a minor scale, has been invented. This is in the form of a grenade which can be fired from a rifle, the butt resting on the ground, to ranges of from 50 to 1,000 yards; the floating light burns from 30 to 45 seconds only, according to its size, but the grenade has the great advantage of being very portable, weighing only 14 ounces, the firing-rod used with it weighing another 4½ ounces. It can be used in positions and circumstances where either searchlight or artillery for firing the star or parachute shell would be out of the question. Our illustration shows these useful aids in action.

AUTOMOBILE-MOUNTED SEARCHLIGHT IN USE BY THE FRENCH ARMY

Chapter XXIX.

FEEDING THE MAN ON THE FIRING LINE

Tents, Shoes and Rations Win Many a Campaign

IN forming a plan of supply for a particular campaign the following points must be carefully considered: the resources of the theater of war and the facility of utilizing the same; the time of year and climate; the nature of the war, whether offensive or defensive; the length of the line of communications; the rapidity of the movements; the propinquity of the enemy; and the temper of the inhabitants.

The national country must provide the supplies for its armies. This is particularly important now, as it has been held that provisions and foodstuffs of ordinarily innocent use, which are usually only *conditionally* contraband, may become *absolutely contraband* of war when actually and especially destined for the military or naval forces of a belligerent.

The right of armies to take from the country all that they require for their sustenance is indisputable, though we usually understand the expression "living upon the country" has direct application to an enemy's country. Military necessity, as understood by all civilized nations, permits the enforcement in an enemy's country of all those measures which are indispensable to facilitate and assist in the conduct of the war, and which are lawful according to the modern law and usages of war.

The preparation, therefore, must extend to an elaborate study of the resources of the home country and of a portable theater of operations. In some of the great powers this work is carried out through the co-operation of the various civil authorities whose duty it is to make instant report of any change in the supply situation in their district. Statistical data and supply maps are prepared showing:

The principal production of the country; the distribution of the available resources; the importance of the last harvest; the amount of the exports of same; the amount locally consumed; the number and kind of meat cattle; the number, motive power, daily capacity, and location of the flour mills; the number and average yield of the bakeries; the number and location of the abattoirs and meat-packing establishments; the number of draft animals; the means of transportation, railways, steamboats and ordinary roads, and their capacity; the number of the inhabitants, urban and rural; the character of the imports and exports; the supply and character of the potable water; the fuel used and its abundance.

In order to assure the continuity of the service of supply, that is to say, the relation between the troops in the field and the centers of production in rear of the army, the work performed by the administrative departments is divided into three distinct spheres of action, viz.:

1. The service performed in rear of the army, established in the national territory or in the governments of the occupied countries for the purpose of collecting the resources and providing for the supply of

2. The service of the Line of Communications; the duty of the commander of which is to provide for the replacement of the stores consumed by the army, and the trans-

portation, subsistence, and quartering of all troops, prisoners, sick and wounded passing over the line, and also provide for its protection.

3. The supply of the troops in the field during active operations.

These three services are entirely separate, but work in conjunction with each other to carry out the main object for which they are created—the supply and maintenance of an army in the field.

The success or failure of the campaign depends upon the proper operation of the service of the Line of Communications, and this important position is always assigned to a general officer of recognized ability and discretion. He is assisted by a large and numerous staff to enable him to carry out the varied and multitudinous duties assigned to him, and, in addition, has a competent force of all arms of the service to preserve order along the Line of Communications, guard the depots of supply, and protect the line from attacks by the enemy. Such officer is subordinate to the commander of the troops in the field, but his duties and responsibilities are second only to such officer.

The commander of the Line of Communications must then see that his depots are adequately supplied, and must forward each day to the troops the necessary supplies for man and horse, and likewise care for the evacuation of the sick and wounded, and the custody and care of the prisoners. To enable him to do this, all the necessary field equipments are provided; for instance, a Field Bakery Company, and equipment for each Division supplied by the Line of Communications. The Field Bakery in the United States Army consists of twelve knockdown bake ovens with all the necessary equipment for producing bread and the tentage in which to install the dough troughs, and shelter the men. Each oven is capable of producing 2,500 rations of garrison bread per diem, or 1,500 rations of field bread; this is bread produced in such manner that it has not as great a "pile" as ordinary (or garrison) bread, and being baked in a much slower oven and no loaves allowed to touch (or "kiss") is completely enveloped with a good, thick crust, thus permitting the bread to be readily shipped in wagons; and its freedom from moisture renders it possible to be kept in good condition for a week or ten days. So that each field bakery can produce daily 30,000 rations of garrison bread, or 18,000 rations of field bread, sufficient to supply a Division.

MIXING DOUGH

CANVAS STORAGE TENTS FOR BREAD

The supplies an army carries with it may be divided into two classes: those carried by the troops themselves, and those which are carried in the trains.

The troops having to march many miles a day, starting early in the morning and probably not completing the march until late in the afternoon, would suffer greatly from lack of food if compelled to await the arrival of the train carrying the same. Therefore it follows that, if troops are to be fed in the field, they must carry rations with them, and the ration consumed during the day must be replaced by the train at night.

A "ration" is the allowance of food for one person for one day and comprises various articles termed components. It is interesting to note that the Turks in the fourteenth century first established the allowance of a soldier's daily ration, and in the same century first had regularly organized supply trains to follow their troops.

Each man carries two days' rations, and the unconsumed portion of the day's ration issued the night before, for the noonday meal.

The transportation attached to organizations is grouped under the following heads, i. e.:

(*a*) The trains assigned to organizations smaller than a brigade, designated combat and field trains, respectively. The ration section of the field train carries two days' field, one day's reserve ration, and for each animal two days' grain ration.

(*b*) The trains assigned to divisions, designated ammunition, supply, sanitary, and engineer trains, respectively.

The supply train of an Infantry Division carries two days' field and grain rations. In the late afternoon or at the end of a march or close of a combat, the division commander directs the *field* trains to move up immediately in rear of the troops, and informs the commanding officers of organizations that one day's rations have been ordered to a designated place. An orderly is sent to that place to conduct the wagons to the organization; after being unloaded they return immediately and join the grouped portion of the ration section. That same night, or early the following morning, the empty wagons are refilled from the supply train, and this latter secures a renewal of its supplies from a designated point on the Line of Communications, or is reloaded from a train pertaining to the Line of Communications, if the distance from the end of that line to the zone occupied by the troops is so great as to warrant the use of a train.

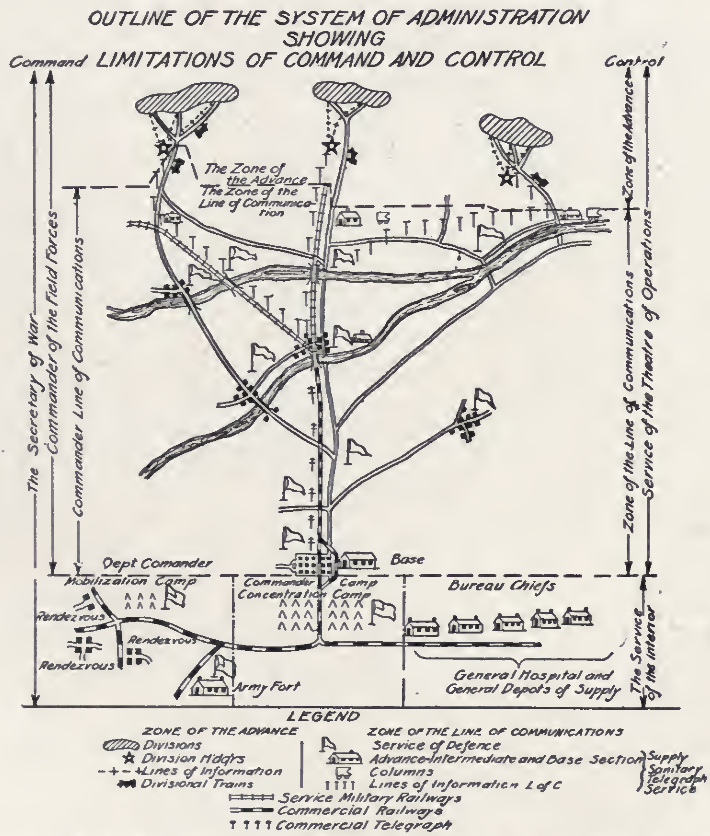


DIAGRAM SHOWING METHOD OF CONTROL OF AN ARMY OF 100,000 MEN IN THE FIELD

There are two methods of supplying an army in the field:

1. By consignments of supplies forwarded by the service of the Line of Communications and distributed as above briefly indicated.

2. By utilizing the resources of the country.

It is generally necessary to utilize to the fullest extent the food, especially the forage, available in the theater of operations. In former times the invader possessed the right of booty and pillage, the resort to which was most unfortunate for the army, as it embittered the population and compromised the safety of the troops in an enemy's country, and in the event of any real or imagined injury being done them, it gave rise to redress and reprisals. It, furthermore, caused the interruption of all commercial transactions, and stores were not offered for sale, as private individuals were compelled to submit their supplies to the rapacity of the enemy. These evils were in a measure remedied by not taking directly from private individuals, but by making upon the civil officials certain demands called requisitions, for a specified quantity of supplies necessary for the troops. The local authorities could apportion the demand among the inhabitants, according to the known means of each, or could produce the stores by purchase. The former practice of spoliation thus assumed the milder form of a war tax, regularly ordered and collected. This eventually led to the practice of giving receipts for the stores delivered, and the indemnity for the same was the next innovation. All these modifications were, of course, only introduced after a great interval of time.

Requisitions have been defined as demands for necessary supplies and services made on the inhabitants of certain districts or localities, *through their civil authorities*, to satisfy the requirements of an army. They are accompanied by force, if it is necessary to resort to such extreme measures, to exact the fulfillment of the demands.

A NEW FORM OF FIELD OVEN USED BY THE BRITISH. THE MEAL IS COOKED BY THE TIME CAMP IS REACHED

Billeting or Quartering.—Supplies of food are, as a rule, to be found for several days in every town or village, and each householder usually has a sufficient quantity to provide his family for a few days, consequently at least the same number of soldiers as there are individuals in the household can obtain subsistence there for a day or two. This method is the one which distributes more uniformly, if not in the best way, the burden of the subsistence among all the inhabitants, and makes it possible to subsist the greatest number of men in a given section of a country.

An exception should always be made in

favor of the poorer classes, who, at the best of times, are barely able to provide for their own families.

The following exceptions are usually made:

First. Any householder who has entertained a wounded man in his house is "exempted from the quartering of soldiers." (Article V, Geneva Convention of 1864, acceded to by United States, March 1st, 1882.)

Second. Charitable institutions, hospitals, asylums for aged and infirm, religious communities of women, unprotected women, and educational institutions for girls should not have troops billeted upon them.

The advantage of this system is that the men at the end of a day's march find their meal ready cooked and prepared. The disadvantages are that it causes very great dispersion and separation of the different units. In addition, this method may lead to oppression on the part of the troops, if they are not treated as liberally as they consider they should be. The dispersion of the troops prevents the officers enforcing strict compliance with orders and is subversive of discipline.

A supply of uniform clothing must be provided from the home country, and a sufficient reserve available at all times to replace the losses which occur in active service. In some of the foreign armies the first reserve of clothing is composed of 10 per cent of trousers and shoes; 5 per cent of caps, coats and overcoats. These percentages are calculated on the maximum war strength of the organization. In those armies every soldier's kit must at all times contain an absolutely new uniform; this uniform the man is required to put on only when the order for mobilization is received. The troops, consequently, march into the field in new clothing, which arrangement very greatly reduces the demands upon the reserves during the campaign.

TRAVELING KITCHEN OF THE FRENCH INFANTRY

In the foregoing discussion attempt has been made to outline in a very brief and cursory manner the supreme importance of the supply of an army in the field and the stupendous task imposed upon the officers charged with the execution of the same, whose work never ceases. As Daru says: "This is, perhaps, the only arm of the service which takes no rest during war."

A Comparison of German Rations

"RATIONS," as the daily food supply of the soldier is known, vary in each country according to racial tastes or climatic conditions. Thus the meat ration of France is quite different from that of Germany. For the purpose of comparison we have taken the daily field ration of the German army, which is as follows:

750 grammes of fresh bread,
or 500 grammes of biscuit;
375 grammes of raw meat (fresh or salted),
or 200 grammes of smoked beef, pork, mutton, bacon, or meat sausage;
125 grammes of rice (groats),
or 250 grammes of pulse or flour,

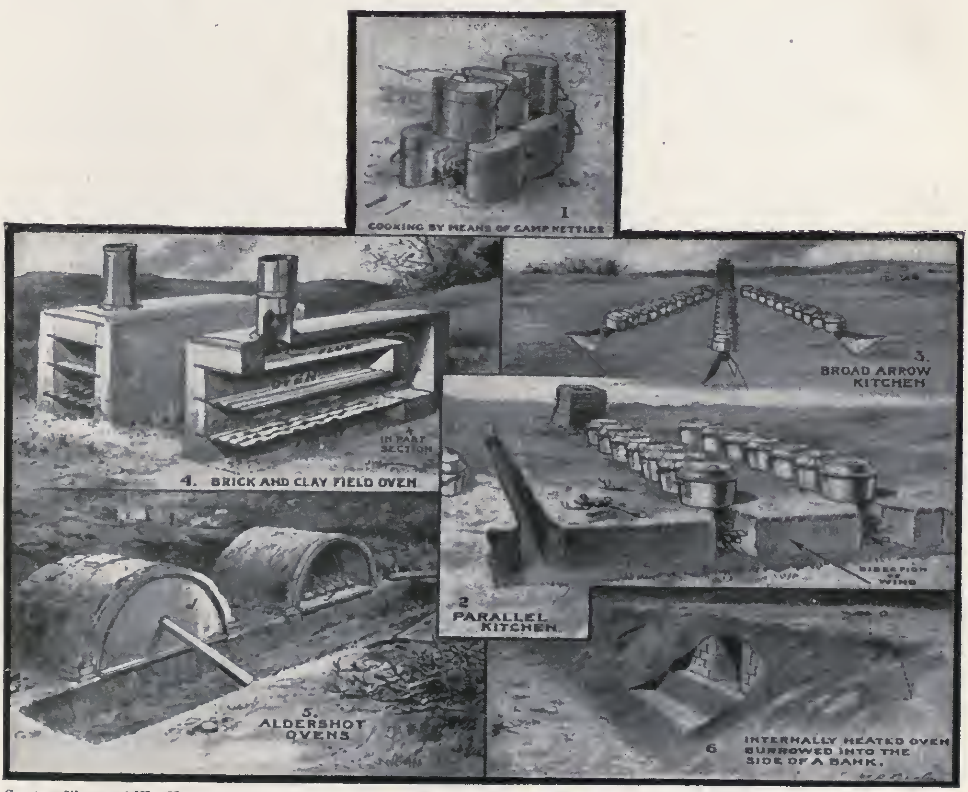
A WEEK'S FOOD SUPPLY FOR THE GERMAN ARMY

or 1,500 grammes of potatoes;
25 grammes of salt;
25 grammes of coffee (roasted),
or 30 grammes of coffee (green),
or 3 grammes of tea and 17 grammes of sugar.

We have shown this supply for a week compared with the huge mass of Cologne Cathedral. The result is very surprising, for we have a loaf of bread weighing 60,130,000 pounds and 393 feet high, which bulks well alongside the lofty edifice. Meat is represented by a side of bacon, but in practice this might be varied by sausage, smoked beef, fresh beef, salt meat, or mutton. The bacon is 180 feet long and would weigh 16,030,000 pounds. Potatoes are the heaviest item, weighing 120,330,000 pounds, and the gigantic tuber shown in the engraving would be 188 feet high and of a proportionate girth. The bag would be two feet less in length, while the sugar bag would measure 38 feet high and would weigh 1,365,000 pounds. Such amounts of food seem almost incredible.

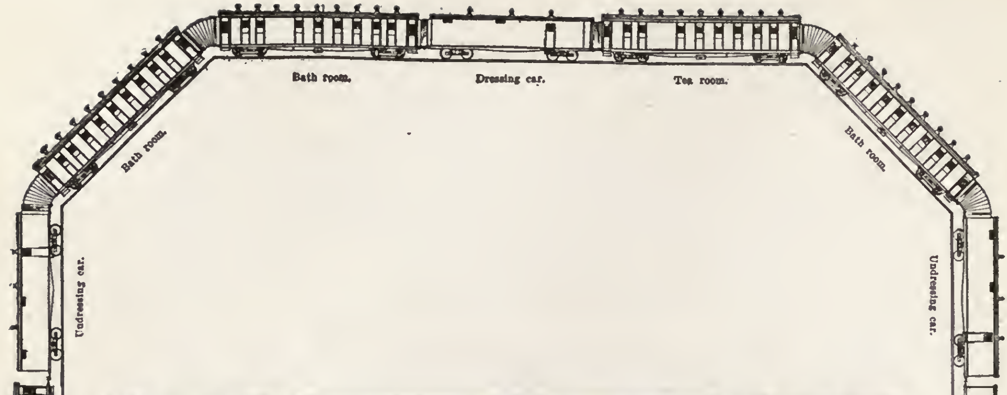
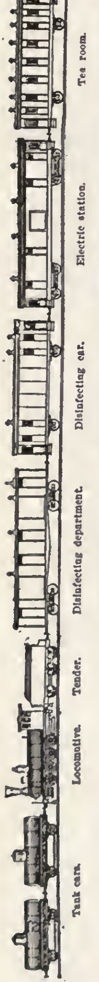
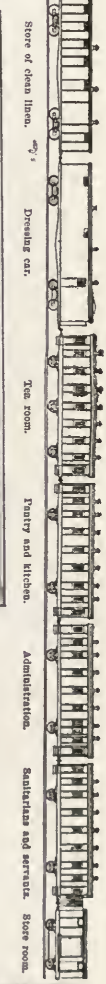
Field Cookery—How it Works

THE fact that an army fights on its stomach is nowhere better realized than in the British army. Figs. 2, 3, and 4 below show types of ovens where the food is inside and the fire burns in an adjoining chamber; while Figs. 5 and 6 show another type where the fire is placed inside the oven and then withdrawn, whereupon the food is cooked in the oven thus heated. The oven shown in Fig. 4 is for a more or less permanent camp; while to build "Aldershot" ovens, as in Fig. 5, would also be waste of time unless the troops were stationary for several days. The latest pattern of the "Aldershot" will make 108 1¼-pound loaves in each batch. With a good heat rations for 200 men can be cooked in 2½ hours. A portable steel oven is now largely used.

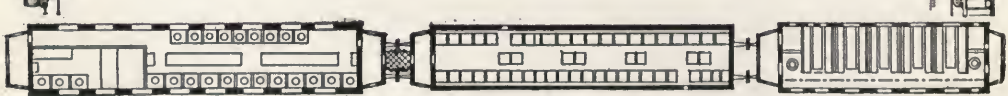


Courtesy Illustrated War News

THE COOKING OF FOOD FOR AN ARMY IN THE FIELD—VARIOUS TYPES OF OVENS AND KITCHENS

INTERIOR OF A BATH CAR SHOWING THE SHOWER BATHS AT EACH SIDE AND THE STEAM ROOM IN THE MIDDLE



SECTIONAL PLAN VIEW OF THREE CARS OF A RUSSIAN ARMY BATH TRAIN

Chapter XXX.

HOW SOLDIERS ARE BATHED

Russian Bathing Trains Can Daily Give a Bath to at Least 3,000 Soldiers. They Provide for the Serving of Refreshments and Afford Numerous Utility Advantages

THE bath is a great institution in Russia. People are accustomed to it, and even the smallest cottage has its little "banja" or steam bath house, where they get their weekly steaming.

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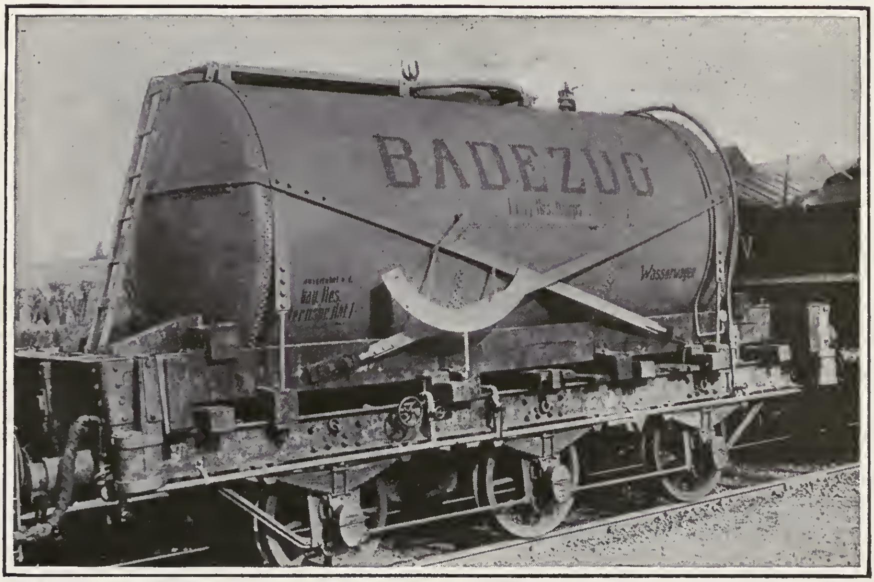
BATHING TRAIN OF THE GERMAN ARMY

During the present war several movable "banjas" or bath-trains have been constructed for the Russian army. The following short description gives a general idea of one of these trains.

As shown along the border of page 188, the train consists of a locomotive and a score of cars. The cars of the bath-train are reconstructed passenger coaches of the third and fourth class and freight cars. All the cars are paneled with felt, cork and wood, to keep them warm, and are provided with everything that is necessary for each car according to its destination. The cars are joined by warm vestibule bellows, that make it possible for the soldiers to pass freely from the undressing car to the bath room and then to the dressing car.

The bath-train is lighted with electricity from the central electric station and heated by steam. The bath-rooms are provided with hot water from the locomotive boiler. In the train there are two tank cars holding water necessary for twenty-four hours' work. Be-



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THE BATHING WATER TANK CAR

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A BATH ROOM IN THE FRENCH TRENCHES NEAR SOISSON

sides there is an electric pump by means of which water can be drawn from any source not farther than 50 to 100 Russian fathoms or 350 to 700 feet.

The undressing car has longitudinal benches with numbered seats. Each car has forty-eight seats. On entering the car each soldier receives a number check and takes a corresponding seat. He puts his outer clothing into one bag and his soiled linen into the other. These bags, also numbered, he finds under the bench and on the upper shelf. In this car the soldier may have his hair cut, and after that he passes to the washing department. Each department has twenty-four partitioned washing fittings and a steam-bath, while there are benches in the middle of the car.

The bath-car has several faucets for hot and cold water. Each fitting has a shower with a mixing cock. Every soldier receives a piece of soap, a bast-wisp for scrubbing, and a basin for suds. The steam-bath also has hot and cold water faucets and a shower in which the temperature of the water can be regulated.

While the soldiers are washing, the attendants of the train take the bags of dirty linen, disinfect it and pass it over to the store of dirty linen, while the bags of clothing are taken either into a special disinfecting compartment or into a special department for destroying parasites.

The dressing car is arranged in the same way as the undressing car. The soldier finds on his numbered seat a bag with a set of clean linen, and his clothes cleaned, mended and disinfected. When dressed he passes to the next car, which is called the tea room, where he can get tea, sugar, tobacco, all comforts dear to the soldier.

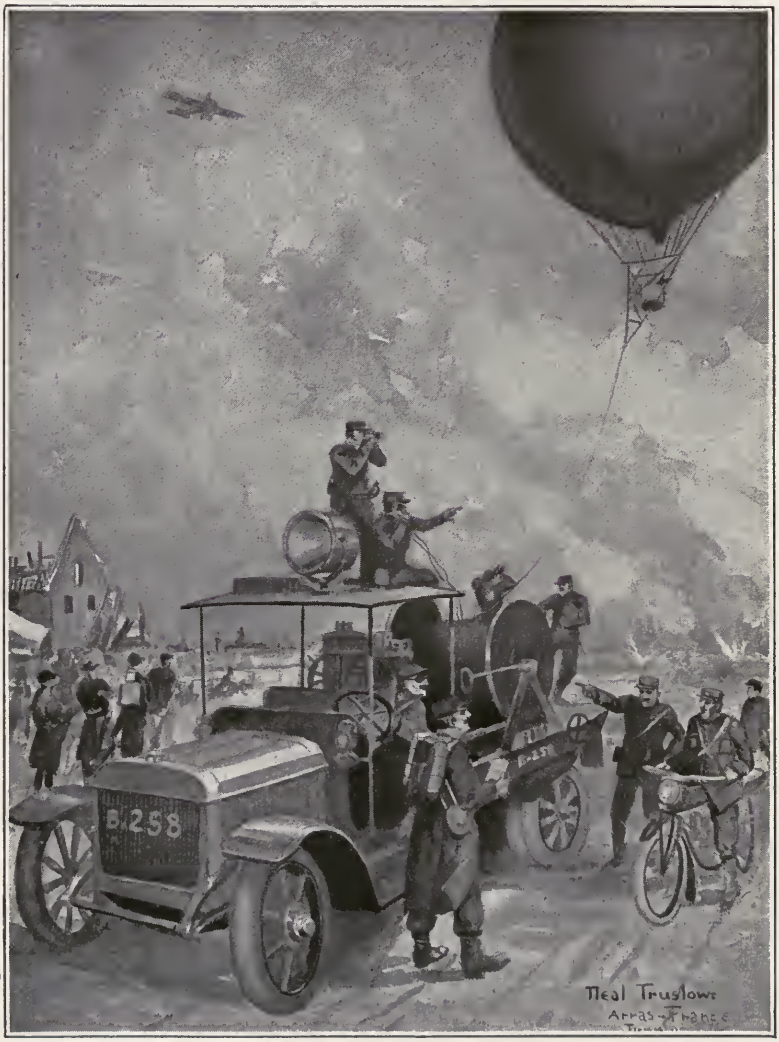
The disinfecting compartment is designed for the disinfection of clothes, boots and fur jackets. After the disinfection the compartment is filled with ammonia to take away the caustic odor of the formalin.

The compartment in which parasites are destroyed uses air heated to 100 deg. Cent. To kill the parasites it is enough to keep the bags in the rotating drums of the compartment for ten or fifteen minutes. The equipment of the other cars calls for no special comment. In one of the cars there is a cobbler shop, with instruments for mending boots, etc. The bath-train is provided with linen by special cars, that supply the stores from Petrograd and other towns.

At present there are three bath-trains in the Russian army. Each of them can daily give a bath to two or three thousand soldiers. Bathing in other armies is deemed equally important and it is a duty a soldier is always glad to perform.

Illustrated War News

HOT BATHS BY CAR FOR WOUNDED AND UNWOUNDED BRITISH SOLDIERS: THE NEW MOTOR-BATH; WITH BATHS IN PLACE. THIS MOTOR-BATH CARRIES TWELVE FOLDING BATHS, WHICH ARE OF WATER-PROOFED CANVAS ON A DOUBLE IRON FRAME. WHEN IN USE, THE BATHS ARE IN A TENT, AS SHOWN. HOT WATER IS CONVEYED TO THE BATHS BY HOSE. THE HEATING-APPARATUS, WHICH IS IN DUPLICATE, IS INSIDE THE BODY. PARAFFIN GIVES THE HEAT. WATER IS SUPPLIED AT THE RATE OF TWO GALLONS A MINUTE TO EACH OF THE TWO BATH TAPS. THE SUPPLY TANK HOLDS FIFTY GALLONS, AND THE TWO BOILERS EACH HOLD FIVE GALLONS. THE EQUIPMENT OF THE INTERIOR INCLUDES A FUMIGATING CUPBOARD, IN WHICH THIRTY SUITS OF CLOTHES CAN BE FUMIGATED AT A TIME.



From a painting made at Arras by Neal Truslow

CAPTIVE BALLOON USED FOR RECONNAISSANCE

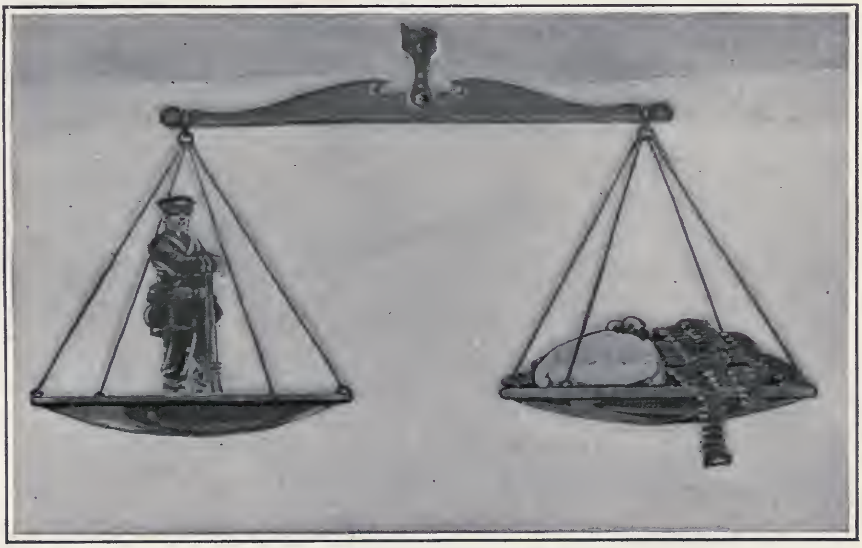
Chapter XXXI.

WAR THE DESTROYER

The Chances of Death in Battle and From Other Causes

BY ALFRED J. LOTKA

THE word *chance* conveys to the untrained mind the idea of something beyond the pale of natural law, something which obeys no rule and defies all measure and prediction. Diametrically opposed to this is the conception which the mathematician and the statistician has of chance. To him the very criterion of chance events is that they follow certain definite laws. The statistics collected by a life insurance company enable the actuary to foretell with much precision the toll that death will exact in a year among the body of insured. It is said that large engineering firms of long experience can predict very closely the number of human lives that a given construction will cost. In war, too, laws of chance are operative, though here, we have not the same wealth of data based on actual observation from which to draw our conclusions, and furthermore, conditions are so widely different in different wars and may change so extensively in the interval between the successive wars, that predictions are necessarily uncertain. Of course, when the requisite data of a problem of chances in war are given, there is no difficulty in drawing the logical conclusions. As an example, consider an army of 250,000



THE COST OF KILLING. IN THE RUSSO-JAPANESE WAR 70 POUNDS OF GOLD AND 1,053 BULLETS WERE SPENT PER MAN KILLED.

men, who engage in battle with a loss of 50,000 killed and wounded. Suppose the gaps in the ranks to be refilled by re-enforcements, and the army, now once more 250,000 strong, to fight a second battle, and so on, the casualties being at each battle 50,000, which are made up by fresh troops before the next encounter. Suppose five such battles to be fought. What are the chances that a man in the original army of 250,000 shall fight through and survive all the five battles?

The answer is not hard to find. The chances of survival unhurt after the first battle are evidently 200,000/250,000, or 4/5.

In the second battle 200,000 men of the original army are fighting, and if we suppose casualties to be evenly divided among the original men and the fresh troops, then again ⅘ of the former, i. e., 160,000, will come out of the battle unhurt. Similarly, at the third battle ⅘ of 160,000, or 128,000, survive in condition to engage for a fourth time. Of these another ⅘, or 102,400, enter the fifth battle, and lastly 81,920 escape from injury in the fifth battle. There were in all 250,000 men in the original army, hence the chances that any one of them will survive five battles with the casualties and re-enforcements as indicated are 81,920:250,000, or 0.32768:1.

And disease is more to be feared in war than are bullets and shells. In the Crimean war, out of every one thousand of French troops 236 died by disease and only 64 from wounds. Among the English troops the corresponding figures were 179 and 47. Napoleon in the march to Moscow lost two thirds of his army, though he fought only one general engagement. The Russian armies operating against him lost, in the course of five months, four fifths of their strength. The losses of the Federal armies in the civil war in two years amounted to 53.2 deaths in the thousand, of which only 8.6 were caused by wounds, the remainder, 44.6, by sickness. In the Franco-Prussian war the losses of the Germans was 34.7 per thousand from wounds, and only 30 per thousand from sickness. This is explained partly by the shortness of the campaign (seven months) and partly by the fact that the Germans were greatly superior in numbers and were able to send their sick home. In the Russo-Japanese war the ratio of deaths by sickness to deaths from wounds was three to one among the Russians and two to one among the Japanese. As for the great European war, Sir William Osler has made the following observations:

"I think this war will set a new record for low mortality among the wounded. Formerly, with the best first aid and hospital work, a mortality record of five or six per cent of those who reached the base hospitals was considered creditable. Up to date there has been but one fatality out of more than seven hundred wounded who have reached

HAVOC WROUGHT IN THE GRAND HOTEL AT SCARBOROUGH BY THE GERMAN BOMBARDMENT the base hospital at Oxford. This death was caused by tetanus.

"This result is partly due to the self-sterilization of the modern high velocity bullets and partly to efficient field first aid. I have yet to see a wound by either a dum-dum or an explosive bullet.

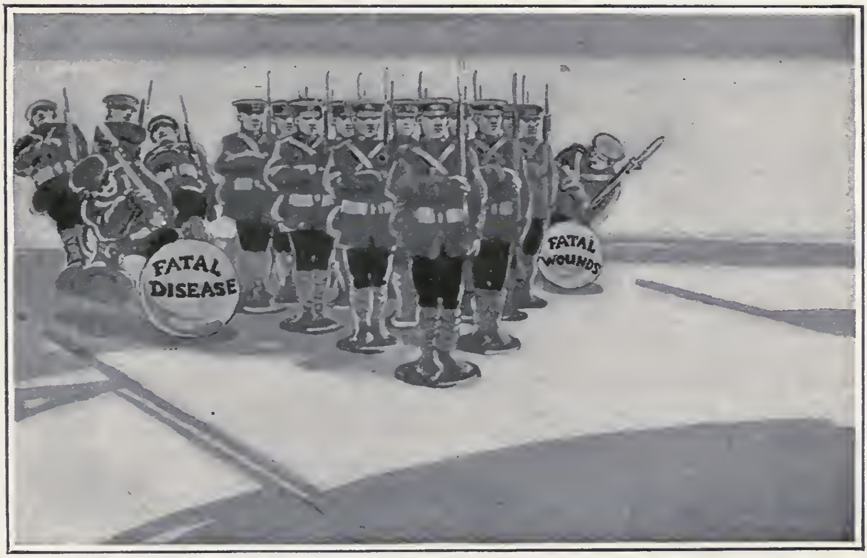
"If the experience of the past counts for anything, the expeditionary force on the Continent has more to fear from the bacilli of typhoid fever than from bullets or bayonets. In the Boer war bacilli accounted for 14,000 of the 22,000 lives lost.

"All fighting forces should take advantage of the knowledge that the human body can be protected from typhoid fever by vaccination. The success of this measure in the armies of the United States and France is proof enough. I do not fear that typhoid fever will break out in the camps in England, but this is not so in the large areas of the Continental theater of war.

"And then, with the coming of winter, the prevention of pneumonia will be a problem. It cannot be prevented like dysentery by the conscientious boiling of all the water drunk. Many people carry pneumonia germs with them, which are harmless as long as a soldier is in good condition, but which make their way to the lungs when the resisting powers of the body are lowered by exposure incident upon long marches and hard fighting in cold and rain."

The question is often discussed whether modern war is more deadly than the wars of the past. The supposition that the progress of modern military science is rendering war more and more deadly is contradicted by the fact that in the Franco-Prussian war 365 bullets were fired for every Frenchman killed, while in the Russo-Japanese war the corresponding figure was 1,053.

The fact is that progress in the art of killing is always surpassed by progress in the art of defense. "The result is," says Gen. Percin, "that the ratio of men killed or wounded in actual battle is continually diminishing. This ratio was 6 per cent under Frederick the Great, 3 per cent under Napoleon, 2 per cent in 1870 and ½ per cent in Manchuria."



THE BACILLUS IS MIGHTIER THAN THE BULLET. IN THE CRIMEAN WAR, OUT OF EVERY SIXTEEN MEN ONE DIED OF WOUNDS AND FOUR OF DISEASE.

The result of this increased efficiency of defense, is to increase the "cost of killing." Thus it has been estimated that in the Russo-Turkish War (1877-1878) the cost of one human life was $15,000; in the Russo-Japanese war it was $20,400. In the Franco-Prussian war the cost was exceptionally high, viz., $21,000. This is due to the small number of great battles.

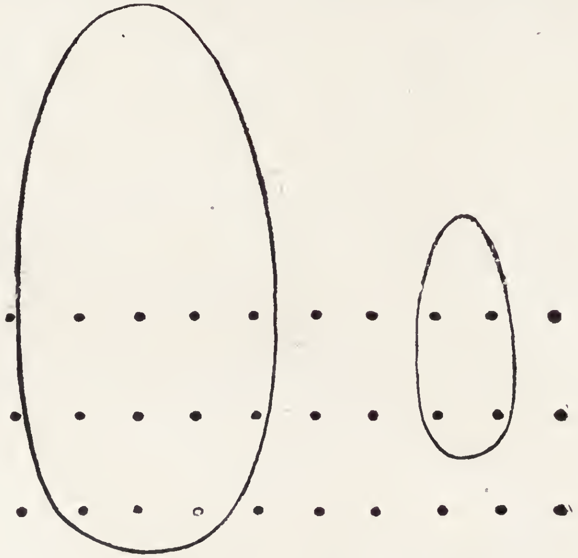
Closely related to the subject of the cost of killing is that of the effectiveness of gunfire. A group of shots fired at a target will spread in a more or less regular manner about the *center of impact*, which, if the firearm is correctly built and the range rightly estimated, should correspond to the point aimed at. The shots spread around this center owing to a number of causes, among them inequalities in the ammunition and errors of the gun. The principal cause of dispersion, however, is inaccuracy of aim on the part of the marksman. The appended table shows the dispersion of average shots at different ranges:

TABLE OF DISPERSION – AVERAGE SHOTS

Range	Mean		
	Vertical	Lateral	Longitudinal
Yards	Feet	Feet	Yards
100	1.07	0.97	308.04
200	2.03	1.77	398.21
300	2.87	2.41	348.79
400	3.59	2.90	282.04
500	4.21	2.26	219.91
600	4.88	3.75	185.37
700	5.62	4.40	156.66
800	6.44	5.23	135.28
900	7.33	6.21	118.57
1000	8.29	7.37	105.89
1500	14.50	11.98	76.00
2000	22.71	18.76	64.00

spread, is long and broad, extending over all three ranks and beyond. Another company, good marksmen, but misled by an incorrect estimate of the range, send their bullets to a much more restricted zone, which fails entirely to reach any of the men of the front rank. It may be remarked here that the error made in estimating range by eye at from 600 to 1,200 yards distance is about 12 to 15 per cent, according to the extent of training. Instrumental range finders are correct to within about 5 per cent, which is about the same as the accuracy attainable by taking the mean of several expert estimates by eye.

The effectiveness of rifle-fire depends not only on accuracy of range, but also upon the rapidity of firing. This varies somewhat with the distance of the target, since a little longer time is required to take an aim at a difficultly discernible object. As an average figure it may be assumed that at a distance



THE PARADOX OF THE BAD SHOT. THE FIRE OF POOR MARKSMEN MAY BE MORE EFFECTIVE THAN THAT OF SHARPSHOOTERS

The phenomena of dispersion gives rise to a strange paradox. Under certain conditions a company of good shots may be less effective than one composed of inferior marksmen. This is illustrated by the accompanying diagram. Two different groups of men are supposed to be shooting at a company of soldiers arranged in three ranks.

The first group has a rather inaccurate aim, and its *beaten zone*, i. e., the ground over which the impacts of their bullets

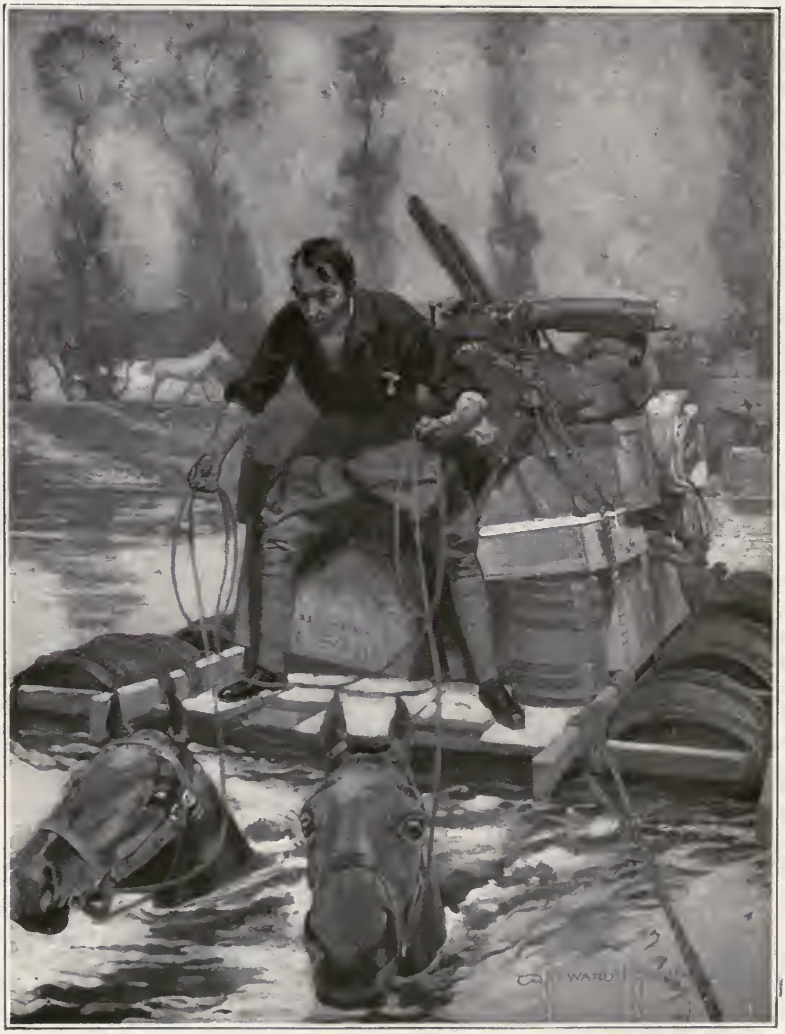
from 200 to 400 yards 10 shots per minute can be fired. At 500 to 700 yards this is reduced to 7.5 shots per minute, at 800 to 1,000 yards to 5, and at greater distances to about 3 shots per minute.

Most of the estimates of accuracy of firing are of course based on target practice in time of peace. In actual engagement there is a considerable deterioration of aim for obvious psychological reasons, and it is stated that the dispersion or inaccuracy is under these circumstances from 2 to 4 times as great as in target practice.

Terrible as are the ravages of war, they are far surpassed by some other disasters which from time to time overwhelm the human race. The Franco-Prussian war killed about 130,000 in seven months. The death roll of the Russo-Japanese reached about 200,000. A single earthquake (1737 in India) has been estimated to have caused 300,000 deaths. The fatalities of the Messina earthquake in 1908 cannot have been far short of 100,000. A tidal wave in 1896 drowned 27,000 persons in Japan, causing a greater loss of life than the whole war with China in 1894. The earthquake in Japan in 1703 is said to have killed 200,000 people. The Lisbon earthquake in 1755 destroyed 50,000 human lives, while 40.000 were lost in the same year in earthquakes in Persia.

Terrible as such disasters are, they pass over the multitudes of the human population of our globe as the merest ripples on a mighty sea. The total population of the earth is somewhere about 1,800 millions. Annually there are added to it 14 million souls. Every year at least 80 millious are born, and 60 or 70 millions die. This means a daily birth rate of about 220.000, a death rate of 180,000. The daily increase in population is 40,000. In comparison with this irresistibly swelling tide, what are the greatest battles, wars or earthquakes, but almost miscroscopic ripples? If we imagine that the power were given to some despot to order a wholesale slaughter, and that guillotines were kept busy beheading one man every minute, night and day, this would add only three quarters of one per cent to the existing death rate!

Compared with the constant and regular causes of death, too, war and catastrophes of nature sink into insignificance. In British India, with a population of 300 millions, 700,000 people die each year of the plague despite the efforts of skilled pathologists. The infant mortality is responsible for some 3 or 4 million deaths annually in Europe alone, probably for some 25 millions all the world over. If this mortality could be reduced four per cent, one million lives would be saved every year. It is estimated that the decline in the birth rate in Germany since 1906 has reduced the number of annual births by about 180,000. Were it not for a more than compensating diminution in the death rate, the effect of this decline on the population would exceed in a single year the influence of the destruction of Messina. The total number of suicides in Europe alone is from 60,000 to 70,000. Every summer in which the temperature rises above its usual range kills hundreds of thousands of infants in excess of the normal rate. And so on, instances might be multiplied almost indefinitely. The human race is insured with almost infinite security against destruction.



FERRYING MUNITIONS IN FLANDERS

Chapter XXXII.

MEDICAL ASPECT OF WAR

How the Conflict with Infection, Disease and Death is Waged

IN all the pages of war news with which the daily press is flooded, perhaps no greater tribute could be found to modern medical science than the following dispatch:

"A correspondent in Ostend says that among the French wounded in recent fighting was a dragoon with six bullet and three bayonet wounds in the upper part of his body. He was expected to recover."

In the Franco-Prussian war a man similarly wounded would not have had a chance for recovery, that is, not if he had been taken to a military hospital.

When men are called to war, a great deal is said about the glory of fighting for the country and dying on the field of battle. Very little mention is made of the illnesses which befall the soldier who goes through the battles unscathed or his comrade who is wounded on the field. According to a statement made by a member of the Health Department of the French Ministry of War, "of every hundred men placed *hors de combat*, only two are killed." The problem of caring for the sick and wounded is therefore of the utmost gravity. But right here the inconsistencies of war are obvious. Each country maintains Red Cross workers whose duty it is to care for the wounded of the enemy as well as for the men who come by their wounds in the defense of their flag. These men and women, while engaged in aiding the victims of warfare, are still in the position of praying for victory for their army. And victory for their army means what? The slaughter and maiming of the enemy. Can inconsistency be better illustrated?

INFECTION A MATTER OF COURSE.

In the Franco-Prussian war the surgeons looked upon the infection of wounds as a matter of course. They regarded the presence of the attendant pus as a necessity, and as long as the pus was what was known as "laudable" they were satisfied with the condition of the patient. Other patients developed another form of pus, streptococcal, which caused the doctors of those days gravely to shake their heads and prepare for the death of the patient. Even the best hospitals were not properly ventilated and were filled with the foul odors emanating from infected wounds and gangrene. All this was considered unavoidable. At that time suppuration and kindred complications in wounded men were regarded as of spontaneous origin, although the researches of Pasteur had already pointed the way to a general understanding of germs. When, at length, purulent infection was found to be the result of germs, disinfectants were brought into use. Carbolic acid was the agent generally employed at first for that purpose, and the attendant success in treating surgical injuries and in performing operations where carbolized dressings were used and the air was subjected to a carbolic acid spray, caused the most profound amazement.

During the Franco-Prussian war 138,871 wounded died in the hospitals, while uninjured sick dying in the hospitals numbered 328,000. Many of these soldiers, if they recovered sufficiently to leave the hospital, were wrecks for the remainder of their lives. In contrast to the hospital treatment in the

Franco-Prussian war let us glance at the Russo-Japanese war. In the great military hospital of the Japanese at Hiroshima there occurred but thirty-four deaths among 9,862 wounded. At first glance this low mortality might be attributed to the fact that the Japanese soldiers as a whole maintained such a high physical standard. But when the fact is considered that this hospital also cared for large numbers of Russian patients, and the death rate among them was approximately as low as it was among the Japanese, the credit must be given to advanced medical science.

A LESSON IN PERSONAL HYGIENE.

The Russian-Japanese war taught a valuable lesson in personal hygiene. The habit of extreme personal cleanliness among the Japanese was an important factor in maintaining the health and resistance of Japan's troops. The Japanese troops kept their bodies clean by frequent bathing, and their rule of never going into battle without putting on clean underwear greatly reduced the danger of infection from wounds. The Japanese rations also had much to do with keeping the men in good condition. These generally consisted of some rice, compressed fish, army biscuit, salted plums, and a juicy pickle all neatly packed in a small tin box and wrapped in a towel. The Russian was fed on soup frequently made from questionable meat, and this has been held responsible for the large proportion of intestinal disorders on the Russian side.

While to-day the war machinery is more deadly, the number of killed and wounded in percentages remains about the same. The small steel-jacketed bullet used in rifle fire makes a clean wound, which rarely becomes infected unless a piece of cloth is carried into the wound with it. In the British army it has been found that bullets will pass through khaki linen, making a clean slit, and will not carry any particles of cloth into the wound. In the case of wool, such as Highland kilts or heavy flannel shirts, bits of wool are frequently introduced into the wound, and when this occurs, suppuration invariably follows.

Photo by International News Service

DISINFECTING CLOTHES AT A BRITISH FIELD HOSPITAL

DISEASE MORE DANGEROUS THAN BULLETS.

The fire of the enemy is by no means the only risk to which the soldier is subjected. Where large bodies of men are gathered into small quarters there is always the danger of disease. Before anti-typhoid vaccination was introduced typhoid fever rivaled the enemy's fire in the terrible toll it took among soldiers. In the Franco-Prussian war in the year 1870 there were 73,000 cases of typhoid fever in the German army. Out of this number there were 7,000 deaths. In the Boer war the British army suffered from typhoid fever to the extent of 57,000 cases, of which 8,000 died. During the war with Spain the United States Army was ravaged with typhoid fever. In 1898 there were 20,738 cases and 1,580 deaths among 108,000 men. In other words, one man in every five contracted typhoid fever. Even among the troops which never left the United States, but remained in the various concentration camps at home, one man in every six came down with the disease. In 1898 nine tenths of the deaths which occurred among the troops in the United States were caused by typhoid fever.

Typhoid fever is a preventable disease, particularly in armies. There are two ways in which it may be conquered, namely, by means of anti-typhoid vaccination and the education of troops to realize the value of cleanliness. The disease is caused by a microbe which thrives in the walls of the human intestine. It is transmitted when the excreta of the infected person comes into contact with water or food which is afterward consumed by other individuals. In camp the immediate disposal of waste is most important. Flies crawling over exposed excreta, and afterward walking over food in the camp kitchen are a sure means of spreading typhoid fever. Other means of spreading it throughout a camp are through personal contact, such as a man whose hands have become contaminated, subsequently handling food or passing a cigar or cigarette to a comrade, passing a pipe from one mouth to another, tracking germs in on shoes, etc. A common method of spreading typhoid fever is now known to be what are called "bacillus carriers." These are persons who continue to harbor and discharge typhoid bacilli even years after they have convalesced from the disease.

As a rule an attack of typhoid fever renders the subject immune to another attack. After a patient has recovered from the fever certain substances will be found in the blood which are known as anti-bodies. These bodies appear to be protective, and their presence renders the person immune to another attack of the disease. These protective substances can be produced by "vaccinating" a person with *dead* typhoid bacilli, and this, of course, is a distinct advantage, for while about 3 or 4 out of every 100 who have recovered naturally from typhoid fever, continue to breed and spread the germs, no such condition is possible after vaccination with dead bacilli. Hence, vaccination is of the utmost value, especially among troops where one bacillus carrier, because of his ignorance of his condition, may do the greatest harm.

AUSTRIAN ARTILLERY CAR FITTED WITH ULTRA-VIOLET RAY STERILIZER

The English were the first to vaccinate their soldiers. This was largely due to the investigations of Sir Almroth Wright. He killed typhoid bacilli by subjecting them to heat, and then tested their effect on animals. He found that the dead typhoid bacilli produced in the blood of the guinea pig substances similar to the anti-bodies produced in the human blood by an attack of typhoid fever. The British fleet used this new vaccine on the soldiers going to the Boer war. In this instance the soldiers only received one dose, and this, we now know, was not sufficient to produce the desired results. The dose has been increased to three doses administered at intervals of ten days.

TEST OF TYPHOID VACCINATION.

In India in 1908 the British vaccinated 6,000 soldiers against typhoid fever, and compared them with a like number not vaccinated. The result of this test was a triumph for the vaccination, for it showed seven times as many non-vaccinated soldiers contracted typhoid fever, and eleven times as many died. In fact, it was found that the same number of the non-vaccinated died as were taken sick among the vaccinated. Of the number who were vaccinated yet contracted typhoid fever, only four received more than one dose. These four developed very mild cases.

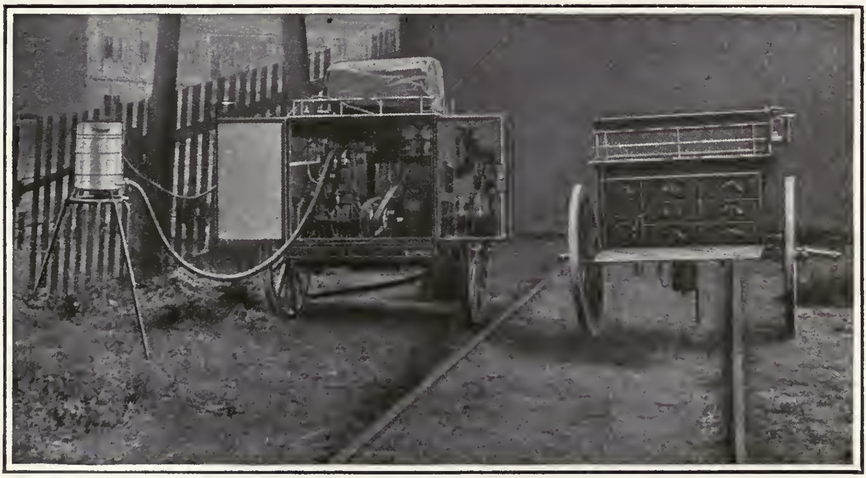
The British and German armies have reported considerable success with anti-typhoid vaccination. The Germans cut the typhoid rate in half during the campaign against the Herreros in Southwest Africa during 1904-07 by the use of the vaccine.

In 1911 vaccination against typhoid was made compulsory for all men in the United States Army under 45 years of age who had not had the disease. The Navy then adopted the same measure, and now both services are believed to be immune. As proof of the immunity, we may take the typhoid figures of a division which was in Florida in 1898 and one which was in Texas during the border troubles in 1911. Climate, season, and general conditions were similar. In 1898 there were 2,693 cases of typhoid fever and 248 deaths among 10,759 men; in 1911 there were 2 cases and no deaths among 12,801 men.

While tetanus does not seem to have been the cause of a very high percentage of deaths during other wars, Austria has recognized that it is a factor to be reckoned with. During August that country ordered fifty liters of anti-tetanus serum from the Department of Health of the city of New York.

In the Russian-Japanese war lockjaw infection was more prevalent during the winter campaign than in the summer. This was accounted for by prolonged housing in earth huts and the proximity of horse manure. In order to avoid tetanus it is necessary to prohibit the men from going about in their bare feet, and to see that the wounds are protected against contact with earth, and especially horse manure.

Other diseases to which troops are subject are dysentery, malaria, measles, smallpox, and plague. Measures for the prevention of dysentery are the same as those for typhoid fever, but experiences with vaccines are still too limited to permit any judgment as to their value. The germ of malaria was discovered in 1880 by Laveran, a French army surgeon. The germ is transmitted by a bite of a female anopheles mosquito. After biting a man suffering from malaria and drawing into her stomach the germs of the disease with the blood, the germs developed with the mosquito are injected into the next person she bites. The methods of preventing malaria are the destruction of the breeding places of the mosquitoes, the use of nets and bars to prevent their biting and the administration of quinine when troops are in a locality where the anopheles mosquitoes abound. In the Union army in the civil war there were 76,000 cases of measles and 5,000 deaths. The only way of preventing the spread of this disease is by isolating the patients. In fact, in an encamped army the first thing which should be done to a sick man is to immediately isolate him. Smallpox has yielded to vaccination. Bubonic



THE ULTRA-VIOLET RAY APPARATUS SUPPLYING STERILIZED WATER plague is caused by a germ which is generally transmitted to human beings through the rat flea. Rats are susceptible to the disease, and when they die the fleas are prone to attach themselves to man. Rats should be relentlessly exterminated. Prairie dogs and the ground squirrels of Manchuria are also subject to plague.

STERILIZED WATER INSURES HEALTH.

The most important factor toward maintaining health in a camp is pure water. There are many ways of accomplishing the purification of water. One of the newest and most interesting is by the use of ultra-violet rays, which have marked destructive action on any disease germs which may be present in the water. Water which has been subjected to ultra-violet radiations is rendered sterile without affecting its taste or odor. For field use a sterilizer with a capacity of 150 gallons an hour can be carried on an ordinary gun carriage. The equipment consists of a sterilizer, a gasoline motor for generating electricity, a hose fifteen to twenty feet long to connect the pump with the water supply, and a tripod on which the sterilizer is mounted. The apparatus will deliver sterile water in five minutes from the time the motor is started.

The Austrian army is using such an equipment with success. The French used it in Morocco and found that the perfectly sterile water which they obtained was of the greatest value in their military hospital at Oudja. In all the cases of wounds which were washed with water sterilized by the ultra-violet rays they did not have a single case of infection. Among the troops using it entirely for drinking purposes no cases of intestinal disease were observed.

Other methods of purifying water are sedimentation, precipitation and filtration. In sedimentation the water is held in reservoirs that the suspended solids may sink. The clear water is then piped off from the top. Of course this method does not kill bacteria. Precipitation is accomplished by the addition of chemicals, generally alum, to water in settling tanks. This causes the formation of a gelatinous precipitate which entangles floating particles, even bacteria, and causes them to sink. There are several methods of filtration, but except for more or less permanent camps, none are ordinarily used in armies.

Ozone, the allotropic modification of oxygen, is also an efficient destroyer of bacteria. For actual field use there have been designed

BARREL OF STERILIZED WATER FOR AUSTRIAN SOLDIERS IN GALICIA apparatus for use of chlorine, ozone, and the ultra-violet ray.

HOW EPIDEMICS ARE FOUGHT IN THE AUSTRIAN ARMY.

Disease is a foe even more dreadful in war than the enemy's shells and bullets, and one of the most important tasks of modern warfare consists in improving as far as possible the sanitary conditions of an army. Alarming rumors were spread, at the beginning of the European war, as to the dysentery and cholera epidemics which, it was said, wrought great havoc in the Austrian army and threatened to become a real danger to soldiers and civilians alike. The first thing done to check cholera as well as dysentery was to install in the towns and villages of Galicia long rows of barrels containing sterilized water, which the soldiers alone are allowed to use. Another effective measure consists of sprinkling the floor of railway stations with carbolate of lime and washing it frequently. Cholera patients are, of course, housed in isolated barracks, each of which is surrounded by a lime ditch. Special stretchers are used for the transport of dysentery and cholera patients.

LIME DITCHES SURROUNDING BARRACKS IN WHICH CHOLERA PATIENTS ARE HOUSED

Chapter XXXIII.

THE CARE OF THE WOUNDED

A Vast and Complicated System

THE first object of an army in war is to disperse or destroy the enemy, but a correlative duty is the care of its own men when wounded or otherwise incapacitated for service; and this involves a very extensive and carefully systematized service that has been as thoroughly studied and developed as the maneuvers of the fighting men. Although the results of the modern systems of handling and caring for the wounded must necessarily, to a great extent, depend comparatively on the different local conditions, the work in the European war shows in every respect a vast improvement over that of pre-

TREATMENT ROOM OF AN ENGLISH HOSPITAL TRAIN vious wars, owing both to experience gained and to constant improvements in medical and surgical knowledge.

In the case of a battle, the first proceeding is to locate the injured men on the field, and trained dogs are of value in the search for wounded after a battle. The dogs find the badly wounded lying in thickets or obscure places and thus bring speedy aid to helpless men who might otherwise die in agony from neglect.

Former wars have shown that wounded who are unable to reach the field hospitals themselves, or who cannot be brought there, often exert their last strength to reach shelter of some kind in the open, in order to escape further wounds or the danger of being ridden or driven over. Others of the severely wounded remain lying on the spot where the shot struck them, and these spots are often not easily found, especially in approaching twilight, and, above all, at night. For, although during a battle the wounded are given such care as is possible by the ambulance corps, yet the carrying of the wounded to the field hospitals from the district under fire is generally only possible after the firing has ceased, nor can a systematic search of the battlefield begin until then. And yet all wounded men ought to be found and carried where they can receive surgical aid as quickly as possible.

Even should the ambulance corps and its assistants exert themselves to the utmost to accomplish their task, nevertheless every region contains spots where wounded could be overlooked, and unfortunately are overlooked. This is proved by the number of "missing" in the reports of losses. Search should be made in fields of standing grain, in ditches, behind hedges and bushes, or in spots where the searchlight cannot penetrate or throw heavy shadows; above all, there is danger of such being overlooked in the undergrowth of woodland.

THE WARD CARS OF THE BRITISH AMBULANCE TRAINS WERE CONVERTED FROM OPEN FREIGHT CARS. THEY WERE REFLOORED, AND HOOKS WERE FIXED IN THE CEILINGS FOR SUSPENDING FOLDING COTS IN TWO TIERS ON BOTH SIDES

HOW MANY WOUNDED MUST BE PROVIDED FOR?

In developing any intelligent or practical system for handling the wounded, as well as those incapacitated by sickness, it is necessary to know how many patients will require treatment, and furthermore, for what periods of time; for some will need but a few minutes attention on the field, while others will require long and careful treatment. How these questions are determined is told by Major F. A. Symons, M.B., R.A.M.C., in *Blackwood's Magazine*.

"In preparing for the treatment of the wounded one must have some idea as to what the likely requirements are to be. How many wounded are to be expected from each engagement? To the uninitiated this question seems unanswerable. In a sense, of course, it is unanswerable. And yet it is upon definite figures of probabilities that all the regulations of the army in the field are based.

PHARMACY ROOM OF THE CONVERTED AMBULANCE TRAIN

"Let us take an army division as our unit for study. A division in war comprises some 18,000 men. Statistics, based on all great previous wars, point to certain average facts, which may be summed up as follows:

"Out of this 18,000 men only about three fifths will be actually engaged with the enemy. The remainder, employed in various non-fighting capacities for the momemt, become for the purposes of calculation a negligible quantity. Say that 10,000 men are engaged. Of these, 10 per cent must be expected to become casualties—i. e., 1,000. Of this 1,000, 20 per cent will be killed. This leaves us 800 to deal with. Of this 800, 20 per cent will be able to walk to what is called the Divisional Collecting Station. There, having received what surgical aid they require, they will remain until the end of the engagement, and then return for the remainder of their required treatment to their units; 640 are therefore left for admission to hospitals; 60 per cent (of the 800) can be carried in the ambulance wagons, sitting up; 15 per cent will require lying-down accommodation; and 5 per cent will be unfit to be moved from the place where they fell.

"It will readily be seen, therefore, that the Army Medical Service in the field starts forth with a fairly shrewd idea as to what it may be called upon to face."

Different systems prevail in different countries, but the writer goes on to describe the British organization, which represents the methods followed generally:

"Let us start with the battalion of infantry. Each company boasts of two 'regimental stretcher-bearers,' who, having been trained in first-aid work, carry a stretcher. At the beginning of an action these bearers, under the command of the medical officer attached to the battalion, fall to the rear, and are located as the medical officer sees fit. A soldier falls wounded. First-aid is at once applied by the bearers, and the wounded man carried to the shelter of a rock, ditch, or trees, close at hand. If the wound is particularly serious the medical officer intervenes. The latter cannot, however, be everywhere at once, and the battalion, in open order, may cover almost a mile of country."

In this connection attention may be directed to first-aid field dressing and emergency packets that in some form are in use by most European armies and are ready for proof, and two safety pins, all of which was carefully packed in an air-tight cover. Another thing which the British found very desirable for field use was a paste for immediate antiseptic dressing on the field of battle. This paste was made up of mercury and zinc cyanide, tragacanth in powder, carbolic acid, and sterilized water. This paste was contained in a collapsible tube, and was particularly satisfactory in that form as it could be carried easily, and, when spread over a wound, would remain in place no matter what position the wounded man assumed.

VIEW DOWN THE CENTER OF WARD CAR OF AN ENGLISH MILITARY AMBULANCE TRAIN, SHOWING FIXED BERTHS AND COTS. IN THE CENTER OF EACH TRAIN IS A PHARMACY CAR WITH TREATMENT ROOM, OFFICE, AND ALL NECESSARY SUPPLIES

instant use when a man is wounded, and will save much suffering and many lives that would be sacrificed if the injured had to await the arrival of a surgeon. The packets used in the English army are fully illustrated and described in the legends accompanying the engravings.

The use of the first-aid field kit is of great importance. During the Boer war the British army carried field kits which contained a piece of gauze, a pad of flax charpie between layers of gauze, a gauze bandage four and a half yards long, a piece of mackintosh water-

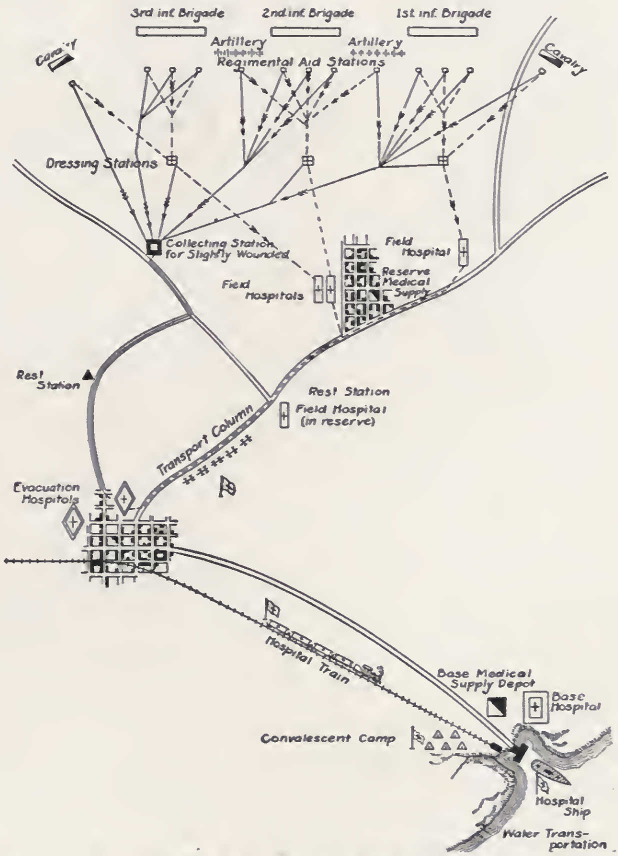
When the wounded arrived at the field hospital the surface surrounding the wound was cleansed with a solution of bichloride of mercury 1 in 1,000, or a 2½ per cent solution of carbolic acid. The wound itself was then cleansed and dressed with double cyanide of mercury and zinc which was covered with a pad of wool and a bandage.

It will be noted that this is purely regimental work and not directly attached to the regular ambulance service, which now takes up its work.

"There are three brigades in a division, and each of these is provided with one field ambulance, consisting of three sections, which may either work together or over separate zones. Each section is again subdivided into a bearer and tent subdivision. In action one tent subdivision is usually pushed forward as near the fighting line as safety will permit, in order to establish a dressing station.

"From this station the bearer subdivisions, equipped with stretchers and supported by ambulance wagons, start forth to search for wounded. In order to insure that no wounded are missed, and also for the sake of avoiding overlapping, each bearer subdivision is appointed to a definite area of the fighting zone, marked out on the map."

From the regimental aid posts, previously mentioned, the bearers collect and convey the wounded to the "collecting station," where the ambulances have been assembled, by which all are taken to the dressing station. Here the wounds requiring it are dressed afresh and urgent minor operations performed. It will be found here that many men require no further treatment except what they can obtain at their regiments, to which they are at once returned. The others are loaded into the ambulances or other conveyances and taken to the rear, out of shell fire, where a full tent division of the field ambulance will be found. This, however, is a *mobile* unit that is required to follow up the army closely, and as it may be required to move at any moment, the wounded are not kept longer than necessary. There is, however, plenty of food and medical necessaries.

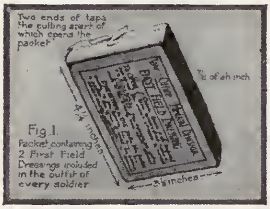


MAP SHOWING LINES FOR RETURN OF WOUNDED FROM FIELD

From this field station the wounded are rapidly transferred to the nearest railroad, and thence to various stationary hospitals, or to the base hospital, according to the length of time the patient will require treatment. The number of these transfers will depend on the distance of the front from the base and the facilities for transportation; but it will be seen that a constant sorting process is operating to return men slightly injured to their commands as quickly as possible, thus relieving pressure on the hospitals, and only serious cases reach the base.

To-day if a soldier is so wounded that an amputation is necessary he knows that he can usually undergo the operation with the chances in his favor. In the Franco-Prussian war, even with the aid of anæsthetics, only forty out of a hundred men who underwent amputations lived to tell the tale. The knowledge of aseptic surgery which army surgeons possess to-day permits of a patient coming through an amputation with a minimum amount of danger.

It is generally conceded that in the case of bullet wounds where the bullet is retained an operation should be avoided. Unless the bullet is directly under the skin or in such a position that the patient's life is in imminent danger, it is best to allow the bullet to remain. The modern rifle bullet is unlikely to cause infection, and frequently may be carried in the body without causing either danger or pain, while the results from an operation performed in a field hospital, in more or less haste, may be questionable.



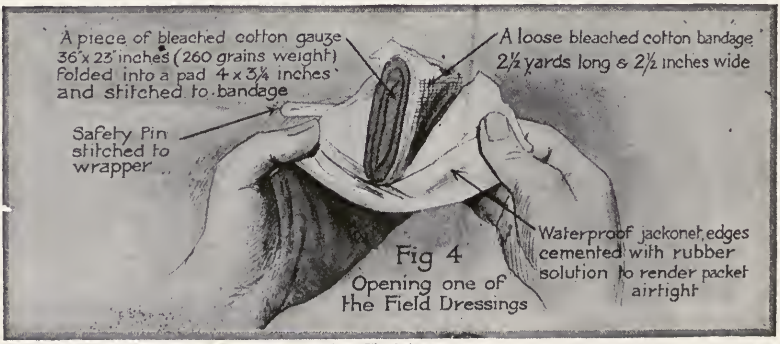
PACKET CONTAINING FIELD DRESSINGS INCLUDED IN THE OUTFIT OF EVERY SOLDIER

OPENING THE PACKET CONTAINING THE TWO FIELD DRESSINGS

ONE OF THE TWO PACKAGES IN THE OUTFIT. BOTH PACKAGES ARE IDENTICAL. THE ARROW ON THE LABEL SHOWS WHICH CORNER OF THE WATERPROOF WRAPPER IS TO BE OPENED FIRST. THE CORNERS ARE SECURELY CEMENTED WITH RUBBER SOLUTION

OPEN AIR HOSPITALS.

The subject of caring for the wounded has raised the question of the efficiency of the primitive stations denominated as hospitals, and in this connection an article on "Open Air Hospitals in War Time," by Prof. Robert Saundby of the University of Birmingham,



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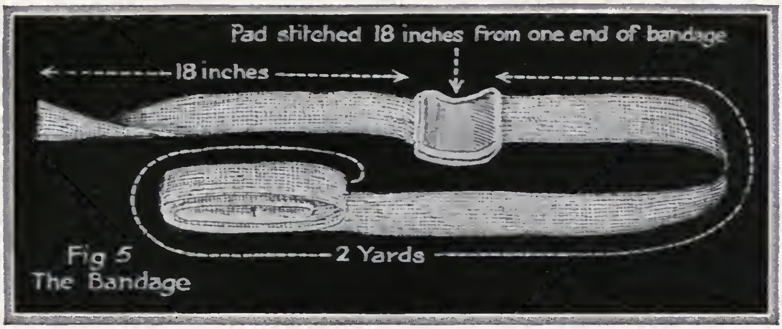
OPENING ONE OF THE FIELD DRESSINGS CONTAINED IN THE PACKET. THE FIELD DRESSINGS CONTAINED IN THE FIRST-AID PACKETS HAVE A WATERPROOF OUTSIDE COVERING WITH THE EDGES CEMENTED WITH RUBBER SOLUTION TO RENDER THE PACKET TIGHT. STITCHED TO THE WRAPPER IS A SAFETY PIN FOR USE WHEN BANDAGING WOUNDS. INSIDE THE WRAPPER IS A LOOSE BLEACHED COTTON BANDAGE 2½ YARDS LONG AND 2½ INCHES WIDE, AND A PIECE OF BLEACHED COTTON GAUZE FOLDED INTO A PAD AND STITCHED TO THE BANDAGE published in *The Lancet*, is most timely and interesting. The professor's summing up of facts and observations that have been well known for years, but for some reason generally ignored, is as follows:

"The usefulness of hospitals is almost in inverse proportion to their architectural merits and our exaggerated notion of 'comfort' is inconsistent with healthy surroundings. Draughts of air, low atmospheric temperature, and dampness are not the disease-bearing agencies they were once supposed to be, while bad ventilation and equable warm temperatures are depressing, debilitating, and retard recovery. Even dampness does no harm where there is a good current of air."

Further on he says: "Why have we been so slow to recognize that fresh air is the best tonic, the best antiseptic? It is cheaper, pleasanter, and undoubtedly more efficient than drugs." And he quotes from the report of Surgeon-General Billings, who says in his report of the medical and surgical history of our civil war, speaking of hospital construction: "The object to be kept in view is to furnish shelter without diminishing that supply of pure air and light which is necessary to health."



THE BANDAGE—SHOWING THE PAD STITCHED 18 INCHES FROM ONE END OF THE BANDAGE

APPLYING THE FIRST FIELD DRESSING TO A WOUND. THE PAD IS APPLIED OVER THE WOUND, AND THEN THE BANDAGE IS WRAPPED FIRMLY AND EVENLY, ACCORDING TO THE DIRECTIONS GIVEN, AND THE ENDS SECURED BY THE ACCOMPANYING SAFETY PINS

NEW AMBULANCE RAILWAY TRAINS.

On arrival from France and Belgium at the various ports and harbors on the south and east coasts of England, the British wounded soldiers and sailors are conveyed to hospital bases at various selected inland places in a number of specially constructed ambulance trains, several of which have been provided by each of the leading British railway companies. Four of these new railway ambulance trains have been constructed by

IDENTIFICATION DISK WORN ON ACTIVE SERVICE. THE IDENTIFICATION DISK IS SERVED OUT TO ALL SOLDIERS IN THE BRITISH ARMY AT THE BEGINNING OF ACTIVE SERVICE. IT IS MADE OF ALUMINIUM, AND IS WORN BY A CORD ROUND THE NECK. ON THE DISK ARE PUNCHED IN RAISED LETTERS THE WEARER'S NAME, REGIMENT, OFFICIAL NUMBER, AND RELIGION the London and North Western Railway Company, three being for the War Office and one for the Admiralty, of which some illustrations are given. The vehicles were taken from main line traffic and altered to suit required conditions, and the trains were completed in thirty hours. The center vehicles are for the accommodation of patients, those at either end being for the convenience of the staff, stores, etc. In the military trains the ward or hospital cars have a pharmacy car in the center. All the carriages were thoroughly well cleaned inside and outside, overhauled, revarnished, and the whole of the interior finished in white enamel, and special ventilators were fitted in the clerestory roofs. The ward cars were converted from open parcel vans, which were already provided with sliding doors on the sides and ends. These were refloored, covered with linoleum, coved at all angles, and hooks were fixed in the ceilings for suspending cots in two tiers on both sides, for the naval train, and folding berths, in two tiers hinged to the sides for the military trains. The pharmacy car in the center of each train is subdivided into treatment room, pharmacy, office, linen stores, etc., and fitted with all necessary requirements such as cupboards, shelves for drugs, medicines, bandages, and utensils. Dining cars are attached to each train, for providing meals, etc., for the staff and patients; the trains are vestibuled throughout.

CHARACTER OF WOUNDS.

In considering the treatment of the wounded in war the nature of the wounds

THE FIRST FIELD DRESSING PACKET. THE FIELD DRESSING PACKET IS CARRIED IN A LEFT-HAND POCKET IN THE LINING OF THE COAT. ON THE OUTSIDE OF THE WRAPPER ARE FULL DIRECTIONS FOR USE

becomes a matter of importance. The modern rifle shoots a small bullet at a very great velocity, and although there may be some slight variation in the action of the bullets used by different nations, as there are differences in size, shape and velocity, still at the present time all classes of modern army bullets are supposed to behave practically

RED CROSS NURSES

alike, and opportunities for studying their action and effect have occurred in our war in Cuba, in South Africa, and other places.

THE EMERGENCY RATIONS PACKET. THIS PACKET IS CARRIED IN A RIGHT-HAND POCKET IN THE LINING OF THE COAT, AND IS READY TO HAND WHEN NEEDED. THE PACKET IS SMALL AND COMPACT AND TAKES UP VERY LITTLE ROOM

From these observations it appears that between the distances of 300 and 900 yards the wounds made are of a penetrative character, even in the case of bones, and unless foreign matter, such as bits of clothing, are carried into the wound, there is seldom any infection, and the wound heals rapidly without trouble. At shorter or longer distances the action of the bullet is erratic, splintering bones badly, and frequently turning over so that it strikes sideways, producing lacerated wounds. These effects are also liable to be produced at any range if the bullet strikes some object, and is deflected in its course. Another effect produced by these high velocity bullets is a disruption of the softer tissues of the body that often leads to the impression that an explosive bullet was used; but the exact cause of this action and the conditions is not understood.

That the wound made by the modern high velocity bullet, covered with its nickel jacket, is more or less aseptic, and that a large proportion of the wounds made by them are not of a serious nature and give but little trouble, has been demonstrated by the records of the conflicts mentioned above. In this respect the work of the army surgeon of the present day has certainly been simplified, and the percentage of fatalities from bullet wounds will show a material decrease.

A very valuable adjunct to the ambulance and red-cross work done in the field is the "sanitary service" established by the British and French armies. This service is under the direction of skilled officers and includes the inoculation of the men against typhoid and enteric fever, diseases which have been so fatal to armies in the past. The "sanitary service" was thoroughly tested in the Boer war with splendid results.

WOUNDED FRENCH AND GERMANS IN A BELGIAN CHURCH USED AS A HOSPITAL

A GERMAN FIELD OUTFIT FOR X-RAY TREATMENT

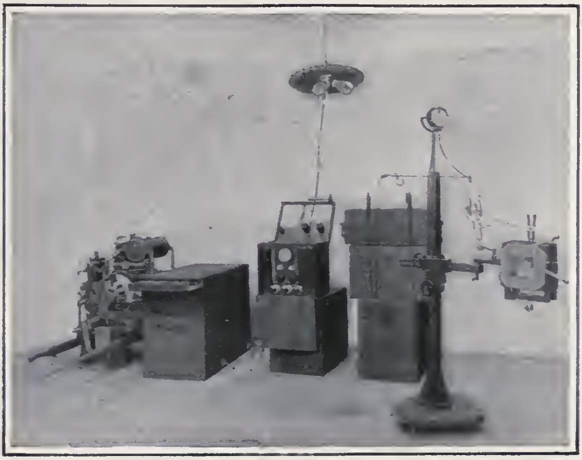
Chapter XXXIV.

X-RAY WORK IN WAR

Developments in Practical Applications as Now Used in the Field and in Hospitals

BY DR. ALFRED GRADENWITZ

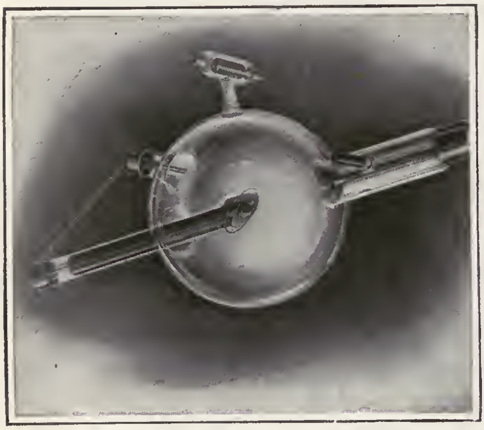
THOUGH X-ray work has, even in normal times, become so valuable an aid to the medical practitioner that no up-to-date hospital can do without it, it is even more useful and necessary in warfare. Whenever, for instance, the shape and position of a projectile in the body of a patient are to be ascertained, Roentgen photography will quickly give all the desired information; if injured bones, and especially the splintering so frequent with bone fractures (shot fractures), are to be examined, it again proves the one safe guide. Roentgen photographs are nearly always welcome if the perforation made by a bullet has such a direction as to suggest the hypothesis of a bone lesion. The photographic plate in many cases shows the lesion to be much more serious than would otherwise have been supposed. In connection with the further checking of the treatment—in ascertaining, e. g., whether displacements of the bone ends have been adjusted by the dressing, repeated X-ray examination is of the highest importance.



PORTABLE MILITARY X-RAY OUTFIT

It is true that X-ray work in its primitive form would have been of little use in the theater of war; but so many improvements have been introduced of late years, the technicalities have been so highly simplified, that even the ordinary practitioner will find no difficulty now in handling an X-ray outfit. Transportable apparatus allows the Roentgen ray to be readily employed everywhere in the field, even in temporary infirmaries.

A particularly valuable feature is that patients submitted to a Roentgen treatment will suffer no pain or discomfort.

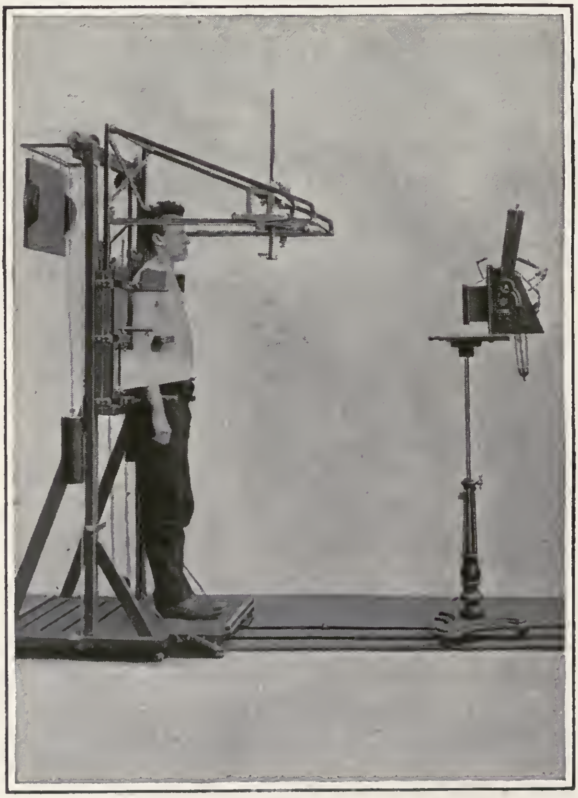


SIEMEN'S TUNGSTEN X-RAY BULB

The apparatus serving to generate the rays may be of the most different types. They either consist mainly of an induction coil and interrupter—the active rays being produced by a rapid succession of alternate current impulses—or of a rectifier converting an alternate current into pulsating direct current, that is, a rapid succession of high-tension current impulses of constant direction.

PROJECTILE LODGED IN CHEST MUSCLES. YIELDS TO SIMPLE TREATMENT

The latter type of apparatus is not only more simple to operate, which is especially valuable in warfare, but generally more effective, allowing snapshots to be taken in fractions of a second.



SCHMIDT'S UNIVERSAL X-RAY STAND

In the military hospital founded by Messrs.

Siemens and Halske, in conjunction with the Siemens-Schuckert Works, the German Red Cross and the military authorities, there has, for instance, been installed an X-ray outfit

EFFECT OF SHOT
THROUGH SECOND
AND THIRD FINGERS

allowing instantaneous views with exposures of only 1/100 second to be taken. This hospital, moreover, shows many other striking features, and may be considered representative of the best German practice in military surgery. It is housed in the administration building at Siemensstadt, near Berlin, and comprises in the four stories of its northern wing, four hundred beds in seven large halls and eighteen private rooms. An operation room appointed in accordance with the best modern practice enables even the most extensive surgical operations to be performed,

BULLET LODGED IN LEFT
HAND

mainly with the aid of X-ray pictures previously taken. By the courtesy of the managers, we are able to reproduce some such views derived from the hospital archives, which will be found most instructive. In another hall there have been installed all sorts of apparatus for electro-medical therapy

Special transportable Roentgen outfits have

X-RAY OF A WOUND IN FOOT CAUSED BY A
RIFLE BULLET

TRIPLE FRACTURE PRODUCED BY A
RIFLE SHOT

SHRAPNEL BULLET EMBEDDED IN THE BONE OF THE UPPER JAW

been perfected for army hospitals installed at halting places, which generally remain stationary for some time. Beside the X-ray generator, these comprise a current generator, mostly a gasoline dynamo, so as to be independent of any electric installation. While these outfits do not lend themselves to taking instantaneous views, they allow even difficult X-ray pictures to be made with a few seconds exposure in conjunction with a reinforcing screen. The various parts of this outfit are contained in cases carried on automobile trucks, which, as long as the hospital remains at a given place, can be utilized for the transport of wounded soldiers. Special type of X-ray outfits have been developed for ship hospitals and hospital ships.

So large a number of pieces of electromedical apparatus have been lately adopted that they cannot possibly be left out of account in a discussion of X-ray apparatus, the more so as they are directly or indirectly the outcome of the latter, and serve as efficient auxiliaries in Roentgen practice. Foremost among these should be mentioned the diathermic apparatus which by the application of high-frequency currents produces

RECORDING FEVER TEMPERATURE OF A PATIENT DURING A TEST OF THE EFFECT OF A SUDATOR some sort of internal heating of the body. Diathermics is used with advantage in the treatment of neuralgic, rheumatic and gouty complaints; it is most valuable in the after-treatment of bone lesions, and its anæsthetic effects are remarkable.

Electric temperature measurements are used in a rather unusual way at the Siemensstadt military hospital. The same as temperatures are determined and checked electrically from a central station in large heating and ventilating plants, the fever temperatures of patients are here recorded electrically and signaled to a central post. This, of course, affords a great advantage over the usual method of determining the temperature of the patients two or three times a day; in fact, the clear record of the course of temperatures thus obtained not only assists more efficiently in making a diagnosis, but affords some useful data in gaging the effect of medicaments or therapeutical methods.

Apart from the Roentgen apparatus proper, we should mention the accessories without which no sharp views could be taken. The same as in ordinary photography, a stop is placed in front of the objective, to keep off any lateral beams of light and thus to improve the definition of the picture, it is a good plan in X-ray work to screen off any secondary rays which are bound to impair the quality of the picture. The "compression" stop devised by Prof. Albers-Schönberg allows any part of the human skeleton to be reproduced with the utmost accuracy. Another type is Dr. Bucky's "beehive" stop, which intercepts any secondary rays produced inside the body before these are al-

SHRAPNEL BULLET BEHIND THE KNEE JOINT. EVIDENCES OF FESTERING OF THE JOINT ITSELF ARE APPARENT lowed to strike the projection screen or photographic plate.

For radioscopic and radiophotographic work on standing, sitting, or lying patients there have been devised quite a number of folding stands which will keep the body straight, in addition to avoiding displacements and insuring an accurate adjustment of the body.

The X-ray bulb itself, of course, is of the highest importance. Each military hospital ought to be equipped with quite a number of bulbs adapted for various purposes, part for radioscopy and part for X-ray photography. According to the special purpose each bulb is intended to serve, the vacuum must be more or less perfect; the higher the vacuum, the "harder" or more penetrating will the X-rays be, and *vice versa*.

A minor, though useful, accessory are the sand bags, which allow the patient to be installed most comfortably in any position.

The ascertaining of foreign bodies (projectiles) in the patient's body is generally limited to the upper extremities, neck, thorax, and to the lower extremities from the knees downward, as well as the skull. In order to mark certain points for subsequent treatment, small lead labels are glued to the skin, or the places in question are spotted with a blue pencil, ink, or tincture of iodine. In order accurately to ascertain the positions of a projectile in the body, two views —in planes vertical to one another—are, of course, required. A safe diagnosis for bone fracture can hardly be made on the strength of radioscopy, X-ray photography being generally indispensable in this connection. For checking the fracture in the plaster dressing, as well as for the diagnosis of sprains, radioscopy, on the other hand, mostly affords sufficient data to allow a safe conclusion to be arrived at.

Another point to be mentioned is that parts generally invisible (e. g., in examining the stomach and intestines) can be made visible by administering to the patient what is called a "contrast" meal, comprising some heavy metal salts, such as bismuth, impervious to X-rays.

Chapter XXXV.

THE MECHANICS OF CONVALESCENCE

Methods of Hastening the Cure of German Wounded Soldiers

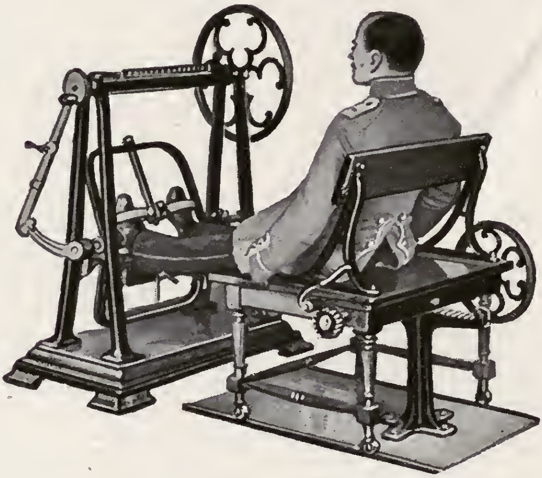
BY WALTER BANNARD

MEDICINE and surgery have had a very serious task set before them in the handling of the vast hosts of wounded men in all the belligerent armies. It is to the credit of the members of the healing profession that, both as individuals and organized bodies, they are coping courageously and wisely with the great undertaking so suddenly thrust upon them. So far as known, they have never failed to give their Samaritan care impartially to friend and foe.

Outside of inoculation for tetanus it is stated that no strikingly new treatment has so far appeared in the care of wounds and disease, unless the vaccine for typhus just announced should prove its utility. The work done has been largely the application of the advances of medical and surgical science in the cure of the ordinary ailments and accidents to which mankind is liable. These advances, though, have of late years been very great. There is above all the advance, most important in surgery, in the prevention of blood poisoning, there are the increased knowledge of sanitation, the use of the Roentgen rays, and the benefits arising from other recent discoveries in the art of healing.

A NUMBER OF ELECTRIC HOT-AIR APPARATUS EMPLOYED FOR TREATING STIFF JOINTS

It is not at all strange that the medical and surgical skill of times of peace should be so successful in the era of war. Rheumatism, pneumonia, and typhus are much dreaded diseases of camp and trench life, and the treatment of fractured bones or other bone injuries by shot resembles that of accidents to the bones in ordinary life. The main object in the surgery both of war and peace is to restore as completely as possible the natural functions of the injured parts, so that the improvements in the treatment of accidents made of late years can now be happily used to shorten the soldier's convalescence. Heat, light, and electricity, which have all their successful applications in medical and surgical science, have been turned to good account, and mechanico-therapy has proved of much value, especially in the after-treatment of injuries which leave stiffened joints.



EXERCISING THE LEGS

MEDICO-MECHANICAL TREATMENT OF MEMBERS STIFFENED BY WOUNDS; PASSIVE EXTENSION OF KNEE AND TRUNK

The methods of mechanico-therapy are not largely used in the United States. This system of treatment had its origin in Sweden and its theories have been largely developed in that country and also in Germany, where the use of machinery in the cure of injuries to the bones, nerves, and muscles is widely extended both in hospital and private practice. Dr. Charles H. Jaeger, the well-known authority on mechanico-therapy, states that, in reply to his inquiry, some six hundred institutions and physicians in Germany said they used medico-gymnastics to hasten convalescence not only in affections of the joints, but also, in many instances, in diseases, as pneumonia and pleurisy, and after operations not referring particularly to joints. Most of them had been using this treatment for a considerable period of years, and convalescence, in the general opinion, was decidedly shortened thereby. One reason for the large use of mechanical methods in the treatment of injuries in Germany is the compulsory state insurance of workmen, which obliges the employer to bear the greater part of the expense of illness from accidents. This

PEDAL WHICH BENDS AND STRETCHES THE FOOT

MOTOR-DRIVEN APPARATUS FOR MASSAGE OF FOOT AND BACK AND PERCUSSION OF ARMS; TO LEFT, CONVALESCENT ON RIDING APPARATUS naturally leads the master to seek after methods for shortening the duration of the workman's inaction, and Germans declare that mechanico-therapy has proved a good way of detecting the lazy worker who wants to live off the insurance fund. This form of treatment being of such general use in Germany, it is not surprising that the military hospitals there are largely equipped for it, as the illustrations show.

The mechanical treatment is generally an after-treatment, although it may begin before the injured bone or joint is entirely healed. It is based on the idea that lack of use leads to lack of nutrition and atrophy of the part, and its aims are the improvement of nutrition and the maintenance of functions. It seeks to attain these ends by massage and gymnastics. Various kinds of machinery are used which have different methods of maintaining movement, but the force of all is adjustable and the movement is defined. The movements are active, the patient taking part, passive, in which the patient is acted upon without his own exertion and resistant, in which the machine exerts a regulated resistance to the action of the patient. In these exercises the patient stands, sits, or lies, according to the treatment required, as may be seen from the illustrations. Among the apparatus used is machinery for bending, stretching, or rotating various joints which may be stiffened from trench-rheumatism or from a wound; machinery for expansion of the lungs, thus permitting better oxidation of the blood after a shot in the breast; machinery for producing mechanically such operations as percussion, friction, kneading, or vibration. These last operations are also performed by hand massage. Hand massage is one of the cures of antiquity revived in the latter part of the last century. The soldier of to-day has the benefit from it once enjoyed by the Roman legionary.

APPARATUS FOR BREATHING GYMNASTICS AND PASSIVE EXPANSION OF THE CHEST

APPARATUS FOR USE IN LIMBERING UP ARMS AND FINGERS

Other aids employed to hasten the cure of soldiers eager to be back at the front are electric light baths, currents of hot air heated and kept in motion by electricity, and electricity in various other forms, as direct and low-frequency currents, which aid in overcoming the paralysis of muscles or nerves caused by a wound. All men who are hurt in a war are not necessarily wounded. In a strenuous life calling for violent exertion many ordinary accidents may befall them, or they may be stunned or otherwise injured by the wind-concussion of the huge shells.

To-day plastic surgery allows the preparation of stumps which can support artificial addition much better than was formerly the case. Maimed soldiers, the melancholy aftermath of war, are not now compelled, as in times past, to inaction and methods of earning a living that are only modified forms of beggary. Suitable action has been taken by all the belligerent nations to care for their crippled warriors and instruct them in suitable ways of making a living, and even the blind are being instructed in ways that will preserve their independence.

Chapter XXXVI.

HOW PRISONERS ARE CARED FOR

Hygiene an Absolute Necessity for Self-preservation

BY DR. ALFRED GRADENWITZ

ONE of the most difficult problems in connection with the housing of war prisoners is the enforcing of rules likely to insure satisfactory sanitary conditions. In fact, the inmates of most German concentration camps are a remarkable medley of nations and races whose ideas of bodily cleanliness do not always conform to the European standard. While filth is one of the most potent factors in the spreading of disease, its invariable concomitant, vermin, has been found by recent research to be the carrier of infection with certain epidemics. Hygiene thus becomes a necessity not only for humanitarian reasons, but for motives of self-preservation.

The first care to be taken on the arrival of each fresh troop of prisoners, therefore, consists of cleaning their bodies and clothes as thoroughly as possible. This, in the case of Russian prisoners, is effected as follows:

RUSSIAN PRISONERS' OWN FIRE BRIGADE

The men, in groups of fifty, are introduced into a hall, where they are made to undress to the skin. While they are then administered a shower-bath, their clothes, made up in bundles, are thrown into a disinfecting oven, in order there to be exposed for about

20 minutes to the action of live steam, the most effective means of killing microbes as well as vermin. After the bath, the men are made to enter another hall, where their clothes are handed back to them. Most of its own wash-house, where the men are at liberty to wash their clothes as well as their bodies. Moreover, there are in each encampment, actual baths and shower-baths of adjustable temperature.

PRISONERS MAKING BASKETS OF STRAW

them, however, must have their hair cut previous to this operation, thus ridding them of the most troublesome and dangerous of pests which in the European war has assumed unprecedented proportions, and which, apart from bodily discomfort, has been shown to be the carrier of petechial fever. Many other processes have been tried, but none has been found as effective against lice as the action of live steam.

RUSSIAN RIFLES CAPTURED IN THE MASURIAN LAKE REGION

BRINGING IN A LOAD OF FIREWOOD

Each barrack, housing 200 to 300 men, has

Another factor making for satisfactory sanitary conditions is an ample supply of good air. The barracks are spacious and well aerated, and the men are at liberty to walk about the grounds without any constraint. All the prisoners' camps are, moreover, situated in healthy surroundings, and some in woody, hilly districts.

Military drill and gymnastic exercises under the orders of the men's own superiors are made regularly to counteract the effects of protracted leisure. In fact, only part of the prisoners can be employed at some work or other—at the Zossen encampment only 3,000 out of a total of 15,000. Further evidence of the great amount of personal freedom left to the prisoners of war is found in the fact that they are allowed to play their native game, e. g., football.

Great care is bestowed on the treatment of patients. Every morning the German doc-

CHEMISTS' SHOP AT GUBEN CAMP CONDUCTED BY RUSSIAN AS WELL AS GERMAN CHEMISTS

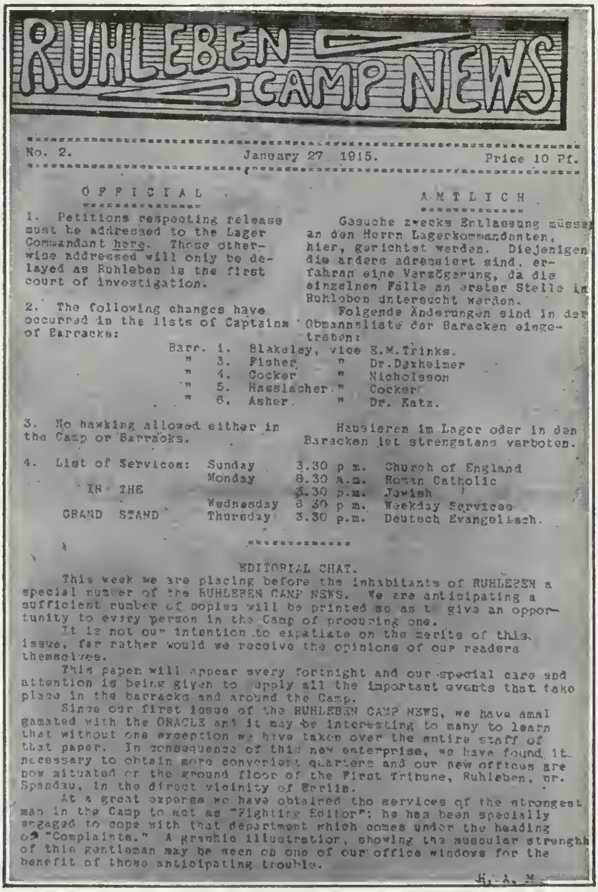
DISINFECTING ROOM FOR CLOTHES AT RUSSIAN PRISONERS' CAMP, AT GUBEN, GERMANY

A SCENE IN THE PRISONERS' HOSPITAL, THE DOEBERITZ ENCAMPMENT

GROUP OF PRISONERS AT MEAL TIME IN ONE OF THE GERMAN CAMPS

LINED UP AT ONE OF THE FOOD COUNTERS

tors make the rounds of the barracks, when those feeling unwell are expected to report themselves sick. There are several stages in the medical treatment, those slightly unwell only calling at the ambulance, while those a little worse are sent to a hospital for slight complaints. Those somewhat more seriously ill go to the Encampment Hospital, while all really serious cases are referred to a large military hospital for treatment. The German doctors are often assisted by their foreign colleagues, and the chemists' shops are likewise conducted with the help of native chemists chosen among those interned at the encampment. Another instance of the great amount of liberty enjoyed by prisoners is the fire brigade of the Guben Concentration Camp, which consists entirely of Russian war prisoners who are thus afforded an opportunity of useful exercise. Many camps, moreover, have their little newspaper issued by the prisoners in their own language; one of our pictures shows a sample of the official organ of the Ruhleben encampment, which gives evidence of the good spirits of its inhabitants. This comes also under the heading of sanitary measures, there being a hygiene of the soul as well as the body. The fact that prisoners are, in a certain measure, e. g., in the case of artists, allowed to exercise their own profession, should finally be mentioned in the same connection.



RUHLEBEN CAMP NEWS

No. 2. January 27. 1915. Price 10 Pf.

OFFICIAL

1. Petitions respecting release must be addressed to the Lager Commandant here. Those otherwise addressed will only be delayed as Ruhleben is the first court of investigation.

2. The following changes have occurred in the lists of Captains of Barracks:

AMTLICH

Gesuche zwecks Entlassung müsse[n] an den Herrn Lagerkommandanten, hier, gerichtet werden. Diejenigen die anders adressiert sind, erfahren eine Verzögerung, da die einzelnen Fälle an erster Stelle in Ruhleben untersucht werden.

Folgende Änderungen sind in der Obmannsliste der Baracken eingetreten:

Barr. 1. Blakeley, vice E.M.Trinks.
" 3. Fisher " Dr.Daxheimer
" 4. Cocker " Nicholsson
" 5. Hasslacher " Cocker
" 6. Asher " Dr. Katz.

3. No hawking allowed either in the Camp or Barracks.

Hausieren im Lager oder in den Baracken ist strengstens verboten.

4. List of Services: IN THE GRAND STAND

Sunday 3.30 p.m. Church of England
Monday 8.30 a.m. Roman Catholic
3.30 p.m. Jewish
Wednesday 3.30 p.m. Weekday Services
Thursday 3.30 p.m. Deutsch Evangelisch.

EDITORIAL CHAT.

This week we are placing before the inhabitants of RUHLEBEN a special number of the RUHLEBEN CAMP NEWS. We are anticipating a sufficient number of copies will be printed so as to give an opportunity to every person in the Camp of procuring one.

It is not our intention to expatiate on the merits of this issue, far rather would we receive the opinions of our readers themselves.

This paper will appear every fortnight and our special care and attention is being given to supply all the important events that take place in the barracks and around the Camp.

Since our first issue of the RUHLEBEN CAMP NEWS, we have amalgamated with the ORACLE and it may be interesting to many to learn that without one exception we have taken over the entire staff of that paper. In consequence of this new enterprise, we have found it necessary to obtain more convenient quarters and our new offices are now situated on the ground floor of the First Tribune, Ruhleben, nr. Spandau, in the direct vicinity of Berlin.

At a great expense we have obtained the services of the strongest man in the Camp to act as "Fighting Editor"; he has been specially engaged to cope with that department which comes under the heading of "Complaints." A graphic illustration, showing the muscular strength of this gentleman may be seen on one of our office windows for the benefit of those anticipating trouble.

H. A. M.

SAMPLE PAGE OF OFFICIAL ORGAN OF RUHLEBEN CAMP, WHERE ENGLISH CIVIL PRISONERS ARE INTERNED

Chapter XXXVII.

THE MENACE OF THE ZEPPELIN

The Military Value of Airships

THE repeated raids of German aircraft on England and the dropping of bombs on English coast towns confirm the view which military engineers of all nationalities long ago expressed when they discussed the efficacy of large dirigibles in technical journals. Although twenty or more bombs were cast upon the Norfolk coast towns, the damage to property and the loss of life was anything but what we had been led to expect from the terrible accounts of a Zeppelin's destructiveness with which we were regaled in the daily press before the war. Even the moral effect of such attacks must be slight, if they are often repeated.

If, then, the giant airship has not lived up to popular expectations, what is the good of it at all? It must have its uses. The Germans have not without reason persevered in the face of disaster after disaster in bringing their airships to a pitch of perfection which has aroused the admiration of aeronautical engineers in all countries. To us it seems that while the Zeppelins and other dirigibles have not been conspicuously successful in military operations, they have a useful function to fulfill at sea. A vessel which can stay in the air for thirty-six hours, which can travel at an average speed of from forty to sixty miles an hour, which is equipped with wireless apparatus of considerable range, which can hover over a single spot for hours, if need be, may obviously perform a very useful service in locating a fleet of dreadnoughts. Of the dirigible's value in reconnoitering we had ample proof when the "Hogue," "Aboukir," and "Cressy" were sunk —three British ships which were sighted by a Schütte-Lanz airship, whose commander wirelessed their location to his base with the result that a German submarine was able to find them and sink them in a fraction of the time which would have been entailed had ordinary sea-scouting been resorted to.

The enormous size of the rigid dirigible has perhaps been the chief reason why it has proven so ineffective upon the field of battle. Let us not forget that land-scouting can hardly be effectively conducted at heights greater than five thousand feet, that anti-aircraft guns have a range of fully twenty thousand feet, and that an airship as big as the average ocean steamer is a mark far more easily found at five thousand feet than a small aeroplane. At sea it is otherwise. Battleships can be sighted and identified from great distances far out of gun range. An area of several hundred square miles can be safely explored from a height of four thousand to five thousand feet. By means of its powerful wireless plant the airship is in constant communication with its base.

And this brings us to the consideration that, if the proper sphere of the Zeppelin is that of naval scouting, it is a prostitution of those wonderful ships of the air to use them for night-raiding of undefended towns and villages. Not alone do these raids stimulate military ardor of the British, but they serve to arouse a widespread indignation, on the ground that such raids are contrary to humanitarian principles as embodied in the findings of The Hague convention. The Hague principles demand that war shall be waged with the least possible injury to non-combatants; and, to this end the convention prohibits the bombardment of undefended towns, and demands that where bombardment is undertaken due notice shall be given so as to enable the non-combatants to withdraw. It is a fact that none of the English coast towns raided were protected.

The Zeppelin

VERY precise information is at hand regarding the useful load of the 1913 class of Zeppelins. The logbook of the "Z-4" (the one that landed involuntarily in France) showed upon examination that this ship, which displaced only 688,000 cubic feet, had a carrying capacity of 10,600 pounds, made up as follows:

	Pounds.
Crew (twelve men)	1,920
Fuel (for 12 hours)	3,780
Ballast	3,500
Armament (replaced by ballast)	1,400
Total	10,600

A fuel capacity of twelve hours at thirty-five knots gives a cruising radius of 420 nautical miles. London being 300 miles from the nearest Zeppelin base (Cologne), the projected aerial invasion would be a thing utterly impossible with this class of airship. In order to increase the cruising radius of the Zeppelin, the 1914 class was given a greater displacement, which was obtained by lengthening the 1913 type through the addition of two balloon sections whose lift increased the useful carrying capacity by 3,400 pounds. This was utilized as follows:

	Pounds.
Crew (four more men)	640
Fuel (8 more hours)	2,520
Ballast or explosives	240
Total	3,400

The increase of the crew became necessary for two reasons: firstly, because all the preceding Zeppelins were undermanned in peace time, there being no provision made for the men required to operate the guns, the bombs and the searchlights; secondly, owing to the difficulty of handling a larger sized airship on a longer cruise.

The above figures give the 1914 military class a cruising radius of 700 miles, i. e., a distance just sufficient for a trip over land and sea from Cologne to London and back.*

Little official information is at hand about the new naval type of Zeppelin, except that it displaces 950,000 cubic feet and carries a crew of at least 28 men, while a fourth motor has been added to its power plant. Let us now figure out how the additional weight is distributed.

We know that the useful load of a Zeppelin amounts to about one fourth of its total lift; 138,000 more cubic feet should, therefore, give an additional useful load of about 5,500 pounds, or else for a 950,000 cubic foot ship a useful load of 19,600 pounds. If we assume that the new type's cruising radius has been increased only through the greater speed attained by an additional motor (50 knots instead of 45) and amounts to 800 miles, no additional fuel tanks having been fitted (except for the fourth motor) we get the following figures:

	Pounds.
Crew (28 men)	4,480
Fuel (20 hours)	8,400
Total	12,880

which being subtracted from the total useful load, viz., 19,600 pounds, would leave available a ballast of 5,160 pounds. Assuming the ship requires the same amount of dead ballast for its navigation as the military type, viz., 3,500 pounds (for the total lift of a Zeppelin increases more rapidly than its weight) the load available for armament and explosives would amount to 1,660 pounds, or practically the same as that carried by the 1914 army type.

Evidently part of the dead ballast may be replaced by explosives; but this arrangement entails considerable risk, for should a Zeppelin be forced by atmospheric conditions to lighten itself suddenly in order to ascend to a higher level and its ballast consist only of explosives, the latter may cause destruction indiscriminately among friend and foe.†

That the most modern Zeppelin does not carry more than 2,000 pounds of explosives is evidenced by the fact that the heaviest bomb dropped by one of these ships (dropped at Yarmouth) weighed about 100 pounds, and that nowhere twenty of these bombs were dropped by one airship. In fact, the

* Evidently fuel might now be replenished at the nearest point of the Belgian coast line.

† Bombs were dropped as ballast in England without fuses and did not explode. Count Zeppelin states this fact personally in proof of the fact that no bomb was aimed at civilians.

heaviest bombardment by Zeppelins was that of Paris on March 21st, and the two ships that carried it out dropped altogether about fifty bombs, out of which only about half a dozen were of the heaviest type, while the remainder was made up of incendiary bombs weighing about 30 pounds.

War correspondents of imaginative mind have told the world more than once that the Zeppelin factories were busy building super-dreadnoughts-of-the-air of 1,400 feet length which launch torpedoes weighing something like 500 pounds, and can therefore destroy a "Queen Elizabeth" with the greatest ease.

Serious-minded people should not attach too much credence to such fantastic reports. The Germans are too practical a people to indulge in such foolish ideas. There are some very good reasons, too, that it should be so.

First, it would take several years to develop an airship thrice the size of the present-day Zeppelins to perfection; secondly, even if such a ship were actually built there would be no place to house it, for the largest German dirigible shed, that of Leipzig, is only 630 feet long; thus, in order to house those phantasmagoric super-Zeppelins, all the sheds would have to be entirely rebuilt, and not only lengthened, because the diameter of airships obviously increases with the length.

DESTRUCTION OF A ZEPPELIN BY AN AEROPLANE BOMB

The German engineers would never take such a plunge into the unknown for the realization of a machine that can be perfected but step by step, through small increases in size, in motive power, in cruising radius, each improvement being applied at a time to every new unit. In fifteen years' time Zeppelins have just doubled in size; can any fair-minded man suppose that amid all the concern of the war the Germans have found the miraculous *moyen* to treble in six months' time the size and power of the latest Zeppelin that was launched just when the war broke out and was spoken of by the same esteemed *confrères* as the "latest word in fighting monsters of the air"?

Although all of Germany's military and naval activity is shrouded by a seemingly impenetrable veil, the Friedrichshafen factory on Lake Constance is credited with having completed up to the month of April, 1915, one airship every three weeks; while the new Potsdam factory is supposed to turn out one airship every four or five weeks. Since then the working capacity of the Friedrichshafen factory has been increased to such an extent that now one airship is reported to leave the yards every fortnight. This output would give April 1st, 1915, a total of seventeen Zeppelins launched after the outbreak of the European war, which, added to the antebellum status of eleven ships, would give a gross total of twenty-eight units.

According to a statement given out by Count Zeppelin's secretary, "fifteen airships of a greatly perfected type, each being armored and capable of carrying two tons (4,000 pounds) of explosive, are to be delivered by July 15th. These ships will be fitted with a system for increasing the ascending speed, which will enable them to attain an altitude two fifths better than the best hitherto possible."

While the actual efficiency of this new type still remains a thing hypothetic, it is interesting to note the amount of damage effected by Zeppelins during the first six months of the war, for which official figures are available: from August 1st, 1914, up to January 31st, 1915, fourteen Zeppelin raids have taken place, in the course of which one hundred and sixty persons were killed and some hundred buildings destroyed. This destructive activity was purchased at the price of half a dozen airships annihilated and sixty men of their crews taken prisoners and thirty killed. On the other hand, in spite of fifty bombs dropped in the course of the Zeppelin raid upon Paris, only one person was seriously injured and none killed, while seven persons were slightly injured. The damage done to buildings was in no proportion to the amount of explosives discharged. Thus, it seems that the Zeppelin's military efficiency is somewhat far from the altogether too optimistic expectations some people have attached to this form of aircraft regarding its destructive and demoralizing power.

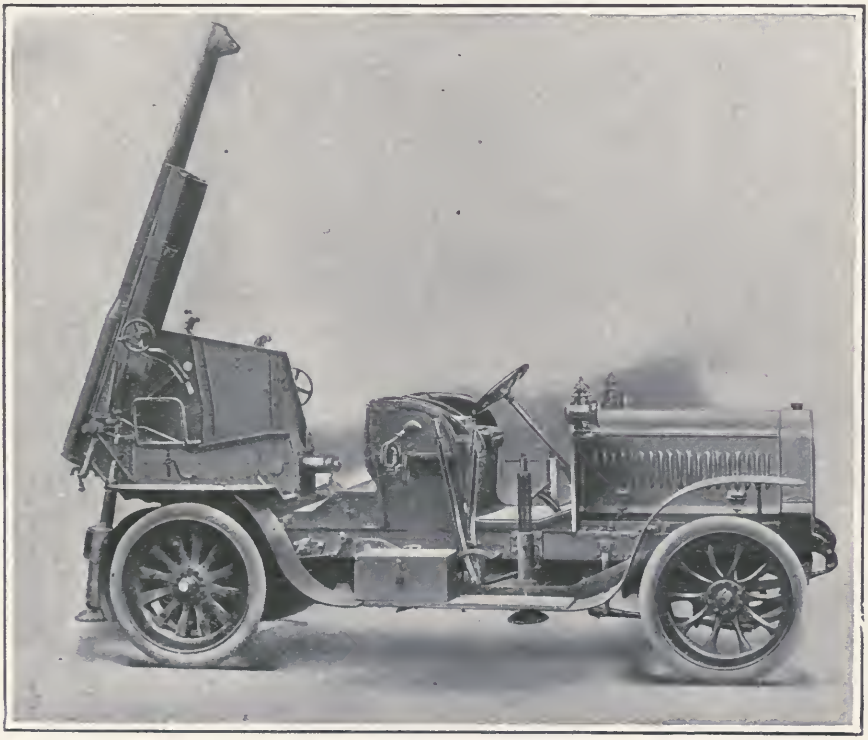
Chapter XXXVIII.

AIRCRAFT ARTILLERY AND BOMB DROPPING

The Value of High=Angle Fire

BY CARL DIENSTBACH

THE European war has shed some light on the much-disputed question, How destructive are heavy bombs dropped from dirigibles? If we compare the effect of Zeppelin bombs and of heavy artillery shells—a comparison easily effected with the aid of photographs which have been published—it is impossible to detect a noticeable difference.



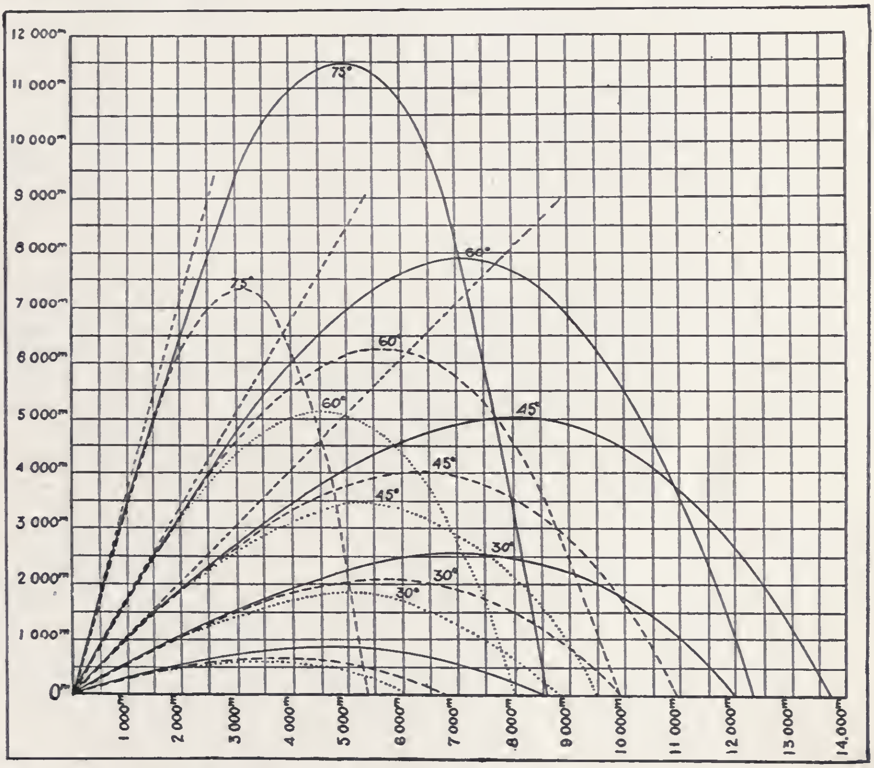
A FRENCH ANTI-AIRSHIP GUN

This is as it should be; for after all there is nothing to prevent a Zeppelin from dropping a bomb in every respect identical with the shell fired from a 42-centimeter mortar. The Zeppelin bomb-droppers, however, seem to have missed their mark. They hit private houses instead of the arsenals and stations at which their terrible missiles were directed,

WAR IN THE AIR, ON THE SEA AND UNDER THE SEA. AN ATTACK ON CAPITAL SHIPS BY ZEPPELINS AND SUBMARINES which does not speak well for a successful solution of the ballistic problem involved in bomb-dropping, all the more remarkable because the problem is, after all, essentially easy.

The horizontal momentum of the bomb, derived from the airship's proper motion, is negligible, and the trajectory of the heavy mass much the same as if it had fallen in a vacuum. Artillery practice has shown that sighting instruments may be depended upon if the ballistic problem has not been obscured by the vicissitudes of air resistance. It may therefore be assumed that the marksmen in Zeppelins missed their targets because they had read their altitude badly, as well as the speed of the craft over the ground at the true vertical direction. Of these three elements, speed is most difficult to determine when a Zeppelin is trying to dodge artillery by following a zigzag course. Moreover, a plumb line as an indicator of direction could not be depended upon when the course is thus constantly changed. Coupled with these difficulties is the fact that a searchlight can be used only intermittently in the dark, and speed measurements become still more difficult.

While there is unquestionably some dodging of special balloon guns which are in use by all the armies—pieces which combine the high initial velocity and quick aiming ability of the field gun with the ability to fire upward at steep angles—there are not enough of them to explain in this way the failure of the Zeppelins to inflict the destruction popularly expected of them. Mortars, too, are fired at high angles, but mortars and howitzers are hardly suited for repelling aircraft, because their low initial velocity demands that they be aimed far ahead of the airship. Hitting the target thus becomes guesswork. Besides, their system of sighting is not adapted to be shifted rapidly, so as to cover a quickly moving target, which is to be expected of siege artillery firing at an immovable object. Were this not so, their superiority over field guns as a means of repelling aircraft would be overwhelming. Were it

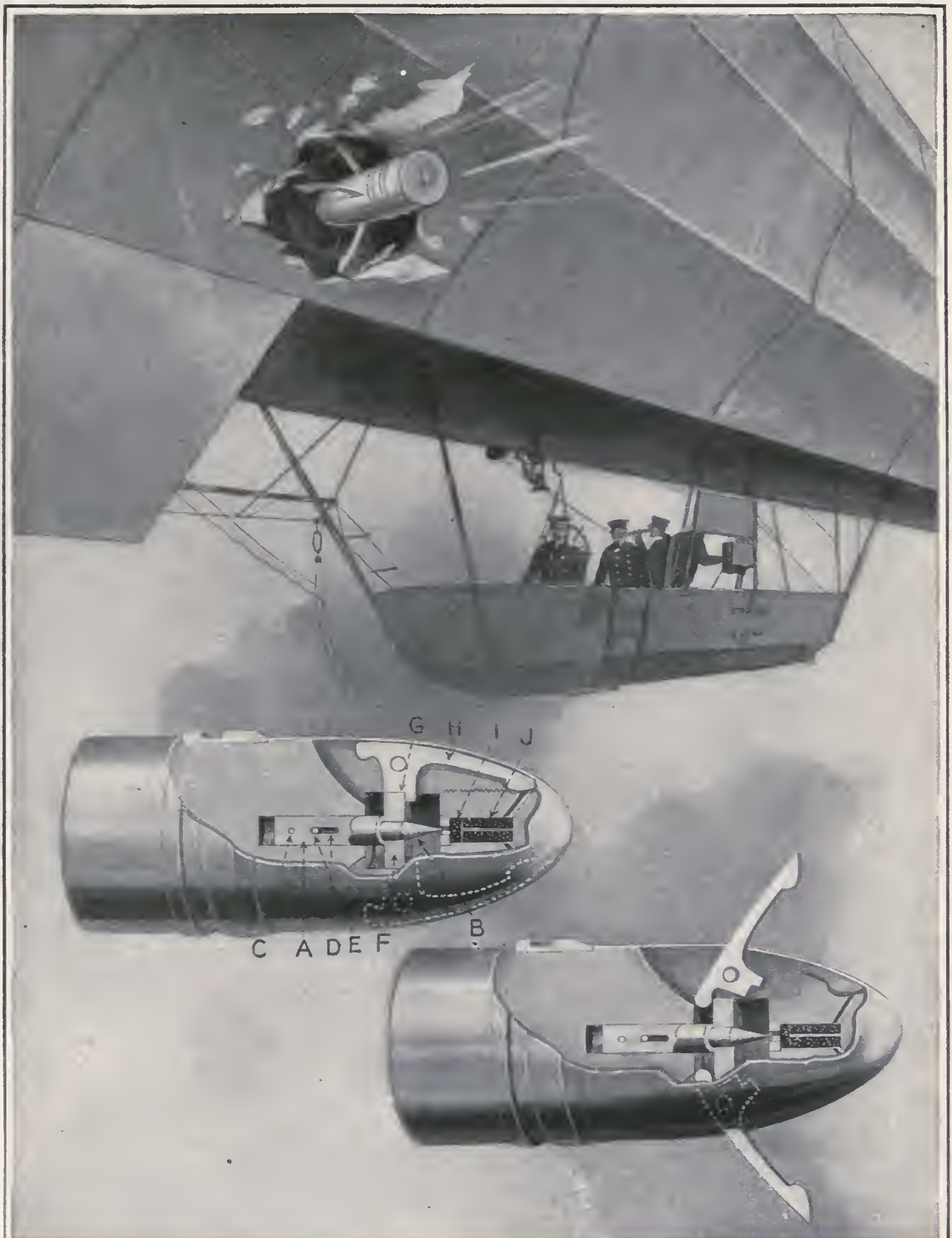


FULL LINES REPRESENT TRAJECTORIES OF 4-INCH NAVAL GUN; WEIGHT OF PROJECTILE, 34 POUNDS; GREATEST ELEVATION, 75 DEGREES. BROKEN LINES REPRESENT TRAJECTORIES OF 3-INCH AUTOMOBILE GUN; WEIGHT OF PROJECTILE, 13 POUNDS; ELEVATION, 75 DEGREES. DOTTED LINES REPRESENT TRAJECTORIES OF 2½-INCH FIELD GUN; WEIGHT OF PROJECTILE, 9 POUNDS; GREATEST ELEVATION, 60 DEGREES possible to fire vertically upward, no aircraft could escape a fair marksman. This applies to field guns as well; for they cannot be elevated much above 15 degrees and attain high altitudes only when the range is great. The trajectory of an ideal gun for the repulsion of aircraft would be practically a straight line; for the wind has but little effect on the projectiles fired from artillery of fairly heavy caliber, and the drift from the rifling shrinks with the flattening of the trajectory. As it is, the more the sighting line approaches the vertical, the more is the trajectory flattened. A mortar could not take full advantage of this fact, because low initial velocity curtails the range of those high angles at which the trajectory still approximates a straight line. With balloon guns all this is very different. Their initial velocity has been increased in order to strike the airship before it has time to move from the point at which it was sighted. The layman is liable to underestimate the height to which even the lightest cannon, aimed more or less vertically, easily sends its projectile. Thus H. G. Wells, in his famous novel, "The War in the Air," con-

By courtesy of Gustav Liersch & Co. From a drawing by Hans R. Schulze

A BOMB-DROPPING ZEPPELIN IN ACTION

veniently but incorrectly assumed that airships simply rise above the range whenever they please. This is hardly possible, even with rifles, whose trajectory is markedly affected by the wind, but which nevertheless enjoy the quality of superior mobility with the ability to shoot vertically. To rise above high angle cannon range would mean the death of the crew from lack of air. Even if the craft were capable of rising above the immense height reached by balloon guns, it goes without saying that the flatter the trajectory the less dependent is the gunner on his range finder. And range finding is proverbially difficult with aerial targets.



A NEW EXPLOSIVE PROJECTILE THAT TEARS OPEN THE GAS BAG OF AN AIRSHIP

With proper aerial sights two high-powered cannon firing upward with an infinitesimal difference in adjustment at an angle of about 50 degrees could not possibly miss an airship between them, even if they knew absolutely nothing about its distance or altitude. Any possible location of the ship would be in the line of at least one of the two flat trajectories. No wonder that a German paper recently reported that only by means of balloon guns was a regiment protected from aeroplanes, busily engaged in giving the range to artillery and dropping down bombs and steel arrows. Field guns are handicapped not only because their projectiles reach high altitudes only at great ranges, but also because the trajectory's curve increases with the range. If that trajectory is to include the location of an airship, the range must be exactly known. Difficult as this task is, field guns have repeatedly scored hits against aeroplanes which overboldly descended in order to make important observations to levels at which they could be reached at more or less normal ranges. This was made possible by the use of self-contained range finders, the altitudes being deduced directly from the range combined with the angle of sight. Rough spotting by observing the clouds of bursting shrapnel as well as the great numbers of guns with tentative different sights made the feat possible. In this connection it must be stated that balloon guns firing at low angles would be no better than field guns.

It is worthy of consideration that if the deadly accuracy of high angle fire will soon render bomb-dropping as risky as torpedoing a battleship in daylight, much may be expected of light cannon which are now mounted on Zeppelins to repel aeroplanes, and which may be directed against targets on the ground from a great distance. If the ship is kept at a constant altitude, by means of a statoscope, for instance, it may be easily steered around the target at an unchanging distance by maintaining the sights at the same angle to the vertical. Spotting from above is then easily possible. Indeed, the conditions may be said to be ideal. The range could be found much more quickly than from below. Zeppelins are perfectly steady gun platforms. Although the destructive effect of small shells is infinitely less than that of heavy bombs, even admitting that the high-velocity 2-inch and 3-inch shell has penetrated nine inches of wrought iron, the aerial marksmen, for whom everything is helplessly accessible and unprotected, are able to apply a slight pressure at the most sensitive spot where it hurts as much or more as the most terrific blow delivered at random. Indeed, this game reminds one somewhat of jiu jitsu, in which everything depends on hitting exactly one small but vital spot. The likeness to this Oriental art appears complete, because speed spells success, not only in getting the range, but also in running in and out of range so quickly that an accurate burst of rapid fire is delivered and a safe distance reached again before the gunners below have time to find the airship range. Far from being easy targets, the growing size of Zeppelins insures safety by greater speed.

"TO be prepared for war is one of the most effectual means of preserving peace. A free people ought not only to be armed, but disciplined; to which end a uniform and well-digested plan is requisite."

From Washington's
First Annual Address

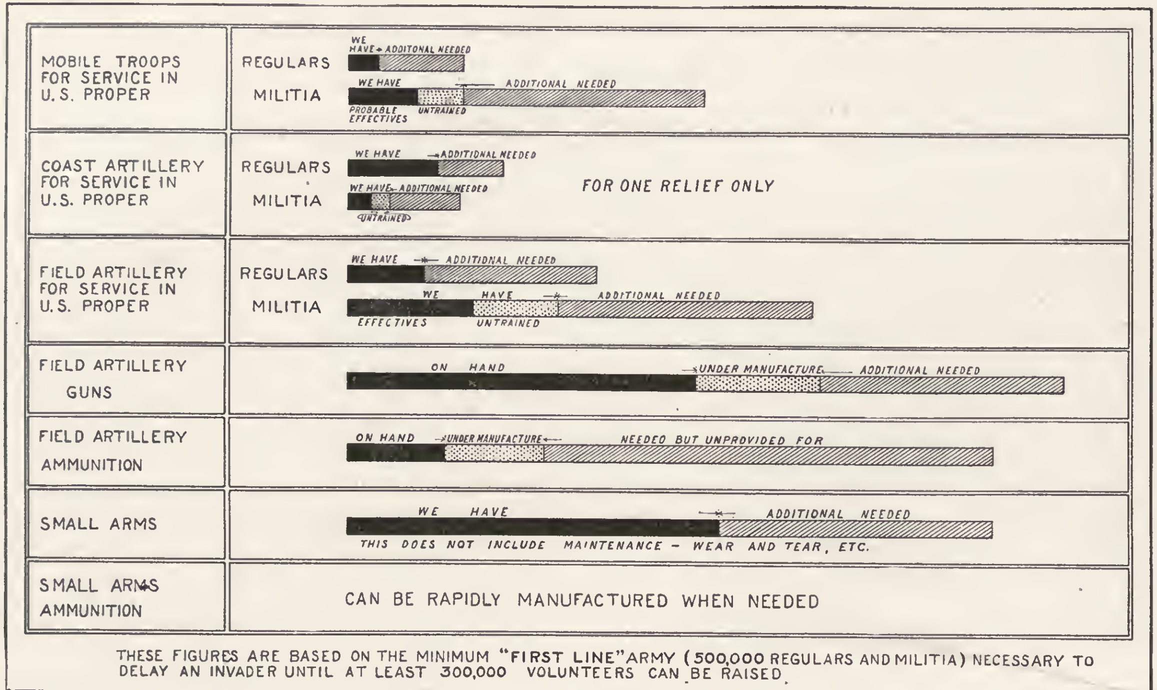


DIAGRAM SHOWING THE ALARMING CONDITION OF OUR MILITARY DEFENSES

Chapter XXXIX.

OUR COUNTRY—AN UNDEFENDED TREASURE LAND*

FOREWORD

The reader has probably wondered why little or nothing has been said about the defenses of our own country. This has all been reserved for the present chapter to which earnest attention is invited. The reader has learned in the foregoing pages how part of Europe, at least, was splendidly prepared for the coming of the war. We have seen new methods, and new material everywhere. It was, indeed, a "lathe-made" war. This only emphasizes the necessity of preparedness and the maintenance of huge munition plants. It is the duty of every American citizen to read the few pages which have been written in sorrow. The painful information conveyed is arch-authentic, and is written by one whose virile hand never wavers in delineating the shocking conditions and dangers which confront the American people. If every reader will ask ten of his friends to look over this chapter, he will have done a real service to his country. The dissemination of this vital knowledge of our national inefficiency is of the utmost utility to the country at large. It is a sad sermon which should be taken to heart.

PART I.

From President Washington to President Wilson, the Executive has persistently urged upon Congress the necessity of providing, in times of peace, a body of citizen soldiery properly trained and equipped, with which instantly to meet and repel any invasion of the United States. With equal persistency, Congress (except during periods of war) has refused to listen to the warnings of its President. To-day, because of this neglect, the United States, the richest of the rich countries of the world, is the most open to invasion. The ocean, once a barrier, now, thanks to steam navigation, offers a choice of half a hundred highways, by way of any one of which a first-class power might slip by our crippled or bottled-up fleet, which is now rapidly losing in relative strength and is without adequate personnel, necessary scout cruisers or submarines, and, within a week or ten days, land a fully equipped advance force of 200,000 highly trained troops. To oppose this, the United States, in thirty days, could concentrate, at the most, 30,000 regular and 60,000 militia.

The present chapter is published with a view to bringing before the country at large and Congress in particular the military defenselessness of the United States. The facts, as here given, are in the highest degree authoritative. They represent the alarming conditions and the remedy therefor, as presented, for many years past, in the annual reports made to the various Secretaries of War by the General Staff of the Army. What is Congress going to do about it?—EDITOR.

THE problem which at present confronts the United States is the establishment of a military policy which will enable us to establish an adequate force for national defense in time of war and maintain a regular army adequate for the peace requirements of the nation.

ONLY 90,000 WIDELY SCATTERED MOBILE TROOPS, INCLUDING MILITIA, FOR DEFENSE

The regular army within the continental United States numbers about 30,000 men

* A reprint from the SCIENTIFIC AMERICAN

(mobile troops, cavalry, infantry, and field artillery) and 16,000 men in the coast defenses. These latter are non-mobile troops in the sense that their duties are in the fortifications. The militia of the United States amounts to approximately 127,000 men and officers, on paper, but only about 104,000 actually mustered. Of these, at the most, not more than 60,000 can be considered as ready for immediate service, so that we have in the United States a total of 46,000 in round numbers of regular troops, 16,000 of whom are tied up in the coast defenses, and 60,000 militia, or a total of 90,000 mobile troops. These are scattered over the continent from Canada to Mexico and from the Atlantic to the Pacific. It is easy to appreciate the difficulty which would be encountered in assembling all the effective militia, for it would mean the withdrawal from the States and our coast cities what few armed men they have available for defense.

WOULD TAKE THIRTY DAYS AFTER ENEMY LANDED TO CONCENTRATE OUR 60,000 MILITIA

We would be exceptionally fortunate to be able to concentrate this number of mobile militia troops at any point on the Atlantic or Pacific coast within thirty days, and when concentrated, they would be without properly trained artillery and cavalry organizations. They would be without ammunition trains. They would have been hastily organized, assembled for the first time in large bodies, and, generally speaking, unprepared to act as an army. This condition of unpreparedness would apply not only to the officers and men of the line, but also to officers and men of the Supply Departments, most of whom would be without previous experience in the actual movement and supply of troops. Moreover, there are practically no reserve supplies and no adequate arrangements for providing them.

BEHIND OUR WIDELY-SCATTERED REGULARS AND MILITIA ARE NO RESERVES WHATSOEVER

The regular army and militia are maintained in time of peace at only a fraction of their war strength. There are no reserves of men or officers to fill them up to war strength. Not only is there a shortage of men for reserves to fill up existing organizations, but many of the officers and men at present on the rolls of the militia will be unable to accompany their comrades, so that the condition of actual shortage in the militia, alarming as it appears, is still well below what must be expected in case of mobilization. To be more explicit, our infantry companies to the regular army in the continental United States are maintained at an average strength of about 65 men per company. Their war strength is 150. The militia organizations are maintained at even lower strength. Their war strength is the same as that of the regular army. Even at war strength our infantry regiments are only about two thirds the strength of the average European regiment.

SHORTAGE OF MEN AND GUNS IN THE (REGULAR) FIELD ARTILLERY

The regular army in the United States is without adequate field artillery organizations, and is short both officers and men and ammunition and supply trains to make up those needed organizations. They could not be created and made reasonably efficient from new *personnel* within four months, and this under the most favorable conditions and with the best officers and non-commissioned officers as instructors. On the completion of our foreign garrisons, there would be left in the United States three regiments, or enough for a division and a half of infantry, and none for the remaining regular troops or for the coast guard and additional volunteer troops which would have to be raised.

WE POSSESS LESS THAN HALF THE NEEDED MILITIA FIELD BATTERIES; WHAT WE HAVE WOULD REQUIRE THREE MONTHS' TRAINING

The militia is even worse off, and has relatively few batteries that can be considered efficient. As a class the batteries of the militia will require at least three months' training to make them reasonably fit for war, and the new batteries which will have to be created for this arm will require at least six months; and in this connection it must be remembered that the militia must create more new batteries than it now has old batteries in order to be properly equipped with field artillery. These statements are most conservative and well within the limit of time which would be required for real efficiency. The militia at present has sixty-five organized batteries, with four guns each, and needs seventy-nine additional batteries to complete its equipment in field artillery. It has only a very small percentage of the ammunition needed. It is without ammunition trains, officers or men for the new organizations, and without the necessary horses for existing batteries. It is without siege artillery, and neither it nor the regular army has any of the heavy field mortars or howitzers (10-inch and upward) which have been of such value in the great war in Europe. We are without any adequate system for expanding either the regular army or militia to war strength.

NOT FOR A YEAR AND A HALF AFTER THE ENEMY LANDED COULD WE PROVIDE THE NECESSARY FIELD ARTILLERY, AMMUNITION TRAINS AND AMMUNITION

We could not supply the men for the necessary field artillery organization for months, or the ammunition trains and ammunition for a year and a half, and not a gun is yet made or appropriated for, for the volunteers. The militia is short in cavalry and requires over fifty additional troops of cavalry to provide the divisional cavalry alone. There is an alarming absence of auxiliary troops. Most of the militia cavalry is poorly mounted, much of it practically without mounts, and with the exception of a few special organizations, has had little or no field training. It needs months of hard work in camp. Engineers, signal and medical troops of the militia are as a rule insufficient in number, deficient in organization, equipment and reserve supplies, and very many of them are far below their prescribed strength and without available *personnel* to fill them up.

EMPLOYERS SHOULD PATRIOTICALLY SUPPORT MILITIAMEN IN THEIR EMPLOY

The militia needs the strongest support of the public, and especially the active support of those in whose employment are officers and men of the militia; support of a practical kind which will make it possible for them to give the necessary time to their militia training without prejudice to their business or professional careers.

THE SHORTAGE OF TRAINED OFFICERS

The militia should have not only a reserve of men, but at least one additional lieutenant per company, so that, when called to active service, there may be at least three officers per company; for it must be remembered that the militia is a part of the first line and will be called simultaneously with the regular army, whenever a condition of war or threatened war arises. This provision for an extra officer could be well applied in the regular army organization. A large number of additional regular officers should be provided as instructors for the militia, so that we may have at least one per regiment of militia infantry and one for each squadron or battalion of mounted troops, and the necessary number for the training of engineers, signal corps, and medical troops of this force. The department has urged these necessary officers, but thus far with little success. The militia can be made efficient only through the supply of a sufficient number of highly trained, competent regular officers as instructors. Even when the regular army and militia have been brought to full strength and placed upon a war footing they will have only about 325,000 men (mobile troops) within the limits of the United States. In order to secure the men for this reserve it will be necessary to secure a radical change in the present form of enlistment for both regular army and militia.

IN CASE OF INVASION WE WOULD NEED 380,000 STATIONARY VOLUNTEER COASTGUARD TROOPS TO GUARD THE APPROACHES TO OUR CITIES AND COAST DEFENSE WORKS, ETC.

The War Department has made an earnest effort to secure a form of enlistment which would render a reserve possible, but its recommendations have received scant consideration at the hands of Congress. We can, perhaps, best judge the demands which would be made upon the United States in time of war with a first-class power prepared for war, by considering first the coast guard troops which will be necessary to guard the approaches to our cities, the coast defense works at and about our harbors, etc. This force is estimated at nineteen divisions, or about 380,000 troops, of whom 275,000 will be required on the Atlantic coast.

WE WOULD NEED 500,000 MOBILE TROOPS (REGULARS AND MILITIA) TO MEET THE ENEMY WHEREVER HE MIGHT LAND

The plan of organization of the land forces, as prepared by the General Staff and approved by the Secretary of War, in 1912, calls for a force of 500,000 men and contemplates the immediate raising of 300,000 additional volunteers. Now, this force is intended to be an active field force or forces assembled at not more than three points on the Atlantic seaboard, ready to meet an enemy in case of invasion.

AS MATTERS STAND, WE WOULD HAVE NO COASTGUARD TROOPS, AND IT WOULD TAKE THIRTY DAYS TO COLLECT OUR 90,000 MOBILE EFFECTIVE REGULARS AND MILITIA

The regular army and militia in its present condition will furnish only 90,000 within thirty days, and, to furnish this number, every militiaman fit for immediate service must be taken from his State and sent to the United States rendezvous, so that, to-day, we stand with less than one fifth of the mobile army required for the field force and without a single man for the coastguard, and we shall continue in this state unless arrangements are made prior to war to provide the necessary reserves of trained men and officers for the coastguard troops. One method of providing a coastguard of trained troops would be to take it from the regular army and the militia. To do this would be to scatter these small forces in driblets along our coast. This would be folly, and would destroy these organizations as a field force. The only other way to provide for the necessary coastguard would be through voluntary assemblages of unarmed and undisciplined citizens. Their value would be practically *nil* until they had received months of training.

FRUITLESS EFFORT OF THE WAR DEPARTMENT TO BUILD UP A RESERVE BEHIND THE REGULAR ARMY

The War Department has for years been attempting to build up a reserve behind the regular army. By a reserve is meant a body of men thoroughly trained by active service, who are held on a status of furlough or leave, ready to come to the colors; that is, to come to the troops whenever needed, in case of war or threatened war, and for a short period of from five to eight days of training each year. This reserve should be sufficient to bring the regular organizations to their maximum war strength and provide an excess of at least 15 per cent to make good the losses of the first months of war. A similar reserve should be built up behind the militia, for, at present, it cannot be counted upon to take the field at more than, at the outside, 30 per cent of its war strength.

THE UNDEFENDED STATE OF THE UNITED STATES IS SOLELY CHARGEABLE TO CONGRESS

No effective steps have been taken by Congress to provide a reserve either for the regular army or for the militia. Everything is left to chance. The law which carried the term "reserve" was passed in such form by Congress as to render a reserve practically impossible. Its defects were fully pointed out by the Chief of Staff, but without avail. The result is that we stand to-day with a force of militia and regulars available within thirty days, but lacking in certain necessary organizations vital to its efficiency, and without previous experience in large bodies, or training as part of the field army, and in strength only about one fifth of that estimated by the General Staff as necessary at the commencement of war to meet the first shock of land attack. Back of this unorganized and largely untrained force, incompletely equipped in certain essential particulars, stands *a reserve of sixteen men*, scattered from Porto Rico to California. This is a statement of fact; in view of it can anyone question the statement that this country is inadequately prepared for defense?

PART II.

WE have shown in the previous part that, in order successfully to meet an invasion, the United States require, in the early stages of the war, a mobile force (regulars, militia, and their reserves) of 500,000 men; whereas, as a matter of fact, we possess only 90,000 such troops to-day.

We now direct attention to the fact that we are without adequate artillery guns or ammunition for this combined regular and militia force, and it will be years at the present rate of progress before we accumulate the guns and ammunition necessary for this combined force at war strength. The estimate on which the Department has been working is for 1,292 guns, and 634 of these guns are actually completed; also 226 others are under contract. Of field artillery ammunition, there is only a small percentage of the total amount required.

LACK OF FIELD ARTILLERY GUNS AND AMMUNITION

We have in the hands of troops, or stored, 634 completed guns. We have under manufacture or contract, 226. These guns will probably not be completed for at least a year and a half. In other words, the number of completed guns is a little less than half the total number deemed necessary for the field force of 500,000 men, and provides no guns whatever for the coastguard troops or new volunteer organizations which will be required in addition to the 500,000 field force. Of ammunition, we have, made and under contract, approximately 30 per cent for the entire project of guns (1,292). Half of this is under manufacture or contract, so that there is not more than 15 per cent actually completed. For the guns on hand and under manufacture we have, of ammunition on hand and under manufacture, about 41 per cent; actually on hand, approximately, 20.5 per cent. For the guns actually made (634) we have 27 per cent of the ammunition necessary. For the guns now in the hands of the regular army and militia we have about

44 per cent of the ammunition necessary. It should be remembered, however, that the guns in the hands of the regular army and militia at the present time are less than half the guns required for these forces when properly equipped with guns, even under our scheme for the assignment of guns and ammunition, which is in both instances far lower than in any of the great armies of today, and the European war has indicated, in the case of one great power at least, that the consumption of ammunition has exceeded twice their maximum estimates, and that the proportion of artillery will, in future, be increased.

At the rate of even last year's appropriations, which were the largest made for field artillery guns and ammunition, it will take between eight and nine years to complete our present modest estimate for guns and ammunition, and the necessary equipment in the way of ammunition trains and other accessories.

WE HAVE ABSOLUTELY NO ARTILLERY FOR THE NEEDED VOLUNTEER COASTGUARD FORCE OF 380,000 VOLUNTEERS OR THE VAST VOLUNTEER MOBILE FORCES THAT WOULD HAVE TO BE RAISED BACK OF OUR FRONT LINE

This total number of guns, 1,292, represents practically only enough guns for the field force of 500,000 men made up of the regular army and the militia brought to war strength and with necessary new organizations. It does not provide a single modern type field gun for the coastguard force or one for the great force of volunteers which will have to be promptly raised in time of war. These forces will be helpless against a well equipped enemy with artillery, and it can be assnmed as certain that any attacking force will be fully equipped in all particulars. Is this haphazard policy either just or fair to our volunteers? Are they not entitled to such equipment as will give them a fighting chance? No adequate steps are being taken to provide it. The present entire gun-building resources of the United States, working day and night, could not make good our deficiencies in guns or ammunition within one and a half years; that is to say, within a period which would exceed that of most modern wars and within the period which would in all probability determine the issue. These are plain and disagreeable facts. They cannot be controverted, and what is worse, there seems little inclination outside the army to make any effort to improve these conditions.

DURING THE FIRST FEW MONTHS OF A WAR OF DEFENSE AGAINST A FIRST-CLASS POWER WE WOULD REQUIRE IN REGULAR AND MILITIA FIELD FORCE, COAST ARTILLERY, COASTGUARD FORCE, VOLUNTEERS, ETC., ABOUT 1,000,000 MEN

The figures as to men required, for the field force and coastguard, represent in round numbers, including the coast artillery and its reserves, about 800,000 men, regular, militia and volunteers, as the force which will be needed at the commencement and during the first few months of war—a million will be more nearly correct when all the demands of the situation are considered. When it is remembered that during the Civil War, when our population was about one third of what it is at present, we had, North and South, nearly 4,000,000 different men under arms and that we had about 1,200,000 North and South under arms at the end of the war, these figures do not seem to be unduly large. This statement shows what we have immediately available (90,000 mobile troops and about half the coast artillery required) and what we shall need in order that we may be reasonably well prepared to meet successfully the first shock of war with a first-class power, and it is only for preparation for conflict with such a power that we need particularly to concern ourselves. The little wars with little nations, we can take our own time to prepare for. In fact, our peace force, if we provide the necessary organizations to complete three tactical infantry divisions with their necessary artillery, three cavalry brigades, the necessary auxiliary troops, etc., within the continental limits of the United States, will generally be sufficient to furnish an expeditionary force for minor operations. The big wars with the fully equipped, strong nations, are the wars which threaten us and the ones for which we have made no preparation, worthy of the name.

THE ARMY STAFF ASKS FOR A SMALL STANDING ARMY WITH A LARGE TRAINED RESERVE OF REGULARS, MILITIA AND VOLUNTEERS WITH THEIR OFFICERS BACK OF IT

The policy of the Army General Staff has not been for a large standing army, but for a standing army adequate for the police work of the day, i. e., an adequate garrison for the Philippines (20,000 men), a garrison for the Hawaiian Islands (16,000 men), for the Panama Canal (9,000 men), a small force for Porto Rico and Alaska, amounting to a regiment each, and the remainder within the limits of the continental United States. It has recommended that the regular army in the United States be increased, so as to provide three tactical infantry divisions in the continental United States, three cavalry brigades, and a division of army troops and a coast artillery force of approximately 19,000 men in time of peace. It has advocated a form of enlistment, under which men could be transferred to the reserve as soon as they were sufficiently trained and their places taken by others. Its recommendations have not been heeded by Congress, and upon the completion of our foreign garrisons, the regular forces in the United States will be sixteen regiments of infantry, with about 840 men per regiment, and eleven and two third regiments of cavalry, with about the same strength per regiment; three regiments of field artillery, with twenty-four guns per regiment, and certain auxiliary troops. Is this an adequate force for a population of nearly one hundred millions of people?

OUR PRESENT EFFECTIVE FIELD ARMY (REGULARS AND MILITIA) COULD BE PUT INTO THE YALE BOWL AND LEAVE ROOM FOR A FOOTBALL GAME

The mobile troops in the United States, amounting to about three times the police force of the city of New York, taken with the *personnel* of that portion of the militia which is efficient and ready for service, can all be put into the Yale Bowl and room still be left for a game of football. Think of it! The total available mobile troops is less than one third the number estimated as needed for an adequate coast guard alone and only about one sixth of that needed for the field force, and no steps have been taken or are being taken to correct this alarming condition. No one who is familiar with the subject expects the country to maintain a force of the strength of that which would be needed in war on a war footing in time of peace; but they realize fully the necessity for making in the greatest detail all arrangements for preparing promptly the forces which will be needed in case of war, and especially do they realize the absolute necessity of having the regular army and the militia so maintained, both as to reserves and equipment, that they can be immediately brought to full strength, fully armed and equipped, and with reasonable reserve supplies. The necessity is also appreciated for completing, in advance, all arrangements for coastguard troops, because, as stated above, it will be destructive to the usefulness of the field force to attempt to take from it coastguard troops. Moreover, the demand for the coastguards will be such as to make it impossible to supply them from the regulars and militia, without entirely using up the available force of these troops.

THE SHORTAGE IN SMALL ARMS

The reserve in the case of small arms is better than in any other detail of equipment, excepting small arms ammunition; but even in the case of small arms (service rifles) the amount available, 698,000, including guns made and under manufacture, is insufficient in view of the number of men which will be required for the field force, coastguard, and additions to the field force in the shape of volunteer organizations in the early stages of war. This force will undoubtedly steadily increase, and will increase at a pace which will be far beyond the capacity of the arms factories to meet. The wastage in small arms is always heavy. Many are broken, many are shot to pieces in action, many are lost through capture; they are bent, injured, and put out of commission in various ways. The reserve of small arms should be liberal—not less than a million and a quarter. The present policy of establishing a reserve of a million is barely sufficient to meet the demands of the first few months; and right here it may be well to point out the inadvisability of the Government attempting to manufacture exclusively its own military equipment. On the contrary, every effort should be made to secure, even at a somewhat added cost, manufacture of field guns, ammunition, small arms and equipment, by outside firms, so that, in case of any sudden emergency, there may be agencies other than the arsenals which have the machinery and, what is equally important, the trained *personnel* to meet the needs of the Government. No economy can be more unwise than that which concentrates in the hands of the Government the entire manufacture of articles of military equipment, and no policy will tend more to establish a condition of inability to meet the demands of war than such a one.

WE HAVE PRACTICALLY NO RESERVE OF UNIFORMS, TENTS, TRANSPORTATION EQUIPMENT AND OTHER MILITARY SUPPLIES

In other departments (uniforms, tentage, etc.) we are practically without a reserve of materials worthy the name, considering the demands which must be met, and met promptly. We have no ammunition trains, no general reserve of transportation or other military supplies, and no adequate plans to supply them. All this is being left to be prepared in the hurry and confusion of war.

THAT "UNDEVELOPED MILITARY RESOURCES" FALLACY

Our people are prone to speak of our undeveloped military resources. These are of value if we have time to develop them, but in the onrush of a modern war are of little more value than a deep-lying coal vein to a freezing community in a Nebraskan blizzard, and reference to them as a military asset of value, when it is remembered that all our possible enemies are dangerous enemies and prepared to the minute, is just about as intelligent and as much appreciated by those who understand what preparation means, as would be advice to the freezing people to use the unmined coal one hundred feet under their feet.

WARS ARE SUDDEN, AND THE OCEAN RENDERS ATTACK EASY AND THE POINT OF ATTACK DOUBTFUL

Wars in these times come with great suddenness. The ocean, instead of being a barrier, is one of the readiest and most convenient means of approach. We have an enormous coast line unprotected, except at the mouths of our harbors, and even those are unprotected against an enemy who lands outside the range of their guns.

WE HAVE ONLY ONE HALF OF THE FORCE NECESSARY TO MAN THE COAST FORTIFICATIONS WITH EVEN ONE RELIEF

The existing regular coast artillery forces even with the existing reserve coast artillery militia, is entirely insufficient to man the existing works and give even one relief. Indeed, these forces combined amount to but little more than one half the force necessary to accomplish this. The idea has been advanced that the coast defenses could be adequately manned by a judicious transfer of *personnel* based upon an enemy's movements. This is, of course, absurd. As the attack would come from the sea, the whereabouts and movements of the enemy would be unknown, and once off the point of attack there would be no opportunity through judicious transfer of troops to meet the attack until several days after it was finished. No, quite the contrary is the policy which must be followed. In time of war all fortifications on the sea coast of the ocean over which the enemy will operate must be completely manned, and with a full supply of ammunition. Any other policy is lacking in appreciation of the needs of the situation. If the attack involves both oceans, then the entire sea coast of the United States will have to be maintained in a condition of defense, and an adequate force of men and supply of ammunition will be required in every work.

It must be remembered that our expensive system of sea coast fortifications will be practically useless as a means of defense unless supported by an adequate mobile force. The term "coast defense" is a misnomer and conveys to the general public a false impression. It is only an element of defense, and unless supplemented by a mobile force will be of little value in preventing an invasion of the country. It may prevent bombardment of harbors and towns behind them by fleets, but never can, without the mobile army, prevent the more serious feature of war, namely, territorial invasion and occupation. Sea coast fortifications will not prevent an enemy from landing on our shores and seizing and occupying what he wants; this can only be prevented by an adequate mobile force. We have no such force.

We have a miniature fighting force, a population unused to arms, without organization, filled with an enormous conceit as to their military ability, which is unjustified by history. The question is, What shall be done to better the present situation?

THE URGENT NEED OF THE HOUR

In the first place, we must provide a reserve behind the regular army and militia as above indicated, and provide the regular army and militia with the organizations necessary to complete them, and also provide the necessary field artillery guns and ammunition, ammunition trains and other supplies which cannot be promptly secured in the open market. It is probable that the State will feel with reference to the reserve and to the special arms, such as cavalry and field artillery, that these are for national uses and must be supplied and maintained by the Federal Government. So be it. If the States are not able, they must be helped. Without these vitally important organizations, neither the regular army nor militia will be efficient. Artillery has become such a dominant feature in the modern battle field that to send troops into campaign without a proper proportion of this arm would be suicidal. Any nation which neglects to provide this important, nay, vital arm, liberally, courts disaster and wantonly wastes the lives of its people.

In fact, troops without artillery are, against troops provided with this arm, no better off than if armed with spears, until they get within a range of 1,200 yards.

PART III.

WE NEED A VOLUNTEER FORCE BACK OF THE ARMY AND MILITIA RESERVES

IN addition to the reserve behind the regular army and militia, we must take up the question of building up a large force of volunteers, because, as already stated, the regular army and militia at war strength will furnish only about one third of the force which will be needed in case of war with a first-class power. No adequate measures have ever been taken to train or organize officers or men for volunteers. It is believed this can be done for the men and in part for the officers through a special form of enlistment, which will interfere as little as possible with the educational and industrial careers of those affected; and it has been suggested that training adequate in character could be secured through three annual periods of two months each. The men under training will be in camp for two months each summer for three years, and subject to an intensive training under the most carefully selected regular officers. Men completing the three periods should be held as volunteer reservists for a period of years, dependent upon the size of the class coming to training each year. All this sounds large and formidable, but it must be done if we are to be ready to meet the emergency which may be thrust upon us at any time. Even if we are unable to train a sufficient number of men for enlisted men of the volunteers, we must, in time of peace, train the necessary officers. This is absolutely essential, for it must be remembered that there will be no time to develop officers for volunteers; in fact, no means for developing them, once war is upon us. All regular and militia organizations and officers will be in the field and the training of volunteers will be conducted under conditions which make it almost impossible to train them. Thousands of officers must be trained in advance if the volunteers are to be even reasonably efficient in the early stages of the war.

During the period of their active service the officers and men must be enrolled in properly organized military units. They must be mobilized each year and their arms and equipment held at all times ready for immediate use. The number of volunteer troops which will be necessary to provide the required force, 460,000 mobile troops, including the regulars and the militia at war strength, will be about 135,000.

In addition to this force of volunteers it must be remembered that the General Staff in its plan of defense, as set forth in the Organization of Land Forces, has recommended as necessary that 300,000 additional volunteers be at once raised. When it is remembered that the coastguard troops (that is to say, troops which will co-operate with the coast fortifications and without which the latter will be open to capture by land attack made by raiding parties from fleets) amount to nearly 400,000 for both coasts, about 275,000 for the Atlantic and Gulf seaboard, it will be seen that steps must be taken to provide the necessary officers and men for this force. Any increase which may be made in either the regular or militia establishment by adding new organizations will reduce by just so much the number of volunteers to be raised in the early stages of a war.

FOLLY TO RELY UPON THE SPRINGING TO ARMS OF UNTRAINED VOLUNTEERS

Any assumption that hundreds of thousands of volunteers are going to spring to arms in a condition of efficiency is most dangerous and wholly unjustified; in fact, such a response would be literally impossible, and any dependence upon it is wholly unwarranted. This fact cannot be too strongly impressed upon the American people.

Above all else in importance in raising and organizing volunteers is the provision of an adequate number of officers—officers who are efficient and well trained. These we must provide in time of peace, even if we are unable to provide the enlisted force, that is to say, the men. Our plans for the mobilization and utilization of this volunteer force, the points of mobilization and area in which it is to operate, must all be worked out in great detail in time of peace, for any war in which we are engaged would probably be one of aggression on the part of our enemies, consequently the attack will come suddenly and at a time when the enemy is fully prepared. Knowing his own plans, he will bring against us the most thoroughly trained and equipped military organizations, fully prepared in every detail to attain his objective. To assume that equally good men, but untrained and without the necessary equipment and trained officers to lead them, would have any chance for success, is folly. Such an attitude on our part can only result in disasters and in the useless and unnecessary wasting of the lives of our people.

THE PRESENT SOURCES OF OFFICERS FOR VOLUNTEERS

The present sources of officers for volunteers are the following: First, men who have had service in the regular army or militia and are still of an age fit to bear arms. Second, men who have graduated from military schools maintaining a course in military instruction under regular army officers. Third, approved graduates from the military instruction camps for college students. Fourth, men who have qualified for appointment as officers of volunteers through examination. All of these sources at present, with the exception of the graduates of the military schools, are limited.

SUMMER CAMP TRAINING OF OFFICERS

It is hoped to greatly increase the number who will be available through training at the summer camps for college men. Last year there were about seven hundred students at these camps, and their record of performance was so excellent that there is every reason to believe these camps will be a most valuable source of supply for volunteer officers. In the first place, the men who attend these camps go because they are interested. This is shown by the fact that they pay their own expenses. They receive five weeks of intensive training, during which they get about as many hours of actual work as the average militiaman does during an average enlistment.

IN CASE OF INVASION WE SHOULD REQUIRE 30,000 VOLUNTEER OFFICERS. MAJOR-GENERAL WOOD'S PLAN

The magnitude of the task in training volunteer officers is apparent when it is realized that it will be necessary to develop not less than 25,000 in case we should have to mobilize enough additional volunteers to bring our total force up to 1,000,000 men. It has been recommended by Major-General Wood for a number of years that five hundred selected graduates of colleges maintaining military instruction under officers of the army be appointed provisional second lieutenants for one year and that they receive full pay and allowance of a second lieutenant, amounting to about $1,750 in money and valued at approximately $500 in allowances, each young man to be appointed subject only to physical examination, as they will be graduates of institutions of high standing. This number should be increased to 1,000. This procedure if adopted will give us a thoroughly well trained reserve officer, a man who has had from two to four years of military training at a college or technical school under the direction of an officer of the army, plus one year of actual service in the regular army. As the line of the regular army is always short about seven hundred to eight hundred officers, incident to detached service of various kinds, and this without in any way fully meeting the demands upon it for officers, it will be seen that these young officers will be of real value during their year of service. The cost to the Government will be comparatively little. The young men themselves will be able to leave the service with from $600 to $800 and should be held as reserve officers for from eight to ten years with the understanding that they will be called to duty only in case of war and for brief periods of training a few days each year. This would give us a steady annual increment of well-trained reserve officers, and these, taken in connection with the men who are qualified at the summer camps and through special means of examination, would eventually give us a reasonable reserve of officers for volunteers.

DURING THE CIVIL WAR CONGRESS MADE LAND GRANTS TO ENCOURAGE MILITARY TRAINING IN STATE COLLEGES

In the early days of the Civil War, Congress passed an Act, known as the Morell Act, which made grants of public lands to various State colleges, known as agricultural and mechanical colleges, and provided that military instructions would be maintained at these colleges. These grants have been of great value to the colleges, and some of them have maintained a rather effective course in military instruction. Others have simply kept up a nominal amount of work. The instruction at all these colleges should be standardized, so that the Government may know exactly the qualifications, so far as military knowledge goes, of the graduates, and an attempt should be made to secure legislation which will hold those graduates who have demonstrated fitness through practical work for a number of years as reserve officers and non-commissioned officers. This is not unreasonable in view of the educational facilities and advantages extended to the students at these institutions. A return in the form of service for six to eight years as voluntary reserve officers would seem but just and equitable.

THE EARLY PRESIDENTS, BEGINNING WITH GENERAL WASHINGTON, STRONGLY ADVOCATED PEACE-TIME PREPARATION FOR WAR

The necessity for the preparation for possible war was recognized by the early Presidents in various messages, but, little by little, interest in the subject of preparedness seems to have disappeared.

Thus, from Washington's first annual address we quote the following:

"Among the many interesting objects which will engage your attention, that of providing for the common defense will merit particular regard. To be prepared for war is one of the most effectual means of preserving peace. A free people ought not only to be armed, but disciplined; to which end a uniform and well-digested plan is requisite; and their safety and interest require that they should promote such manufactures as tend to render them independent of others for essential, particularly military supplies."

From his third annual message (speaking of the militia):

"This is certainly an object of primary importance, whether viewed in reference to the national security, to the satisfaction of the community, or to the preservation of order. In connection with this the establishment of competent magazines and arsenals and the fortification of such places as are peculiarly important and valuable naturally present themselves to consideration. The safety of the United States, under divine protection, ought to rest on the basis of systematic and solid arrangements exposed as little as possible to the hazards of fortuitous circumstances."

From his fifth annual address:

"I cannot recommend to your notice measures for the fulfillment of our duties to the rest of the world without again pressing upon you the necessity of placing ourselves in a condition of complete defense and of exacting from them the fulfillment of their duties toward us. The United States ought not to indulge a persuasion that, contrary to the order of human events, they will forever keep at a distance those painful appeals to arms with which the history of every other nation abounds. There is a rank due to the United States among nations which will be withheld if not absolutely lost by the reputation of weakness. If we desire to avoid insult we must be able to repel it; if we desire to secure peace, one of the most powerful instruments of our rising prosperity, it must be known that we are ready for war."

From his eighth annual address, speaking of the country's inability to protect its foreign commerce:

"Will it not then be advisable to begin without delay to provide and lay up materials for the building and equipping of ships of war and to proceed in the work by degrees in proportion as our resources shall render it practicable without inconvenience, so that a future war of Europe may not find our commerce in the same unprotected state in which it was found during the present."

JOHN ADAMS SAID: "AN EFFICIENT PREPARATION FOR WAR CAN ALONE SECURE PEACE"

From John Adams's special message:

"With a view and as a measure which even in time of universal peace ought not to be neglected, I recommend to your consideration a revision of the laws for organizing, arming, and disciplining the militia, to render that natural and safe defense of the country efficacious."

From his second annual message (message dealing with the relations with France):

"But in demonstrating by our conduct that we do not fear war in the necessary protection of our rights and honor, we should give no room to infer that we abandon the desire of peace. An efficient preparation for war can alone secure peace. . . .

"We ought, without loss of time, to lay the foundation for that increase of our navy to a size sufficient to guard our coasts and protect our trade."

THOMAS JEFFERSON ADVOCATED COMPULSORY SERVICE

Jefferson in his fifth annual message advocated:

"The organization of 300,000 able-bodied men between the ages of 18 and 26 for offense or defense at any time or at any place where they may be wanted."

In a letter to Monroe he advocated compulsory service.

"We must train and classify the whole of our male citizens," he said, "and make military instruction a part of collegiate education. We can never be safe until this is done."

From his eighth annual message:

"If war be forced upon us in spite of our long and vain appeals to the justice of nations, rapid and vigorous movement at the outset will go far toward securing us in its course and issue, and toward throwing its burdens on those who render necessary the resort from reason to force. . . .

"Considering the conditions of the times in which we live, our attention should unremittingly be fixed on the safety of our country. For a people who are free and who mean to remain so, a well organized and armed militia is their best security."

PRESIDENT WILSON ON THE NEED FOR THE WAR-TRAINING OF OUR CITIZENS

"It will be right enough, right American policy, based upon our accustomed principles and practices, to provide a system by which every citizen who will volunteer for the training may be made familiar with the use of modern arms, the rudiments of drill and maneuver, and the maintenance and sanitation of camps.

"We should encourage such training and make it a means of discipline which our young men will learn to value. It is right that we should provide it not only, but that we should make it as attractive as possible, and so induce our young men to undergo it at such times as they can demand a little freedom and seek the physical development they need, for mere health's sake, if for nothing more."

PART IV.

The peril of the invasion, the necessity for being prepared to meet and repel it, the certainty of overwhelming national disaster and disgrace if we stay as we are, are immeasurably greater to-day than when Washington, Adams, and Jefferson urged upon the United States the necessity for maintaining armed forces for the protection of the country. In those days war gave ample notice of its coming, and there was time to make emergency provisions to meet its gradually accumulating pressure. To-day war falls likes a thunderbolt from heaven and the first blow is often the decisive blow.

For a nation which, like our own, is totally unprepared, a modern war is won almost before it is begun. Every solemn warning uttered in the preceding, and in this the final part of this chapter, is based upon absolute facts, and he who tells this country that an effective army of defense can be raised between sun and sun is his country's worst enemy. The words of Washington are as true to-day as when they were spoken: "To be prepared for war is one of the most effectual means of preserving peace."—EDITOR.

AT the end of the Civil War we had, North and South, about three million effectives who had seen actual military service. In other words, we had a splendid unorganized reserve, out of which first-class armies could have been made on short notice; we had a very strong navy, and immense reserves of guns and other munitions of war. All these men have gone. The guns are obsolete, and we are now, with greatly increased responsibilities, absolutely without reserves, and with a regular army and militia which are, in effect, only a handful of men.

FALSE ESTIMATES OF OUR MILITARY PROWESS.

We have never had war with a first-class power prepared for war, which we have fought unaided. During the Revolution, the English opinion concerning us was divided, and at a critical stage of the war we had the invaluable assistance of France. In the War of 1812 England was engaged in the death grapple with Napoleon, and the largest number of British regular troops in this country at any one time was about 16,800. In fact, from the military standpoint, we were a side issue. England's energy and effort were concentrated against Napoleon. While we had individual, brilliant, single-ship actions at sea, at the end of the war such ships of war as we had afloat were under blockade, our coastwise commerce practically destroyed, and our commerce on the high seas suspended. We were almost universally unsuccessful on land up to the Battle of New Orleans, where for the first time the British met a foe skilled in the use of the rifle and men many of whom had been under fire.

MORAL OF THE LOSS OF THE CAPITOL IN 1812

We put into this war 527,000 different men; we abandoned our capitol to a force little more than one half that of the defenders, with a loss of eight killed and eleven wounded, and this at a time when nearly every American was familiar with arms and knew how to take care of himself in camp and field. It should also be noted that the force defending the capitol was made up largely of troops drawn from sections which had furnished some of the best troops of the continental armies. The reason for failure and general defeat on land was because we trusted to untrained, raw levies, men utterly unprepared to meet well-trained troops. The nation was responsible, and showed that it had learned little from the experience of the past and that it was fairly entitled to the criticism of Light Horse Harry Lee, who said in effect, "That nation is a murderer of its people who sends them unprepared and untrained to meet in war men mechanized and disciplined by training."

WE WERE UNPREPARED AND UNTRAINED IN 1812, AND, RELATIVELY, WE ARE EVEN WORSE PREPARED TO-DAY

The people of 1812 were unprepared and untrained. To-day we are not only unprepared, but are absolutely ignorant of the use of arms; the population has a large percentage of newcomers, who are not deeply interested in our institutions; the possibility of war is many times greater than hitherto; and the nations whom we have to fear are always ready. We are, relatively speaking, less ready than ever before.

The days of small standing armies, of slow preparation, and of still slower transportation have passed. The possible enemies of to-day are fully prepared. They control almost unlimited transport, and once in possession of sea control can land when and where they wish, certain that no well-organized or thoroughly equipped force will be ready to oppose them. The weakness of our military establishment, our total lack of reserves, or trained men, or of adequate reserves of material, are known to the last detail by all our possible antagonists, some of whom have more thoroughly trained reservists in this country than we have immediately available mobile army and efficient militia combined. This is true of both seaboards and for the country as a whole.

WHAT AUSTRALIA AND SWITZERLAND HAVE ACCOMPLISHED

The solution of our difficulties will be found in the establishment throughout the country of a system of military instructions on the general lines of that which is in force in Switzerland or Australia. Switzerland, with a small population, is able to put 222,000 men in the field in two days and to follow it with nearly 300,000 more in a week, and she has accomplished this through the operation of a system which has cost her only a little over $6,500,000 a year. The effect of this training has been generally beneficial both upon the physical well-being and economic efficiency of the individuals affected, and has increased their respect for law and order, as shown by the comparatively low criminal rate and the orderly character of the people.

THE RESERVIST WOULD PATRIOTICALLY ANSWER THE CALL TO ARMS

There has been a great deal of opposition to a reserve in this country on the ground that we shall be unable to keep track of the men. People seem to think that the American reservist is going to be a type of shirk, who will be skulking and hiding when needed for military service. Of course, if this is true, the country will be largely defenseless in time of war; but it is not true. We shall have no more difficulty than other nations have. Their reservists have gone back to the great war by tens of thousands, and done so voluntarily, as they were quite outside the reach of their country's authority. A system of general instructions in the schools, such as is in force in Australia, New Zealand, and Switzerland, will result in an increased sense of responsibility on the part of the individual toward the State and the gradual doing away with the idea that, while we all pay the routine taxes of every-day life, we are not under any obligation to pay the tax on which all others depend, namely, the tax represented by service in war. All history indicates clearly that when the citizens of a nation fail to recognize and pay this tax, the life of the nation is run.

THE IMMEDIATE MILITARY REQUIREMENTS FOR THE DEFENSE OF THE COUNTRY

To sum up briefly what we need: First, are the new organizations for the regular army as shown in the table of organization of the land forces prepared by the general staff; the necessary field artillery guns and ammunition and other reserve equipment. Second, an adequate reserve behind the regular army. Third, the artillery and cavalry organizations, field artillery guns, ammunition and reserve supplies for the militia and the reserve of men, in a word a properly balanced militia, with its reserve of men and material. Fourth, a great number of men trained to be officers of volunteers. Fifth, a gradual building up of trained enlisted *personnel* for volunteer organizations, at least sufficient to supply the coastguard troops above referred to and the additional troops needed to bring the combined regular army and militia when at war strength up to a force of at least 500,000.

MODERN WARS ARE BRIEF, AND WE CANNOT PREPARE FOR WAR WHEN WAR IS ON

Unless we take to heart the lesson so clearly indicated by the experience of others and prepare in time of peace all this will have to be done, when war comes, in the hurry and confusion of war, and it will be accomplished at a frightful cost of life and treasure and with great attendant humiliation; for this country is not prepared and cannot defend itself successfully against any well-organized force of reasonable strength, landing on its shores, without such loss and delay as would be gravely disastrous. Such a force will take and hold until we can organize and build up a sufficient military establishment to drive it out of any area it chooses to occupy. Idle talk and boasting will have no effect upon its operations.

We should strive to establish throughout the Republic a universal system of military instructions through the public schools on the general lines now in force in Australia or Switzerland. Such a system will be in every way beneficial. It will make the American youth a better citizen physically, morally, and from a patriotic standpoint. It will also greatly increase his economic efficiency through the habits of regularity and promptness which characterize military training. He will learn to respect the laws, the constituted authorities and the flag of his country. The system of reserves can be maintained very economically and, once established, both militia and regular army can be kept, in time of peace, at the lowest strength consistent with the needs of the hour, because they can be promptly filled up. We can maintain ten reservists for the regular establishment for the cost of one man on the active list. This proportion may not hold good for the militia, but still the militia reservist will be much cheaper to the State than the man who is on the active list of the militia.

THE UTTERLY VICIOUS BOUNTY SYSTEM

We must never again depend upon the bounty system. In all our wars we have been afflicted with its curse. Washington cried out against it. It was one of the great evils of the Civil War, and yet there are those who are so short-sighted and foolish as to advocate it at the present time. Its adoption means nothing but disaster and the looting of the public treasury, and indicates clearly on the part of all who propose it an entire ignorance or disregard of the teachings of history, so far as it relates to the workings of the bounty system in the armies of the Republic. Its result is merely the assemblage of a lot of men of unknown qualifications, who respond, not because of patriotism, but merely in order to secure the bounty offered. It is not only defective in that it secures a poor type of men, but it is vicious, in that it serves to place patriotism upon a straight money basis. The present reserve law is, in effect, a bounty system, which should be done away with and a straight monthly pay provided for the reservist. The enlistment contract for the regular army should be so drawn as to permit men to transfer to the reserve, which is equivalent to returning to civil life so far as freedom of occupation and movement is concerned, as soon as they are qualified.

DISCHARGE FROM THE SERVICE BY PURCHASE SHOULD BE ABOLISHED

Discharge by purchase should be abolished, and release from active service through transfer to the reserve should replace it and be dependent upon proficiency. In other words, a condition should be established under which men can be transferred to the reserve as soon as they are, in the opinion of the proper officers, well-trained soldiers. The men so transferred would continue in the reserve during the remaining period of their enlistment. In other words, if a man is enlisted for, say six years, three with the colors and three with the reserves, and qualifies for transfer at the end of a year, he would then serve five years in the reserve.

Such an enlistment contract will attract a much more intelligent class of men than at present. In other words, once this condition is established, men will come into the army who have no idea of making the military profession a life profession, but who do want to qualify to be efficient soldiers in time of war. Our general policy should be the instruction of the greatest possible number of men with the minimum of interference with their economic career.

EVERY AMERICAN BOY HAS MILITARY AS WELL AS CIVIL OBLIGATIONS AND SHOULD BE CALLED UPON TO FULFILL THEM.

We should strive to impress upon every American boy the fact that he has an obligation to the State, from the military side, quite as binding upon him as his obligations from the civil side, and that obligation is that he should do everything possible to prepare himself to render efficient service as a soldier in time of war, and the State on its side, should extend to him every opportunity to so prepare himself. The consciousness of this obligation will make our men more valuable as citizens, will give them a higher sense of responsibility toward the State, and will make them more conservative with reference to war, as they will appreciate fully that if war devolves upon them it is an obligation which they must fulfill.

Peril of Our Military Unpreparedness

DURING the short time since the above was written the great European war has continued with ever-increasing violence. If there has been one lesson which has stood out above all others, it has been that the successful conduct of a modern war means organization in the greatest detail of the resources of the nation in men and material. Nothing must be left, as we are doing, to chance preparations, to be made, no one knows how, after war is upon us. It means preparation, in time of peace, of vast quantities of explosives, great quantities of small arms, machine guns to an extent never before dreamed of, mobile artillery, and, above all, artillery ammunition of all calibers, in amounts which surpass the dreams even of the artillerists of the days before this war. A small, highly trained army, such as was formerly considered adequate to meet the national emergencies pending the preparation of a larger force, would be of little or no avail in holding hundreds of miles of frontier or seacoast.

The lesson of the great war, so far as men go, is to the effect that a nation must have its male citizens instructed in the use of arms to an extent which will render them efficient soldiers. It must have prepared in advance its reserves of arms and ammunition, in quantities sufficient to equip the huge force of citizen soldiers which must be suddenly raised to meet the on-rush of a modern war. These forces of men are almost useless unless there are well-trained officers ready to take charge of them. Officers must be trained in time of peace. We have not enough to-day for our small peace army and militia at full strength.

It takes a long time and extensive machine plants to manufacture the mobile artillery of to-day, ranging, as it does, from the three-inch gun to the huge howitzer now present on the battlefields of Europe. Not only must guns be built and vast supplies of ammunition provided, but all the paraphernalia incidental to their handling and instalment must be made ready prior to the outbreak of war. Men must be instructed in their use. Are we taking any steps in the direction of these preparations which no amount of money, enterprise, energy or patriotism can provide except with such delay as would be fatal to the successful conduct of war?

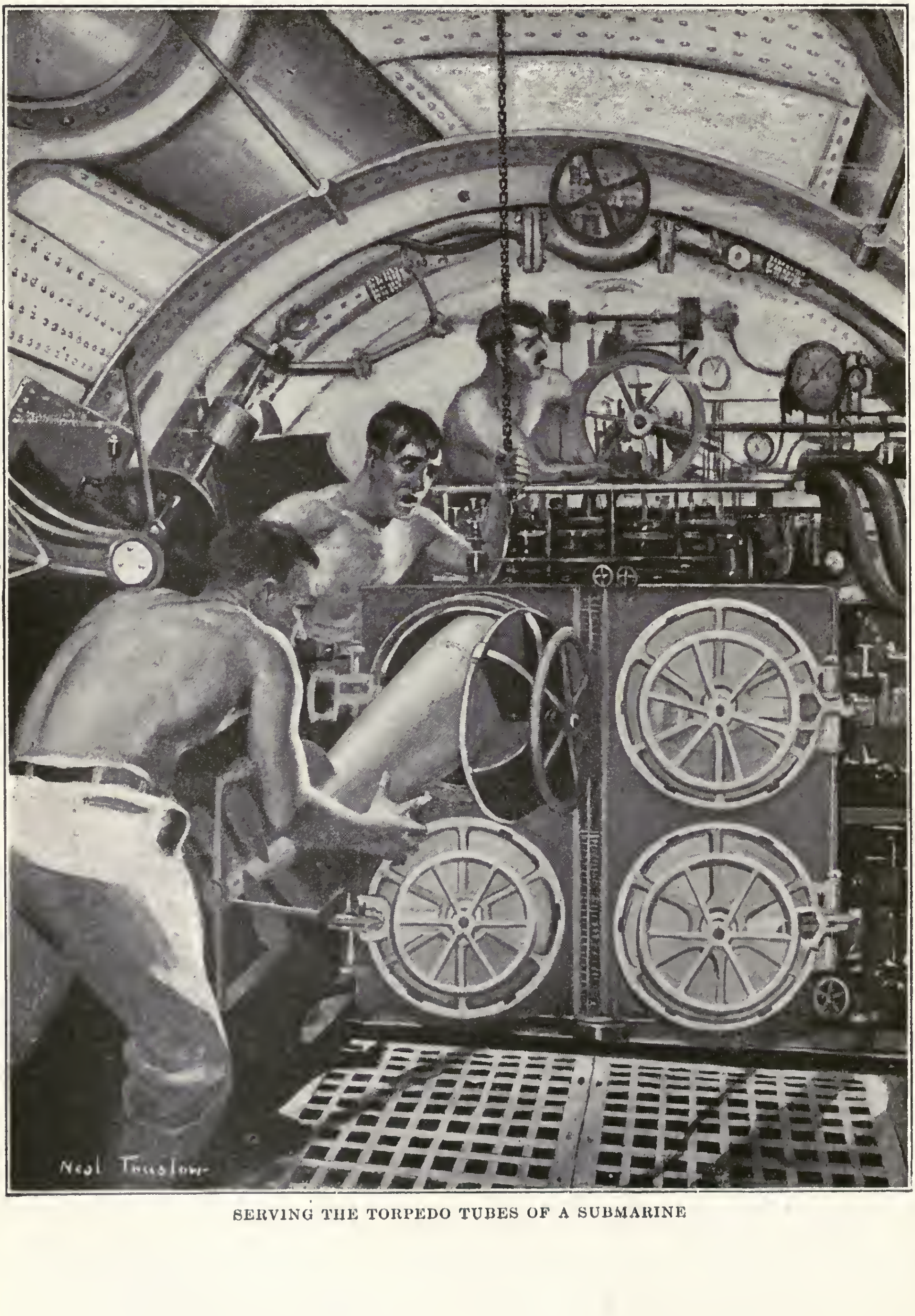
The answer is NO. Our half-filled regiments, *our reserve of regulars of sixteen men!* Our puny supply of field artillery ammunition, the partially filled magazines of our seacoast batteries, our seacoast cannon on carriages which strip them of 40 per cent of their effective range and open our ports to bombardment by superior naval ordnance, without power of reply; our incomplete fire-control systems, our great shortage in searchlights, our Navy without reserve of men, without a single battle-cruiser, without adequate submarines—either in number, speed, or size; our alarming shortage of field artillery guns, and our total want of reserve officers to train our volunteers, our lack of preparation in the war of aeroplanes, in both Army and Navy—all point to failure to have taken heed from the lessons of the times, and to failure to have made even a reasonable degree of preparation. Anti-enlistment societies and leagues to induce emasculated young men to swear that they will not fight, add to the gravity of the situation. It is time—high time—to give heed to the dangerous pass to which ignorance, conceit and an unintelligent military policy have brought upon us.

It is reliably reported that the consumption of field artillery ammunition by the Teutonic allies has exceeded three times their maximum estimates. The puny reserve of the United States in the way of guns and ammunition is insignificant in amount. *The ammunition reserve reported in the previous pages is little more than a day's consumption by a group of allied forces.* Representatives of the fighting countries are beseeching our arms factories and ammunition factories for supplies. Limitless credit stands ready to pay practically any price we demand for high explosive shell, fuses, shrapnel, for small arms, and for certain forms of high explosives. The great war has lasted for a long time. Money for the purchase of supplies in the United States has been practically limitless in amount. So far as the United States is concerned, a condition of profound peace has prevailed, and there has been not the slightest interference with the activity of her factories or powder works or in the manufacture of the desired supplies.

Has the United States been able to meet the demands made upon her? The answer is most decidedly NO. The output in shrapnel and explosive shell, judged from the standpoint of consumption in the great war, has been practically negligible. Is this because the United States is making demands upon private arms plants to fill up her own empty arsenals? The answer is emphatically NO. She is doing little or nothing in this direction. *She stands as she has stood for years—unprepared, unready, apparently unthinking, and without realization of the great danger which has come upon her through lack of reasonable preparation.*

Every American should draw this lesson from what has happened and is happening, so far as the production of military supplies is concerned, viz., that this great country—with all its mechanical development, with its industrial energy undisturbed by war, with every incentive to production in the way of prices, which know no maximum—has been unable to contribute materially to the conduct of the war, so far as small arms, shrapnel, high explosive shell and guns are concerned. If she has been unable to do this, when undisturbed, what would have been the condition had we been attacked, especially had the attack fallen upon the Atlantic seaboard and made lodgment where it surely will, namely, near the vitals of the country—which means somewhere between Boston and Washington, probably in the vicinity of New York? It is not difficult to answer this question when it is remembered that a circle within a radius of one hundred and sixty-five miles, with New York as its center, covers the bulk of the arms-making and powder-producing facilities of the United States—nearly all of them within easy reach of the seacoast.

The present condition ought to bring home to every thoughtful American a realization of the grave danger to the country from a continuation of our present condition of unpreparedness and a realization of the folly—indeed worse than folly—involved in depending upon haphazard expedients to meet a degree of organization and preparedness such as the world has never before known. Can we not take warning from the lessons of the hour, or must we, without an adequate Navy and without any armed force worthy of the name (speaking in the terms of modern military preparedness) drift on unthinkingly, trusting ignorantly to the fallacy that none of our possible enemies will be free to attack us? We have been attempting to dictate to great countries their method of conducting war. We are absolutey unprepared to bring any form of pressure other than moral upon those with whose methods we disagree. A continuance of the present condition is dangerous to the very existence of the nation. Unless we prepare to defend our heritage we may lose it.



SERVING THE TORPEDO TUBES OF A SUBMARINE

Chapter XL.

THE SUBMARINE—THE NEW TERROR OF THE SEA

Ingenious Construction and Appliances by Which the Submarine Has Obtained Its Present Efficiency

BY R. H. M. ROBINSON*

ADMIRAL SIR PERCY SCOTT of the Royal Navy, in his now famous letter to the *London Times* of June 5th, 1914, took the strongest possible stand for the submarines and, incidentally, against the battleships, concluding his letter with the statement: "In my opinion, as the motor vehicle has driven the horse from the road, so has the submarine driven the battleship from the sea."

The menace of the submarine arises, first from her invisibility, and, second, from the fact of the difficulty of providing against the damage which will result from a blow from the weapon she carries.

Sir John Biles, LL.D., in a recent paper before the British Institute of Naval Architects, says:

"There can be only two forms of defense: first, the destruction of the submarine by other vessels, submarines or others; second, the protection of the bottom of the surface ships from the effect of under-water attack. The first, the destruction of the submarine, is obviously not the work of a battleship or large cruiser, but must be left to some vessel of the same order of size as the submarine. This destruction must be sought on the surface when the submarine is not submerged, for it seems improbable that a submarine will be able to chase another effectively under the water. [This has happened.—EDITOR.] In any case, the submarine will be dangerous to the large surface ships until it is destroyed, and, as the means of destruction are not yet certainly at hand, the question of effectively protecting the battleship against under-water attack seems to be deserving of consideration, unless someone is ready with a real reply to the submarine."

A great deal of attention has been given by naval architects to providing, in the dreadnoughts, protection against the automobile torpedo, with astonishingly small success up to the present time.

For a ship at anchor a reasonable protection against the possibility of damage from the automobile torpedo may be obtained by the use of torpedo nets, although the development of the net cutter, attached to the torpedo's nose, has made even this uncertain. It is almost impossible to use a torpedo net on a ship under way. In the first place, it enormously decreases the speed and handiness and enormously increases the fuel consumption of the vessel wearing the net, and, in the second place, the mere fact that the vessel is under way causes the bottom of the net to rise to the surface and thereby largely does away with the advantage.

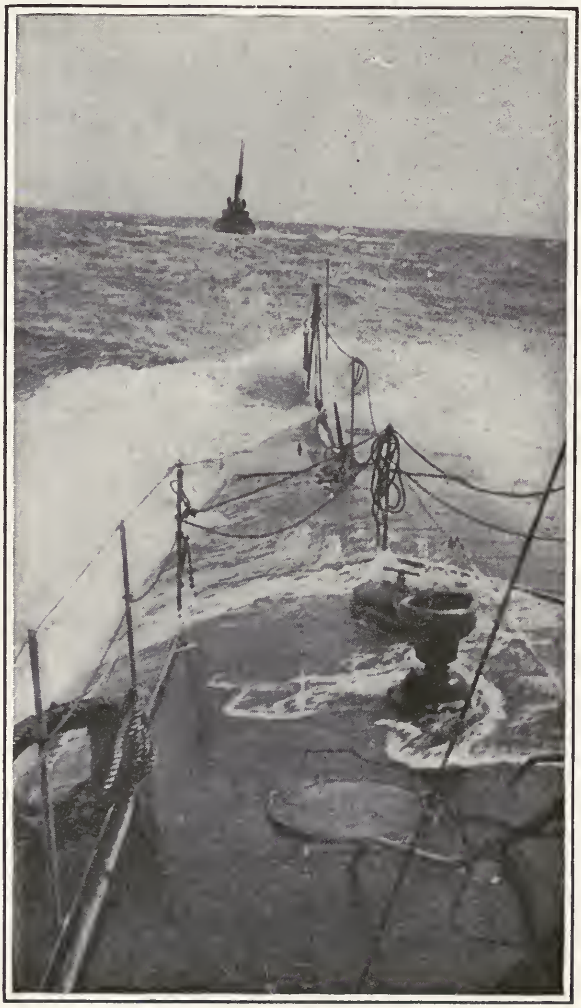
This being the case, the only remaining possibility is to include within the structure of the vessel itself provision against damage by attack from a torpedo. Unfortunately, it is much easier to increase the power of the torpedo than it is to increase the defensive protection built into the hull of the dreadnought, with the result that, if any given class of surface ship has protection against the then existing torpedo, it is fairly easy to vitiate the value of this protection by increasing the power of the torpedo.

* Abridged from an address printed in the *Journal* of the Franklin Institute.

Briefly, the provisions which may be embodied in the design of a ship against the damage of the torpedo comprise under-water armor, additional compartmenting, and compressed-air installation for localizing the inflow of water. The under-water armor, on the face of it, looks like a good solution of the problem, but, as a matter of fact, it is of very little use to put under-water armor on the external hull of the ship. A torpedo explosion has a crushing effect, which results in tearing the riveted joints. The rivets seem to be attacked in detail, and an increase in the amount of metal applied externally does not do away with the necessity for riveted joints, and, if under-water armor were put on the ship in the same manner as the above-water armor, there would be *no* connection at the joints, since the armor above water is simply plastered up against a backing plate.

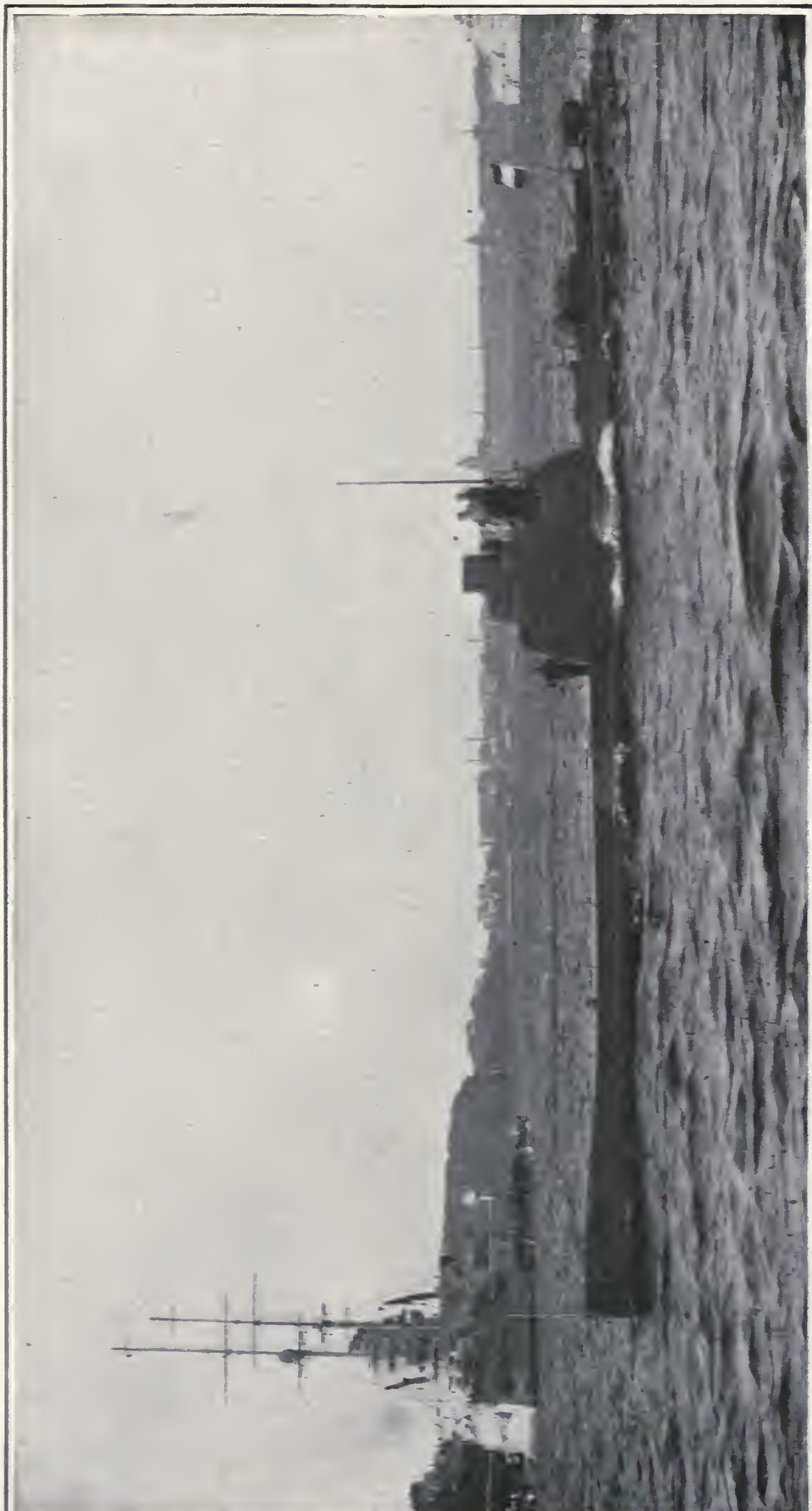
Careful and minute compartmenting, of course, covers a large number of possibilities, but provides only against the damage done by the torpedo in localizing the effect of the damage.

The compressed-air installation is a means of preventing water entering the body of the ship in too large volumes as the result of any damage done by a torpedo. It has to be specially applied, utilizing what is called the "backing up" method, using pressure in the adjacent compartments of varying degrees so as not to damage the ship's structure by the air-pressure.



DRIVING INTO A CHOPPY SEA

The best solution of the problem is a com-



ONE OF TWO GERMAN-BUILT SUBMARINES FOR THE AUSTRIAN NAVY. LENGTH, 142 FEET; BREADTH, 12 FEET 4 INCHES; DRAUGHT, AT SURFACE, 9 FEET 8 INCHES. DISPLACEMENT: SURFACE, 235 TONS; SUBMERGED, 300 TONS. SPEED: SURFACE, 12 KNOTS; SUBMERGED, 8.6 KNOTS bination of the three methods referred to above:

Proper compartmenting, under-water armor not located on the external hull of the ship and so designed as to give a maximum strength to the structure of the ship, and a graduated compressed-air installation for checking the water after it gets into certain compartments which cannot be prevented.

The submarine at present must carry two entirely distinct and separate sources of power, one for surface work and one for submerged work, and the storage battery per unit of power is very heavy.

The essential features of any submarine from a military point of view are surface speed, surface radius, submerged speed, submerged radius, and armament.

SURFACE PROPULSION.

The early successful submarines had gasoline engines. These were later superseded by heavy oil engines of the Diesel cycle—first, four-cycle engines, and, more recently, two-cycle engines, of which several types have been used. None of these can be said to be perfect yet, but great improvements have been made and are still making.

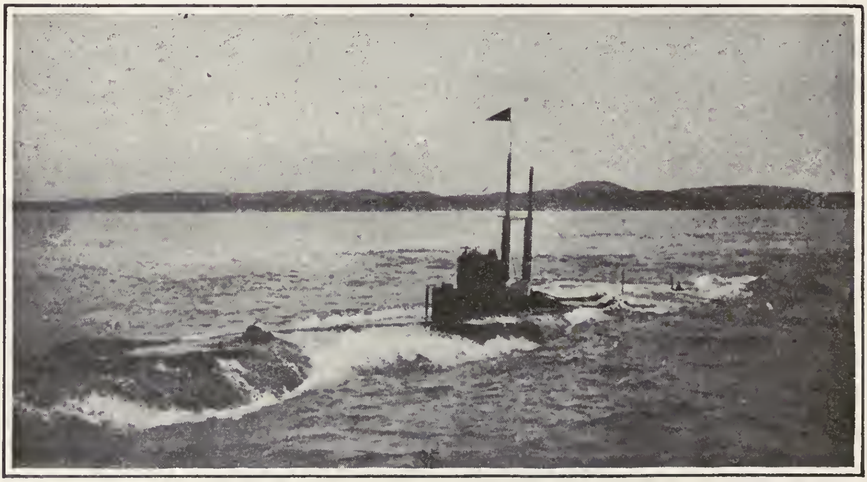
The safety and success of the attack of a submarine depend to a great extent on her ability to approach the enemy while submerged and to remain submerged for a long while. In a high-sea engagement the enemy's fleet may naturally be assumed to be under way at some speed, so that the development of the sea-going type, to which some reference will be made later, will logically include some increased submerged speed and considerable increased submerged radius for maneuvering in the vicinity of the enemy for a long period.

Increased submerged speed and increased radius of action submerged will make the batteries proportionately larger than are at present used.

In the case of the sea-going type of submarine the design of the storage battery requires study in order to get the battery best adapted to obtain the maximum speed submerged and the greatest radius of action along with a reasonable length of life.

As in all other types of naval ships of war, the submarine has two general rôles, defensive and offensive.

Defensive operations include:



LIFTING TO A SEA WHILE RUNNING AWASH

Harbor defense, which, at the beginning of submarine development, was regarded as a primary duty.

Coast defense, an amplification of harbor defense, rendered possible by increase of radius of action and habitability, in virtue of which the submarine may be used to prevent landing in force or other operations along the coast anywhere within limits, equal, roughly, to nearly half their radius of action.

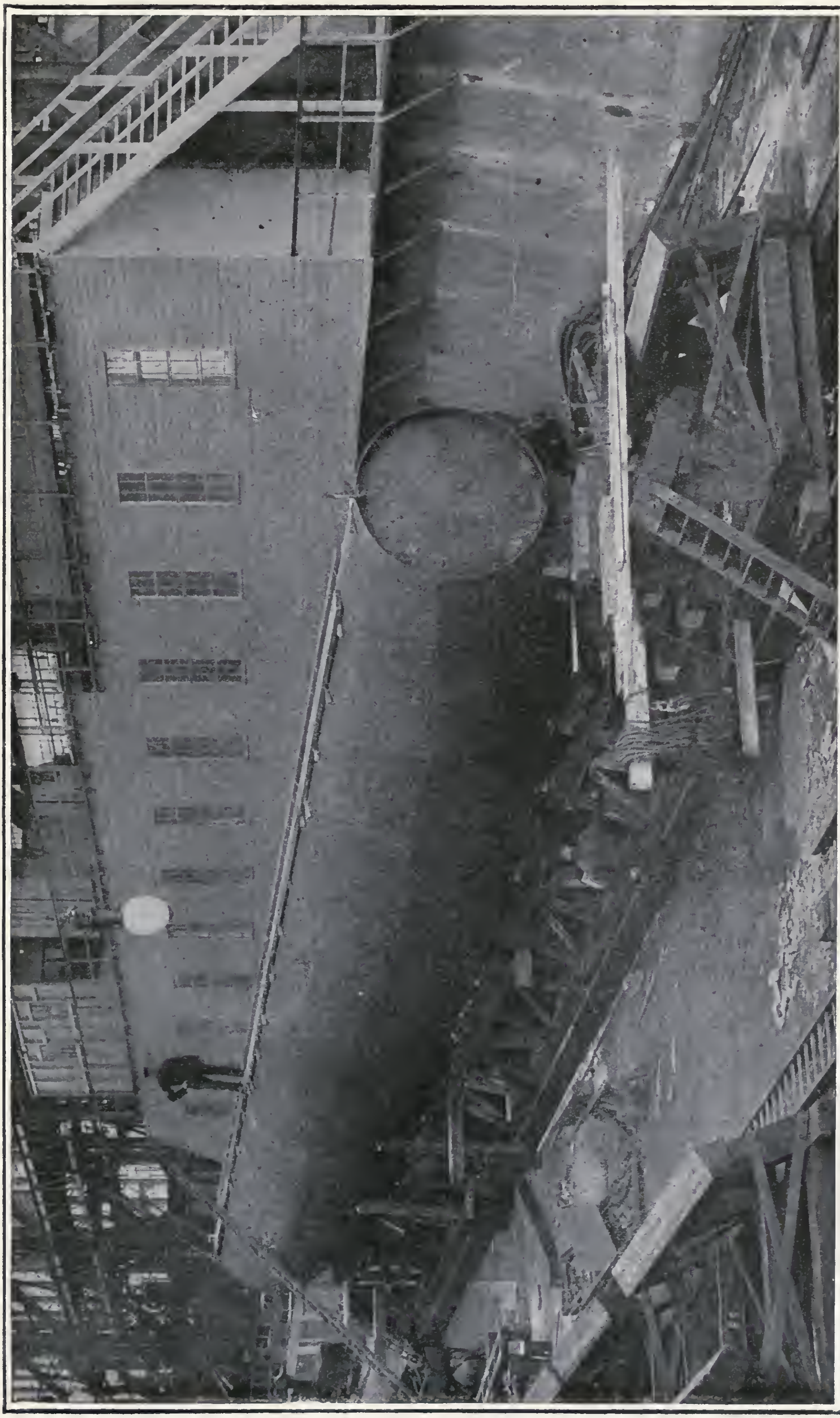
Offensive operations include:

Destruction of vessels with which the enemy attempts to either hold or control the sea or to carry on military operations.

Attacking the enemy's ships and ports.

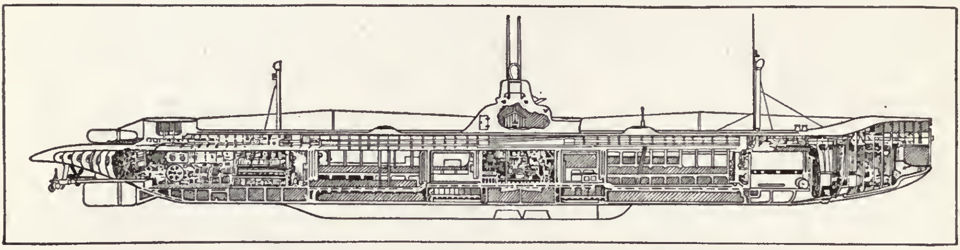
Operations in conjunction with the fleet on the seas.

One occasionally reads of submarines of destroyer speed, which to the layman appear entirely practicable and to the military man highly desirable, but to the submarine man it seems impossible, and certainly is to-day,

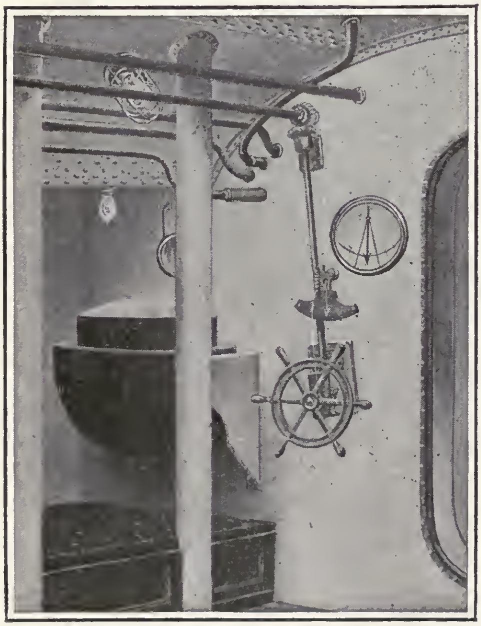


THE INNER CYLINDRICAL SECTION OF THE LATEST SUBMARINES FOR THE AUSTRIAN NAVY. THIS HULL CONSISTS OF NINE CIRCULAR WELDED SECTIONS. UPON THIS IS BUILT THE LIGHTER OUTSIDE HULL OF SURFACE TORPEDO-BOAT FORM meaning, as it does, about 30 knots on the surface.

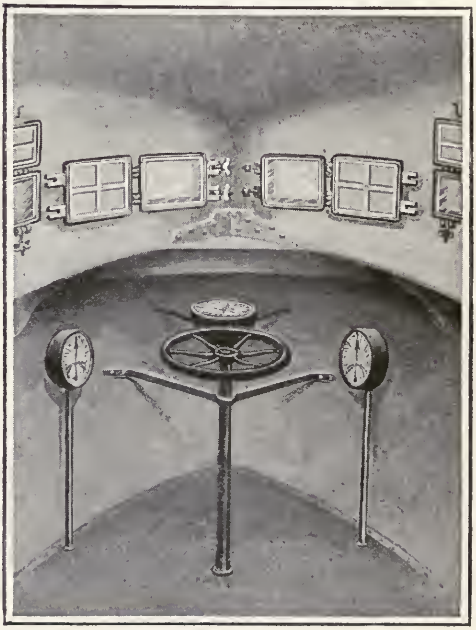
All of the submarine operations so far chronicled during the European war may be said to be in the nature of naval raids, as distinguished from strictly tactical evolutions. The surface radius of even the smaller types of submarines is quite sufficient for any of the raiding operations of which we have read.



LONGITUDINAL SECTION THROUGH A TYPICAL GERMAN SUBMARINE



THE NAVIGATING COMPARTMENT OF U.S.S. "G-2." IN THIS SPACE ALL CONTROLS OF THE SUBMARINE ARE LOCATED. OUR ILLUSTRATION SHOWS THE GYROSCOPE COMPASS, THE STEERING WHEEL, THE RUDDER INDICATOR, AND THE INDICATOR SHOWING THE ROLL OF THE VESSEL. THE DOOR LEADS INTO THE TORPEDO ROOM. IN A VERY SMALL AMOUNT OF ROOM A REMARKABLE NUMBER OF INSTRUMENTS MUST BE INGENIOUSLY DISPOSED IN THIS MANNER.

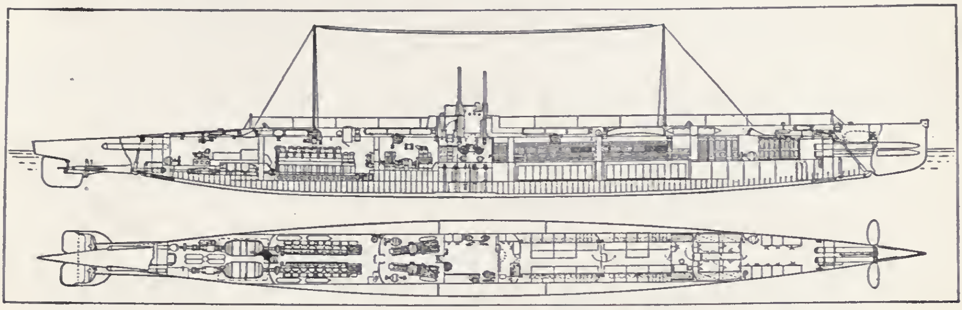


IN THE CONNING TOWER OF U.S.S. "G-2" IN THIS SMALL COMPARTMENT ARE DUPLICATES OF ALL GAGES, INDICATORS, AND OPERATING DEVICES WITH TELL-TALE CONNECTIONS TO THE MAIN OPERATING ROOM. IN THE FORWARD END, AS SHOWN, ARE FOUR WINDOWS WHICH GIVE THE NAVIGATOR WHEN THE BOAT IS RUNNING AWASH A VIEW OF THE HORIZON. WHEN TOTALLY SUBMERGED THESE PORTS ARE PROTECTED BY STEEL SHUTTERS WHICH ARE SCREWED TIGHT

Undoubtedly the submarine proceeds on the surface to a point where previous reports indicate that the enemies' ships are, or are apt to be, then comes to the awash conditions and waits. If his quarry is sighted, he may submerge and await him, or so direct his course as to cross that of the enemy.

The fact that he was a long way from his base was, at least in the early days of the war, an undoubted benefit to the submarine, as no one suspected him of being there, but, even if they did, his invisibility when submerged and his close approach to it even on the surface made him reasonably safe, though on a long run the crew might not be luxuriously comfortable.

It is quite possible that the submarine will continue to be most heard from in this form of operation, to which its inherent qualities are well adapted. The moral influence of this hidden danger and its constant wearing away of a near or far blockading fleet or one by a 600-foot target is a little under one degree. When the periscope height is 3 feet above water the sea horizon is distant 4,000 yards, and when one foot is exposed becomes 2,200 yards.

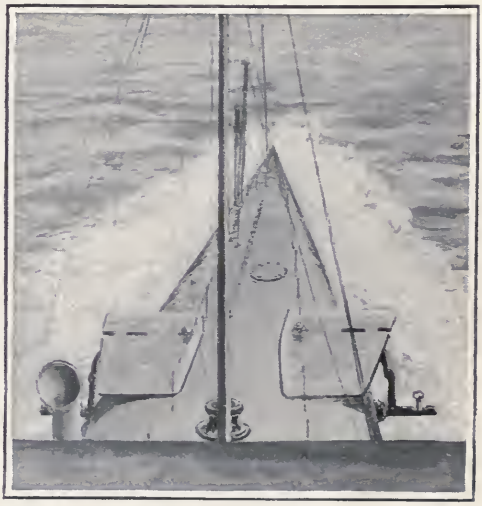


LONGITUDINAL AND PLAN VIEWS OF A SUBMARINE OF THE LAURENTI TYPE

patroling the seas to keep them open, is not to be underestimated in its effect on the fleet itself or the public whom the fleet represents.

The question of the tactical use of the submarine in groups is, however, of importance and will become increasingly so. The maximum range for successful attack of a submarine is limited by the circle of visibility. The sea horizon, viewed from a periscope 20 feet above the surface, is just 10,000 yards. At this range the horizontal angle subtended

THE BRIDGE OF U.S.S. "G-2." AS FITTED FOR SURFACE CRUISING. THIS STRUCTURE IS MADE OF PORTABLE PARTS, FLOOR, STANCHIONS, RAILS, STEERING WHEEL, COMPASSES, CHART TABLE, SEARCHLIGHT AND VENTILATOR, ALL OF WHICH CAN BE REMOVED IN A SHORT TIME AND STOWED BELOW DECKS OR IN THE HOLLOW SUPERSTRUCTURE, LEAVING NOTHING BUT THE BARE CONNING TOWER



FORWARD DECK OF U.S.S. "G-2." SHOWING TWO OF THE LATERAL PLANES OR DIVING RUDDERS BOLTED TO THE DECK FOR SURFACE RUNNING. THE PLANES WHEN OPERATING FOR SUBMERGING ARE FOLDED OUTWARD AND LIE HORIZONTALLY ON A SHAFT WHICH IS CONTROLLED FROM EITHER THE CONNING TOWER OR OPERATING ROOM. THE WIRELESS MAST IS PORTABLE, AND WHEN THE VESSEL IS IN SUBMERGING TRIM IS LASHED TO THE DECK

The practical difficulties of finding and then firing at specks on the horizon are so many as to compel the submarine to take advantage of her invisibility and immunity from gunfire, to push the attack to close quarters—2,000 yards or less—or, if unable to do this, then to hold fire until more favorable opportunity offers.

Before entering into a discussion of the tactics of submarines, one should first consider the various means of communication between submarines and scouts or shore stations before sighting the enemy, and between submarines themselves after sighting the enemy.

On the surface the submarine has the following means of signaling, the order of their estimated value being as given:

Radio (day or night).
Searchlight (day).
Searchlight (night).
Shape signals (day).
Flag signals (day).
Wigwag or semaphore (day).
Very's start (night).
Wigwag torch (night).

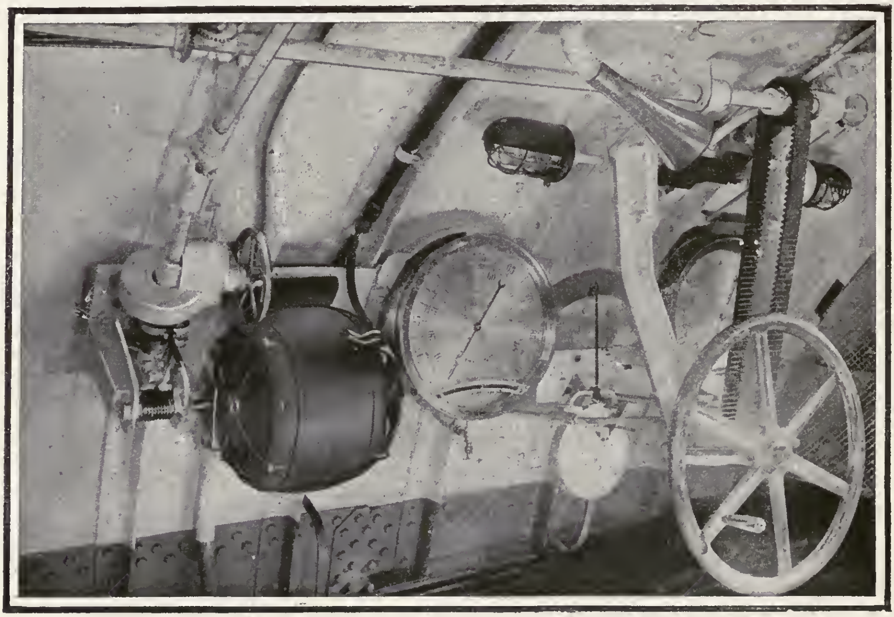
Submerged the submarine has the submarine bell signal apparatus, and, more recently, the Fessenden oscillator, which performs the same function even more satisfactorily.

The submarine bell can be used between submarines or between submarines and tenders or shore stations, at distances varying with the attending circumstances. Under the most favorable conditions (i. e., all machinery stopped) signals may be exchanged at distances up to 8 miles with fair success. With machinery running, and under the most unfavorable conditions (i. e., boats running in opposite directions), signals may be exchanged at distances up to one half mile.

Of the various means of signaling, none can be used in the face of the enemy without danger of betraying the presence of the submarine group.

As the submarines of the types at present in existence have a submerged speed probably inferior to the surface speed of the enemy, and as in that case the enemy can keep out of torpedo range, it is important that no signals be sent that might give the enemy warning of the presence of submarines.

For the purpose of tactics, submarines may be divided, according to their capabilities, into three classes, viz.: harbor defense, coast defense, and sea-keeping offensive submarines.



DIVING WHEEL AND DEPTH PRESSURE GAGE. THE HAND WHEEL OPERATES THE DIVING RUDDERS USED FOR STEERING IN A VERTICAL PLANE. IN FRONT OF THE WHEEL IS A GAGE WHOSE POINTER SHOWS THE DEPTH OF THE BOAT. THE CURVED DARK LINE BELOW POINTER IS A SPIRIT LEVEL WHICH SHOWS THE INCLINATION OF THE BOAT.

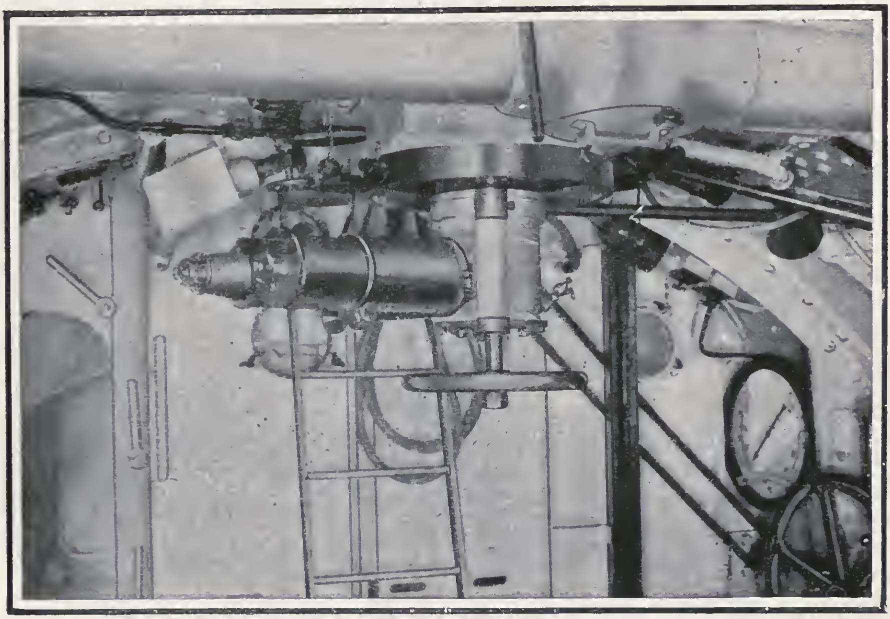
The tactics of a group of harbor defense submarines are simple. Their limited submerged radius and speed do not enable them to operate far from the entrance of the harbor which they are protecting. The lack of reliable under-water communication makes it impossible to change plans of action, once their group is submerged, without giving the enemy a clue as to the submarine's whereabouts. Any form of under-water signaling device in use at the present time can be accurately located in direction by the enemy. The apparatus for locating the direction of submarine signals is installed on practically every modern ship. For this reason alone the detailed plans for a group of harbor defense submarines must be made explicit enough to cover in advance every plan of an attack by a determined enemy.

Each boat of a group would be assigned a certain area outside of the harbor as its zone of defense, these zones to be so selected that all approaches to the harbor are protected, and to be at such a distance from the point of defense that the enemy will never come within gun range.

Most of our harbors lend themselves naturally to such a method of defense by the form of the channels leading to them or by the presence of islands in the vicinity. A harbor defense group, having received warning from scouts or shore stations of the movement of the enemy off the coast, immediately proceeds to the entrance, leaving the tenders inside the harbor. Submarines anchor in the "awash" condition, radio up, in the centers of their zones, and keep a lookout for the enemy. By sub-dividing the total area outside of each harbor into small squares and using short code words to designate squares and directions, scouts in touch with the enemy can easily keep the waiting group of submarines informed as to the enemy's movements.

The waiting submarines, having been warned that in all probability the enemy will pass close to their harbor, are prepared and immediately get up their anchors and submerge as soon as smoke appears on the horizon.

With a moderate amount of their periscopes exposed, a submarine can easily see a large ship in clear weather for a distance of 7 or 8 miles. The submerged group, each boat in its zone, remains stationary until the movements of the hostile fleet are definitely ascertained. By the arrangement of the zones the enemy must pass close to one submarine; the other boats would then move over toward the enemy at such speeds and with just periscope exposure to enable them to get within torpedo range without detection. Once within torpedo range, they keep their periscopes exposed and make all speed possible to get within easy torpedo range to fire their torpedoes at that part of the enemy's formation previously assigned to them. In this last maneuver each boat would act regardless of the other boats and must take the risk of collision. On this final charge the submarine bells may be rung continuously to assist the submarines to keep clear of each other. Having fired their torpedoes, the boats submerge totally, and reload their tubes if they have spare torpedoes. During the period of reloading they may run at such depths as would enable them to pass under the enemy's ves-



EYEPIECE AT BOTTOM OF PERISCOPE. THIS SHOWS THE ROOF, NOT THE FLOOR, OF THE SUBMARINE INTERIOR. THE HORIZONTAL EYEPIECE AND THE VERTICAL TELESCOPE TUBE ARE ROTATED BY MEANS OF THE HAND-WHEEL WHOSE PINION ENGAGES AN INTERNAL GEAR RING sel, or, if the depth of the water permits, they can rest on the bottom until the reload is finished, when they should return to the surface to inflict such further attack as is possible. A submarine, having exhausted her supply of torpedoes, has still a most formidable weapon in her ram. This has been proved in several instances where accidental ramming has occurred.

The harbor defense group, having exhausted its means of offense, should return to the tender, submerged, if necessary, under cover of darkness, to replenish torpedoes and storage batteries.

For the night defense of the harbor submarines remain on the surface in their zone, being used in this manner most effectively as surface torpedo boats. The tactics on the surface as torpedo boats are similar to the tactics employed in surface torpedo craft, though as such they are somewhat less efficient, owing to their lesser speed.

The distinction between a coast defense and a harbor defense submarine lies principally in the greater submerged and surface endurance, the greater submerged and surface speed, and the better habitability conditions of the coast defense boat, which gives it a wider range of action than its smaller sister.

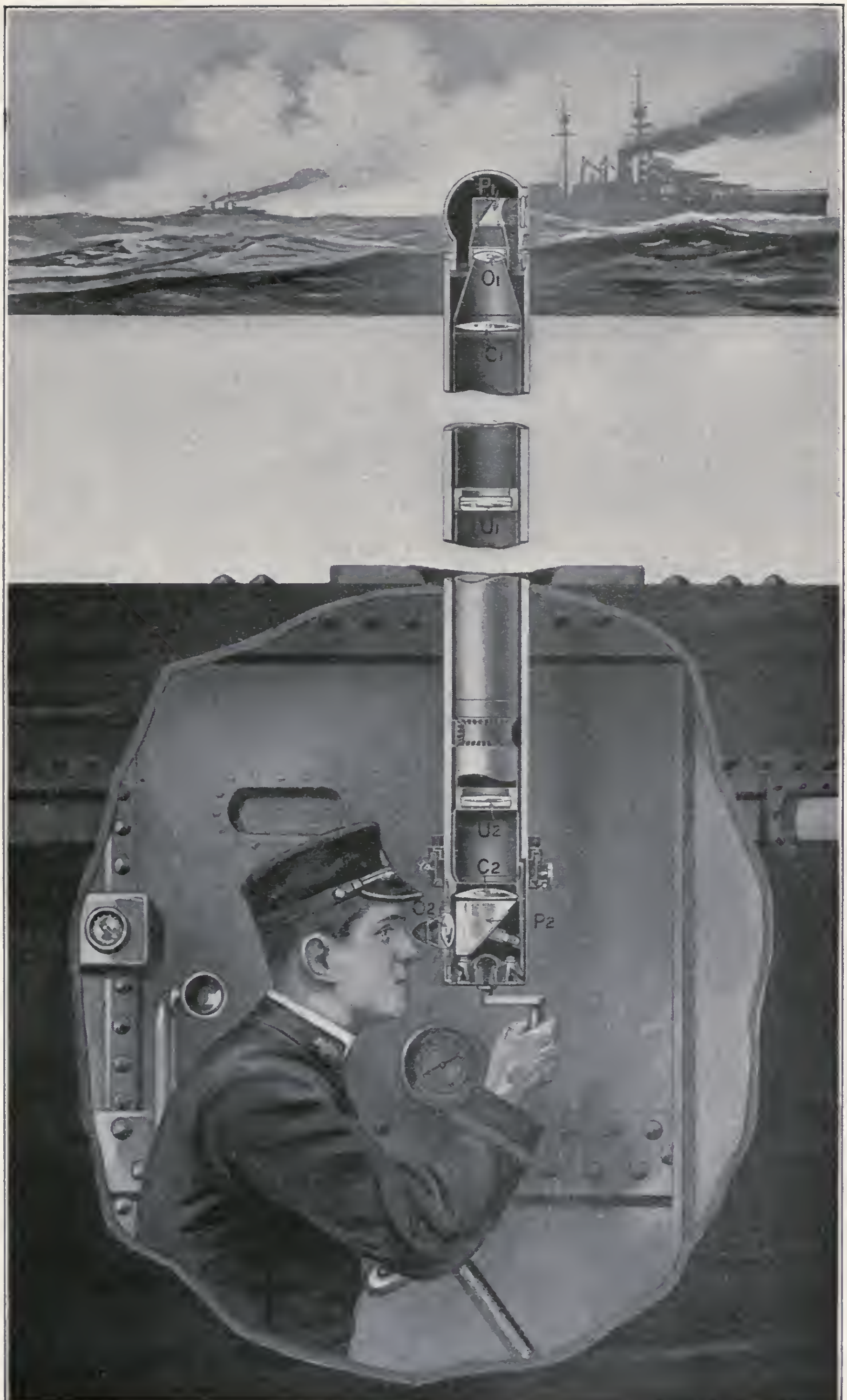
The "Periscope"—The Searching Eye of the Submarine

THE mysterious and sensational performances of the foreign submarines have excited much wonderment in regard to how this stealthy scourge of the sea finds its way about under water, and locates its prey with such deadly certainty; and although pictures of this vessel, with its mast-like spying tube, the periscope, extending up from below to just above the surface of the water, are familiar, few realize the vital importance of this contrivance or the slow development that it has passed through before becoming the efficient piece of apparatus that it is today, and which is so essential to the successful prosecution of underwater attack. The power of the submarine is vested in its invisibility; but while the submarine is hidden from the enemy it must itself be able to see everything that is going on in order to solve its problems of offense and escape.

Something of the history of the periscope was told recently in the year book of the *Schiffsbautechnischen Gesellschaft* by Dr. Weichert, director of the Goertz optical works, from which publication the following facts are obtained. It is stated that the oldest known device for viewing objects from a concealed position was by means of a telescope with a doubly bent tube, which device was invented by Helvelius in the seventeenth century, and this may be regarded as the progenitor of the periscope. It may be noted that at long range this instrument gave a field almost too small for practical purposes.

The simplest sighting apparatus for submarines was invented in 1854, for it must be remembered that the work of experimenting on submarine vessels has been going on for a hundred and fifty years or more. This apparatus consisted only of a vertical tube that had a plane mirror set at each end at an inclination of 45 degrees from the perpendicular, and it contained the fundamental principle involved. In 1872 totally reflecting prisms were substituted for the reflecting mirrors, but in both of these forms it was necessary to use very short and wide tubes in order to cover a sufficiently wide field of view for working purposes.

The next step in the evolution of the periscope was to employ a system of lenses in connection with the prisms; and this construction is shown in the illustration, which, however, is of a later and much improved pattern. Following out the optical development of the instrument at this point, the question of the reversal of the image is provided for now by means of an "erecting prism," which is located near the lower end of the apparatus. As shown in the picture, the part of the instrument tube that carries this erecting prism is connected by means of gears with the rotating top of the instrument, that carries the upper prism and the objective, in such a manner that the erecting prism turns with half the angular velocity of the top, which compensates for the difference of azimuth between the rotating upper prism and the lower fixed prism. As its name indicates, this erecting prism reverses the image as it is projected through the instrument, and presents it to the observer in its natural position. In the earlier forms the instrument was in the form of a single long tube, and in order to allow it to be raised and lowered, and also turned in different directions, it was fitted in a watertight stuffing box in the top of the steering tower; but it was found that the pressure of the water against the tube, when the vessel was mov-



THE "PERISCOPE" THE SEARCHING EYE OF THE SUBMARINE

SUCCESSFUL SUBMARINE ATTACK AT CLOSE RANGE ing, bent the tube backward to some extent and caused it to bind so tightly in the stuffing box that it was very difficult to turn it in order to make observations through any considerable angle; so an improved construction was devised in which the periscope tube proper was contained within a heavier fixed protecting tube or sheath within which the periscope turned. Further improvements resulted in a construction in which only the head of the instrument, carrying the upper prism, is revolved, the connection with the erecting prism below being retained.

The head of the periscope can be turned in any direction by the handle at the bottom of the instrument, and the image of any object in sight is received by the prism P_1, and by it transmitted through the system of lenses shown to the lower fixed prism P_2, by which the image is reversed so that it is viewed in an upright position by the observer within the vessel who looks through the eyepiece O_2.

The working parts of the instrument are carried in a heavy tube, fixed to the steering tower, and strong enough to withstand the pressure of the water against it when the boat is moving. The construction is such that when not in use the instrument can be lowered into the hull.

To enable the vessel to be steered by the observations made by the periscope, the officer in charge must have some means of knowing the exact relation of the line of sight of the instrument with the axis of the craft, and various devices have been employed for the purpose. In the earlier models this was accomplished by a mark on the tube and a graduated circle inscribed on the deck, and also by a second graduated circle and index inside the tube, and visible to the observer. A later system, adopted when the lower part of the tube is fixed and the upper part movable, makes use of two glass plates within the tube. One of these plates is inscribed with a graduated circle and is attached to the fixed lower part of the tube, while the other plate bears an index mark and turns with the upper part of the tube.

The magnifying power usually found in these instruments is 1.5, but by the employment of special devices a power of from 5 to 6 magnifications can be secured temporarily. A more recent instrument contains a novel and valuable improvement that gives a sharp magnified image of the object sighted, surrounded by a view of the entire horizon on a smaller scale. This is accomplished by means of an annular lens that is located over the objective. Lenses of this sort were first employed in topographical work by Col. Mangin of the French army. Long continued observation with a periscope, using but a single eye, becomes fatiguing, and considerable relief can be secured by adjusting the instrument to throw the image onto a ground glass screen, where it can be viewed comfortably; but this plan can only be adopted in very clear weather, and even then the grain of the glass screen is liable to obscure distant objects.

The very latest designs have a compass and a telemeter scale, by means of which the distance of the object can be determined ingeniously, combined with the periscope.

The development of the periscope has made the submarine practical, and indeed it is this very question of directing the movements of the vessel when under water that has been responsible for much of the delay that has occurred in the successful development of the submarine. That the problem has been quite successfully solved is apparent from recent performances in foreign waters, for it has been demonstrated that by the aid of the latest directional instruments the boat can dive below the surface when beyond the sight of an enemy, and easily find its way into the midst of hostile fleets, or into crowded harbors.

Methods of Control of the Latest and Most Dreaded Type of Warship

BOTH in its moral and material effects the submarine has certainly established itself for all time as one of the most formidable weapons of naval warfare. We say this without any reference to the sinking of unarmed merchant ships; for that is a savage abuse of an otherwise efficient and legitimate instrument of warfare. It is difficult to say whether in its moral or material effect the submarine has proved more useful in the present war. Its material results are seen in the sending to the bottom with a single blow of cruisers and battleships, some of which were supposed to be able to take the blow of at least two torpedoes without foundering. Its moral effect it is impossible to gage; but undoubtedly the dread of this potent craft has exercised an enormous effect upon the strategy and tactics of the European war.

By the courtesy of our contemporary, *The*

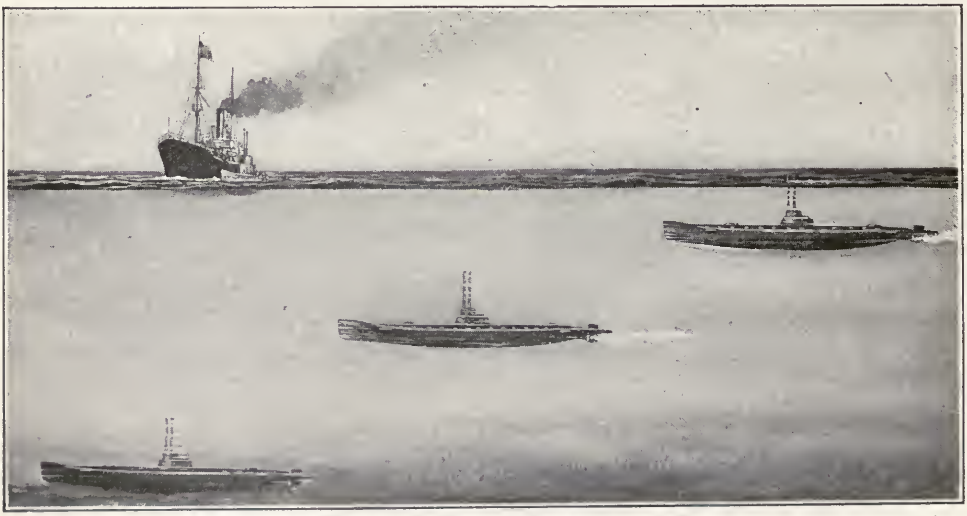
Sphere, we reproduce a set of illustrations showing the German type of submarine in various stages of flotation, such as at the surface, awash, diving, on the bottom, and when discharging a torpedo.

Horizontal Rudders, or Hydroplanes. Motors set working and submarine glides under — Submarine awash—diving trim. All hatches and vents secured. Main ballast tanks filled — Submarine in surface trim for cruising on the surface of the sea

THREE POSITIONS OF THE SUBMARINE—DIVING, AWASH AND SURFACE NAVIGATION

The flotation of the submarine, or its position with regard to the surface of the water, is determined partly by the operation of compressed air and water ballast tanks and partly by the reaction of horizontal diving rudders. At the surface and in the cruising condition the modern submarine has considerable freeboard, as will be seen from our illustration. The decks are well above water, the craft is able to open her hatches, and the ship is navigated from the bridge, in the same way as an ordinary surface vessel. The German type has a long, flat deck, carried upon a light superstructure which has nothing to do with the flotation of the ship, being freely perforated to allow the water to enter and leave at will. The deck is surrounded by a rail consisting of stanchions and wire rope. She carries two masts hinged at the deck, which can be raised to the vertical position for carrying the wireless, as shown in the engraving. When the ship is going to submerge the wireless is removed, the two

Tender made to appear like a trawler. Recharging oil tanks — Submerged. Steering by the aid of periscopes



Resting. By allowing a little more water to enter the tanks the boat can be made to rest lightly on the sea bottom — The submarine when in this position is blind and steers by means of compass and clock — Kept at correct depth by action of the hydroplanes. If engines stopped, boat would rise to surface

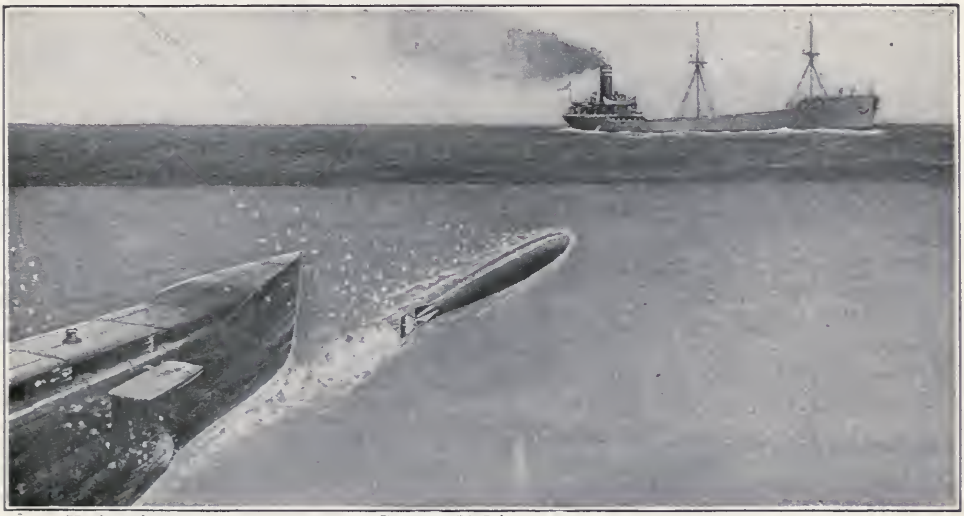
SUBMARINE "ASLEEP ON THE BOTTOM," SUBMERGED AND STEERING BY PERISCOPES masts are folded on deck and secured, the hand railing is taken down and sent below, as are also the bridge and its fittings. After the last of the crew has disappeared through the hatchway, it is closed and bolted securely from within.

The second illustration shows the submarine in the awash condition, the main ballast tanks being filled, all hatches and other openings being tightly secured. In this condition she has a slight reserve buoyancy of a few hundred pounds. The oil engines are now disconnected and the electric motors are started. As soon as she has way on, the horizontal diving planes are depressed and the ship descends at a moderate angle until the desired depth is reached. The small reserve buoyancy tends to make the boat rise to the surface, and this is counteracted by maintaining a slight degree of horizontal helm.

Inside the boat is a pressure diagram which shows the depth at which the boat is traveling, and by this the man who controls the horizontal rudders is guided.

For attack, the boat is sunk until just the tops of the periscopes are above water, and through these the commander has clear vision, the view being very much the same as would be obtained were he standing at the surface with good binoculars at his eyes. Should an enemy ship approach, a slight additional depression of the diving rudders brings the boat down until its periscopes are entirely below water. In this position the immersion indicator will guide him as to his depth, and he lays his course by a ship's compass, steering the boat in the horizontal plane by means of the vertical rudders at the stern.

If the enemy is numerous and the commander wishes to play safe, he admits sufficient water to destroy the reserve buoyancy and settles quietly to the bottom. This is known as "going to sleep." When the commander wishes to rise to the surface, he can do so by admitting compressed air to the ballast tank, and blowing out a portion of the water, and starting his electric motors. Then, by lifting his horizontal planes, he can come to the surface, where and as rapidly as he desires.



Hydro-plane
Torpedo tube

German 21.5 inch torpedo carrying 400 lbs of explosive—cost $5,000

IMPENDING DESTRUCTION OF AN UNARMED MERCHANTMAN BY A TORPEDO

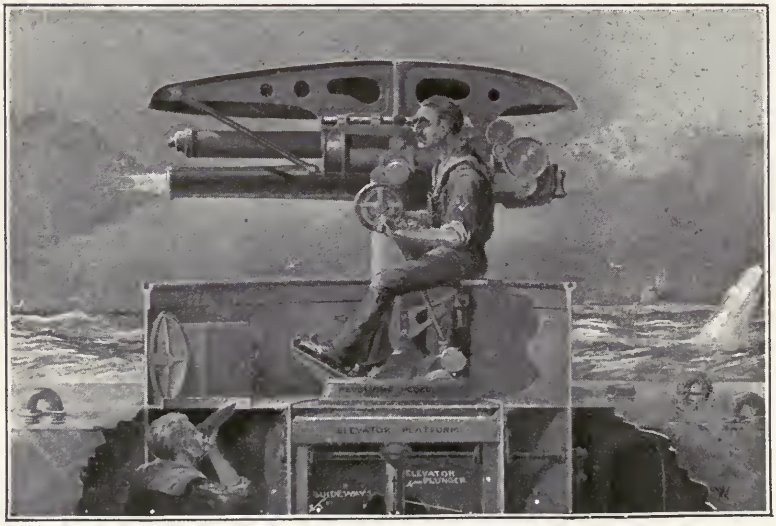
Illustrations pages 270 and 271 redrawn from "Sphere"

The latest and largest German submarines, with a surface displacement of 800 to 1,000 tons, have a wide radius of action; for when running at low speed at the surface they can probably travel from five to seven thousand miles without replenishing their oil tanks. Their maximum speed at the surface is about 18 knots, and possibly 20 in the later type, and submerged they can speed about 10 or 11 knots with a radius of possibly 100 miles. Ten or a dozen torpedoes are carried on these boats, and some of them have four torpedo tubes ahead and two astern, making it possible for them to fire the whole of their torpedoes in quick succession if the exigencies of the situation call for it. The submarine is the gun, the torpedo the projectile, and the whole submarine must be steered to point in the direction of fire before the torpedo is let go. This, because of the comparatively slow maneuvering ability of the submarine, is a handicap, and many a miss is made because of the difficulty of "laying" the submarine true to the mark, especially if the mark is moving fast.

The question of fuel supply is solved by providing oil tenders for each flotilla of submarines. The oil tender may be a trawler, tug or any small vessel, and if it flies a neutral flag it has a good chance to meet the submarines in some designated locality and replenish their fuel tanks. This is done by passing hose from the tender to the submarine and pumping the oil to the fuel tanks.

The Submarine as a Commerce Destroyer

THE submarine in the rôle of a commerce destroyer has proved a surprise to the military world, and the Germans have again scored through their initiative. But it was inevitable that this method of attack would prove too expensive if hits were to be made by the torpedo alone. The merchant craft of the Allies were not slow in realizing the limitations of the under-sea boat when relying upon the mechanical fish as a weapon of destruction, and many have been the instances where zigzagging and full speed have made it possible for the ship of trade to dodge the oncoming torpedo.



DISAPPEARING GUNS WHICH IT IS REPORTED ARE USED ON GERMAN COMMERCE-DESTROYING SUBMARINES

Latterly, the U-boats have been halting their quarries by means of gunfire and then have blown them up, after abandonment, by dynamite charges planted aboard where they would be likely to sink the merchantmen quickest. But this order of procedure has now become impracticable because of the greatest alertness of the flotillas of British and French destroyers. Accordingly, the Germans are now sending the traders to the bottom by gunfire alone in many instances, and this method of attack is far more formidable than has hitherto been believed possible on the part of submarines. Its present climax is extremely significant, for it heralds a new stage in the offensive development of the under-sea boat.

It is a matter of common report that the German submarines that figured prominently in the early months of the European war were equipped with two sorts of guns. One a 37-millimeter weapon firing from a fixed pedestal mount a shell of 1½-inch caliber; and the other, a more formidable piece, arranged to disappear into the superstructure and to throw a 12-pound projectile. This gun is a stumpy but powerful rifle, having a caliber of 2.95 inches, and at moderate range likely to prove an unpleasant antagonist for a torpedo boat. But again this meant exposure for the gun's crew, for the men had to come out upon the deck in plain sight if the submarine were running light, as she would of necessity have to be, to measure forces in this fashion with a surface fighting craft. To get under suddenly, the deck hatch might have to be closed before the men at the gun could retreat into the submarine.

We are able to illustrate, from a reliable source, the housing, gun and mount, which is said to be identical with that employed by the Germans in their very latest and largest U-boats. It is quite manifest that the installation is a long stride forward in making the submarine more formidable and efficient, especially when used as a commerce destroyer or when called upon to put up a fight against the worst of her foes, the high-speed sea-going torpedo boats. More than that, the arrangement shelters the gun crews from aerial attack. The particular installation which we are able to show is that for a quick-firing 14-pounder, but the operative principles would be the same for heavier weapons, such as the 4-inch rifles which we are told some of the U-boats now carry.

The gun, with its superposed recoil cylinder and sheltering hood, is mounted upon a revolving pedestal provided with seats for two operators—one controlling lateral movement and the other manipulating the elevating gear with his left hand and firing with his right. The revolving pedestal, in its turn, is supported by a plunger elevator, functioned by means of a pneumatic cylinder. The gunhood is really the hatch cover, and when the weapon is lowered this cover is seated watertight against a rubber gasket in the recess at the top of the hatch or barbette. The gun pointers take their positions when the elevator is lowered, and rise with the rifle when the hatch cover lifts and the gun is cleared for action. The piece can be elevated and lowered in a few seconds.

It is perfectly plain that an installation of this character adds in fact and potentially much to the military powers of a submarine. Because guns of this sort can be worked in the semi-light trim a submarine need not expose so much of her hull or superstructure and, accordingly, should be able just so much quicker to seal up and disappear below the waves for greater security. It is equally evident that a disappearing mount of this nature can be housed beneath and within protecting armor of moderate thickness and a frontal shield set upon the gun, thereby greatly increasing the resistance against attack. In this we can see the first step in an evolutional line which will blaze the way to the still larger sea-going submarine with its upper works in mail.

DIVER LEAVING A SUBMARINE TO PLANT A MINE

Chapter XLI.

SUBMARINES THAT ARE STRICTLY INVISIBLE

A Type That Can Pass Through a Mine Field and Attack a Blockaded Fleet

BY SIMON LAKE

Simon Lake, the inventor of the even-keel submergence submarine torpedo boat, which in its ship-shaped form with double hull and buoyant superstructure, a form covered by Mr. Lake's patents in the United States and adopted in principle by the United States, Russia, Austria, Germany, and Italy, is of the opinion that the full capabilities of the submarine boat have not even yet been fully realized. Mr. Lake has developed a great variety of submarine vessels for various commercial purposes, as well as for war, and he is well qualified, because of his great variety of submarine experiences, to discuss the possibilities of the submarine in warfare.

IT has been well established that submarine boats should be divided into two classes; one, a torpedo boat with as high surface and submerged speed as it is possible to attain, with a large radius of action, capable, if possible, of exceeding battleship speed when on the surface so that it may intercept a battle-fleet on the high seas and submerge in its path of approach before being discovered; the second class should consist of smaller, slower speed, mine-evading submarines, with torpedo and mining and counter-mining features. Such submarines are essentially defensive; but if they have sufficient radius of action to reach the enemy's harbors and to lie in wait off the

MINE-PLANTING BY SUBMARINE. THE MINES ARE PLANTED BELOW THE WARSHIPS BY A DIVER, WHO MAKES HIS EXIT THROUGH THE TRAP-DOOR OF THE FRONT COMPARTMENT. THEY ARE SO PLANTED THAT AT A GIVEN HOUR IN A CERTAIN STATE OF THE TIDE AND CURRENT EVERY SHIP WILL BE ABOVE A MINE-FIELD. THE FIRING CABLES ARE LED TO THE SUBMARINE, WHICH DETONATES THE MINES SIMULTANEOUSLY entrance to such harbors, or to enter submerged the harbors themselves and there destroy the enemy's craft, they have become potent offensive weapons of the raiding fleet. For a European power it is relatively easy to give such boats the radius necessary for them to invade an enemy's ports.

I have not pushed the consideration of the submarine of the second class, with its anti-mine features, because I have been kept busy trying to profitably meet the wishes of the various governments which demand constantly increasing speeds at a sacrifice of some characteristics which I personally regard very highly. Most governments have been more attracted to vessels of the first class, as speed in all classes of vessels more than anything else seems to appeal to the imagination; but I think it may be the old story of the "Tortoise and the Hare" over again; and I refer to the recommendation of a special board, appointed in 1903, recommending the purchase of a number of Lake type boats for the defense of our own coasts as a proof of this contention.

As regards the first class of submarines, the present submarine boats engaged in the Continental war (written January 16th, 1915) consist of vessels only a few of which have a surface speed exceeding 12 knots or a submerged speed exceeding 10 knots for one hour or 8 knots for three hours. There may be a few in commission that exceed these speeds, but very few. Some are in course of construction that are expected to give a surface speed of 17 and 18 knots for forty hours and about 11 knots submerged for one hour, or a slower speed for a greater number of hours.

Governments are asking for bids for submarines of greater speed, and some have been designed which are expected to make 20 knots on the surface. However, none of them are in service as yet. One reason that higher surface speeds have not been reached is the difficulty of securing a perfectly satisfactory high power, heavy oil, internal-combustion engine, suitable for submarine boat work. As soon as a proven satisfactory heavy-oil engine is turned out by the engine builders, capable of delivering 5,000 horse-power per shaft, submarine boats may be built capable of making up to 25 knots on the surface.

PASSING BELOW PROTECTIVE NETTING. WHEN THE SUBMARINE, TRAVELING ON THE BOTTOM, REACHES THE NET, THE LATTER IS LIFTED BY THE PROJECTING ARMS AND SLIDES OVER THE SMOOTH BODY OF THE BOAT

The largest heavy-oil engines so far built for submarine boat work develop about 1,300 horse-power per shaft; but rapid progress is being made, and I believe that 25-knot submarine boats will be laid down within the next two years. Even this high speed, however, will not fulfill the destiny of the submarine, which, in my opinion, is a weapon destined to promote peace between maritime nations by making it impossible for one nation to invade or harass the coast line of another nation where submarines exist, and by making it impossible for the enemy to leave their own ports or harbors with an invading army or armed vessels.

The submarine, even at its present development, has shown its superiority over the battleship in coast operations; however, to intercept a battleship at sea, even a high speed submarine must lie in wait, perhaps for days or even weeks at a time, much like a gunner in a "blind" waiting for a flock of ducks to pass within gun shot. Because of its relatively slow speed, it would have to wait a long time, also, for a battleship or fleet to pass sufficiently near to be headed off, especially if the submarine were *entirely submerged*, because the moment the periscope appears above water the quarry will take to its heels.

The principal means used in my mine-evading submarine are the bottom wheels and driving compartment, which were incorporated in my 1893 design, which also carried my pioneer features of lateral hydroplanes to get even keel submergence; high, watertight superstructure, which is indispensable for high-speed, ocean-going submarines; anchors, and lifting and lowering sighting instruments. Excepting the bottom wheels and diving compartment, most navies have now incorporated these features in their submarines. Three navies have adopted the bottom wheels, etc. These mine-evading craft are able to enter the enemy's own territory and destroy his merchant ships and warships in their own harbors.

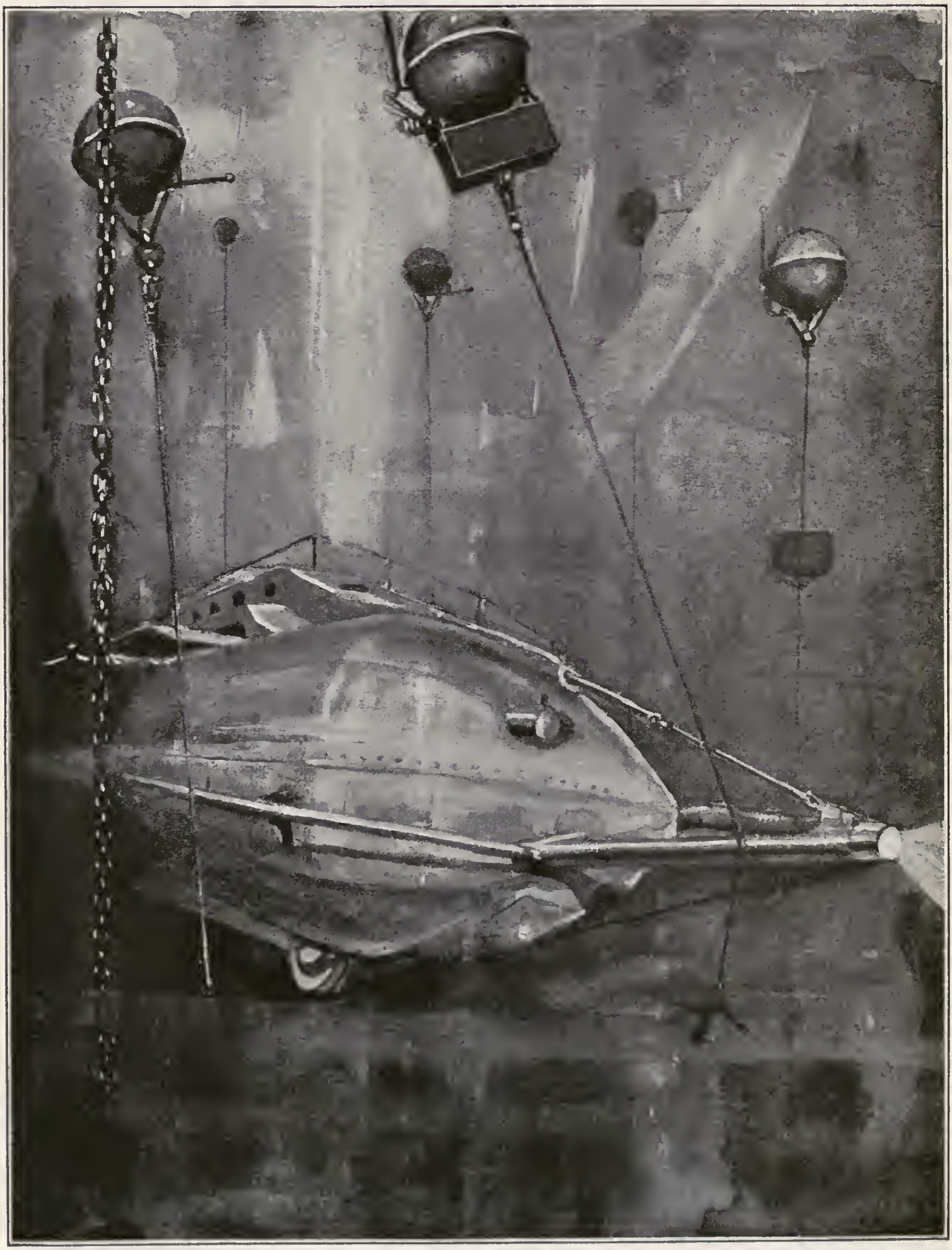
The mine-evading submarine can enter with comparative safety through a mine field, like a shuttle passing through the woof of cloth during the weaving process, and I take the opportunity to explain, for the first time, through the SCIENTIFIC AMERICAN, my method of entering harbors. To comprehend thoroughly the safety with which this is accomplished, it is necessary to appreciate the almost insuperable difficulty of discovering an object like a submarine vessel when once sunk beneath the surface of the water. There are many sunken ships containing valuable treasures and cargoes that lie along our coast, and in most of the harbors of the world, that have been known to have sunk within a radius of less than a mile from some given point, but which have never been located and probably never will be until science evolves a means to enable divers to withstand deep sea pressure.

During several years of experimental work with submarines, investigating bottom conditions, I have traveled many miles in the Chesapeake and Sandy Hook bays, along the Atlantic Coast and Long Island Sound, and later in the Gulf of Finland and the Baltic Sea, and it is a fact that cannot successfully be disputed technically, by anyone, that a submarine of the type recommended by the United States Army Board may be taken into any harbor in the world entirely unseen and remain there, if necessary, for a month at a time, and destroy shipping, docks, and war craft deliberately and leisurely, and defy discovery.

My method of entering harbors or through mine fields consists principally in providing submarine vessels with bottom wheels and other component undisclosed details. When submerged, the vessel is given sufficient negative buoyancy so that she will not be drifted off her course by the currents when resting on the bottom. The vessel is what might be termed a submarine automobile, and it may be navigated over the bottom as readily as an automobile on the surface of the earth. The submarine automobile has one great advantage over the surface type in its ability to mount steep grades or go over obstructions, because the vessel is so nearly buoyant that she will mount any obstruction she can get her bow over.

My early experience proved to me that a submarine could not be satisfactorily navigated submerged in shallow, rough water by the same method of control as was found to be satisfactory in deeper water, for the reason that the vessel would jump up and down with the rise and fall of the sea. Neither could the vessel lie at rest on the bottom as the lift of the ground swell in bad weather was sufficient, even with a considerable negative buoyancy, to cause the vessel to pound so badly that the storage battery plates would be destroyed in a few minutes. I therefore suspended the wheels on swinging arms and applied a cushioning cylinder. The hull of the vessel was then free to move up and down, synchronizing with the lift of the ground swell, and at the same time the weight of the wheels kept the submarine close to the bottom and able to keep her position while at rest or to be navigated over the bottom at any speed desired.

Many of our Atlantic Coast, Long Island, and Chesapeake Bay water-beds are comparatively uniform as to depths. In other countries I have navigated over rocky bottoms filled with giant boulders. A rough bottom limits the speed at which it is advisable to travel, but I have never seen a bottom so rough that it could not be readily navigated.



PASSING THROUGH A MINE-FIELD. A LAKE SUBMARINE TRAVELING ON THE BOTTOM CAN PUSH THE ANCHORAGE CABLES ASIDE BY MEANS OF THE GUARDS ATTACHED AT THE BOW

Lake boats, fitted with bottom wheels, have, in a competitive test abroad, entered land-locked and fortified harbors without discovery, where the entrance from the sea has been through a tortuous channel. All other vessels, except the one fitted with bottom wheels, were discovered long before reaching the outer fortifications, because it was necessary for them to show their periscopes to sight their way. They struck the sides of the dredged channel, which caused them to broach and be discovered, because they had to maintain a comparatively high speed to be kept under control. In tests carried out in Russia the boat fitted with bottom wheels simply wheeled along in the channel at slow speed and stopped and backed to change course at will. The revolutions of the bottom wheels gave the distance traveled, the manometer gave the depth, and the compass the proper direction; consequently, with a correct chart as to courses and depths, navigation on the bottom in entering harbors is very much easier than on the surface, unless the channels are well buoyed.

Most mines, as at present installed, are either of the observation or contact type; the observation mines are fired usually from shore stations when the enemy is seen to be over them, while the contact mine is anchored a few feet beneath the surface and is either exploded by contact with the surface of the vessel's bottom or by the agitation caused by the rush of water due to the swiftly passing vessel. The European belligerents have put out contact mines to protect their capital ships from the submarines. The dread of these mines is holding the submarines outside of the mined areas and the mines are, therefore, effective. None of the British vessels are fitted with bottom wheels and diving compartments, and they must be navigated at such speed to keep submerged control that they would explode a contact mine if either the mine or its anchor rope were touched. This also applies to some of my later boats, as the bottom wheels have been omitted to meet the demand for greater speed on the surface and submerged.

I am inclined to the belief that this has been more or less of a mistake, because the bottom wheeled submarine can go to and "dig" the enemy out of its base, in addition to hunting the big surface craft of the enemy on the high seas.

With the bottom wheels, navigation can be conducted so carefully over the bottom that inspection of the course can be made, if desired, foot by foot, as progress is made, and all mines can be avoided.

The diagrammatic sketches illustrate the Lake method of operation in cutting cables, evading mines, planting counter-mines, clearing away mines or passing under chains, cables, and nets that may be stretched across the entrances of the harbors, to effectively stop the progress of surface vessels and submarines not fitted with bottom wheels in the manner described.

Escape from Sunken Submarines

SUBMARINE accidents have been many and serious without losses which have occurred during war. Submarine service is justly deemed very hazardous and inventors have devised many plans of escape. We illustrate the Castle and the Rose plans, both of which have been favorably commented upon by naval architects.

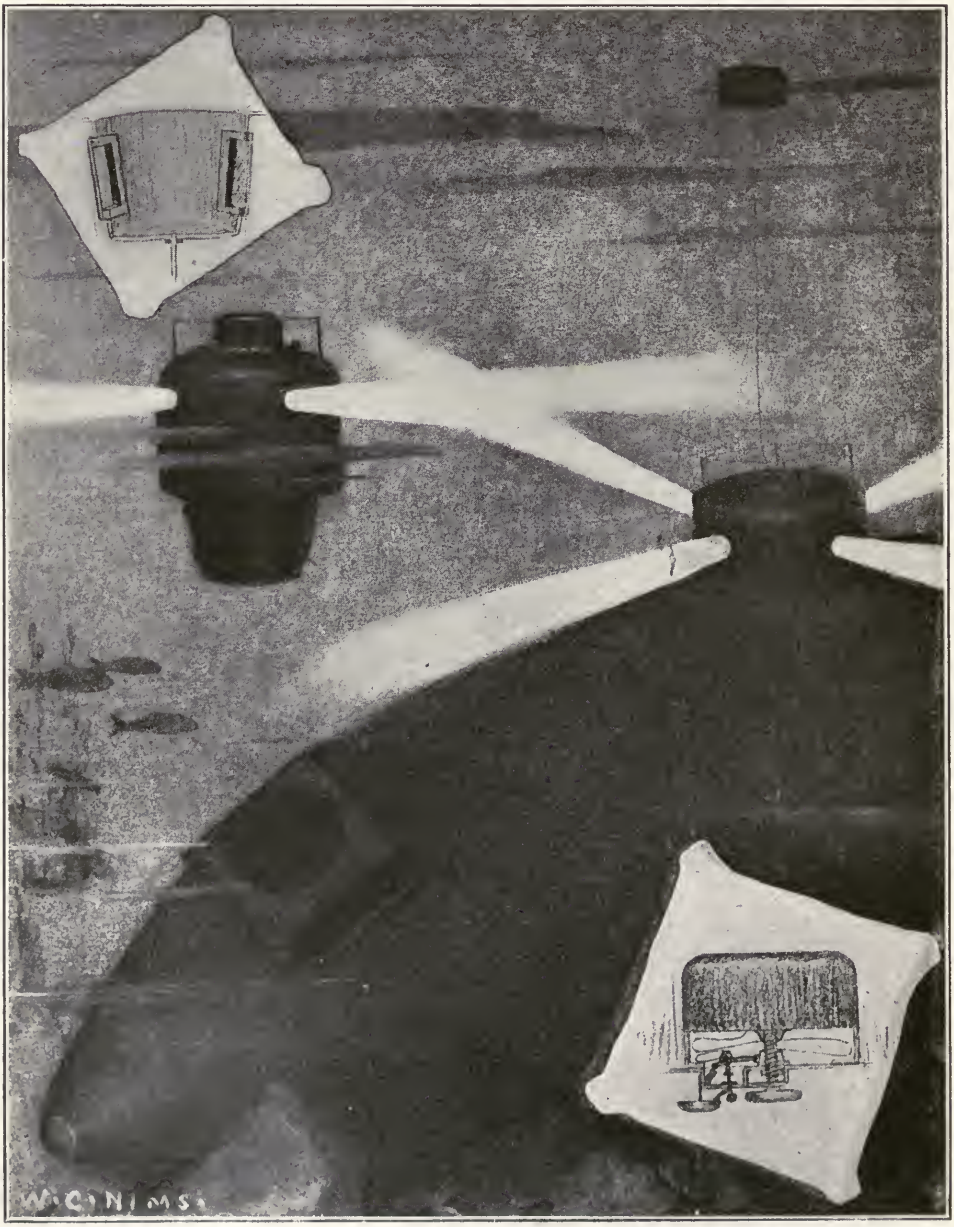
The Castle device consists of two towers placed on the water-tight bulkheads. By this method, in the event of any one compartment getting waterlogged by escaping into an unflooded one, the crew can release themselves from the vessel by opening the escape scuttles on either side of the bulkhead in submarine and towers, and closing both when inside (making the vessel intact) and detaching them by means of clips. By this method escape is afforded from three compartments for about eight to ten men in each. A small hydraulic is provided for the purpose of exerting an upward pressure if required.

On the manhole cover in each tower is a signal apparatus fitted with a cork buoy, which, on being released from inside by turning back the screw, rises to the surface, taking with it a fine flexible steel wire line; communication can be made to those inside the towers and at the surface, and will show the position of towers. The towers are 3 feet 6 inches above the deck, but they can be fitted at varying heights to reduce resistance if required.

A flexible wire is stowed in a water-tight ring, the buoy resting upon it, the wire passing over a bracket, so as to have a vertical pull in the event of the vessel being inclined. The alarm is located below the cover; ballast is fitted for the purpose of keeping the towers stable in the light condition.

Although the fitting of chambers is not a new idea, as a few have been patented, this plan is theoretically and practically correct for life-saving purposes, and would not weaken the vessel, while at the same time giving good chances for the crew to get out at either end at great depth. There would be a danger, as with the present conning-towers, of damage in case of collision, but still the vessel would continue to be water-tight.

Mr. Rose's invention includes a submarine lifeboat and buoy. The lifeboat consists of a cylindrical chamber some 8 feet in diameter, held under normal conditions within a water-tight compartment by means of a stout screw carried through the base. At one spot within the water-tight compartment is a secondary chamber containing a buoy attached to a length of wire. On an accident happening to the submarine, the crew enter the water-tight belt, and, sealing the door behind them, pass on to the inner cylinder. One stays behind sufficiently long to release, by



THE CASTLE DEVICE FOR SAVING MEN FROM SUNKEN SUBMARINES. THE SMALL DRAWING IN THE UPPER LEFTHAND CORNER SHOWS THE WATERTIGHT ESCAPE SCUTTLES WHICH ARE FITTED TO EACH COMPARTMENT, AS WELL AS TO THE TOWERS. THE DETAIL DRAWING IN THE LOWER RIGHTHAND CORNER SHOWS THE SIGNAL APPARATUS, WHICH IS LOCATED ON THE MANHOLE COVER IN EACH TOWER. THE WHOLE IS FITTED WITH A CORK BUOY, WHICH ON BEING RELEASED, RISES TO THE SURFACE, TAKING WITH IT A FINE FLEXIBLE WIRE, BY MEANS OF WHICH IT IS POSSIBLE TO COMMUNICATE TELEPHONICALLY WITH THOSE IMPRISONED IN THE TOWERS. BENEATH THE COVER IS AN ALARM means of a bevel gear, the buoy in the smaller chamber. The buoy rises to the surface at once, and indicates the whereabouts of the submerged craft. As soon as the crew are within the inner cylinder and the doors are shut, the cylinder is released from its contact with the body of the submarine by the unscrewing of the grip beneath the floor. If the compartment in which the cylinder rests has not been damaged, the cylinder at once rises to the surface by its own buoyancy. There is an electric light in the conning-tower and an apparatus for firing distance-rockets, so that, whether by day or night, attention can be called to the position of the floating cylinder, with a view to obtaining help and avoiding collision. In calm weather, a collapsible boat can be launched

SAVING MEN FROM A SUNKEN SUBMARINE

through the conning-tower, to enable help to be sought from the shore or from passing vessels, or to locate the search-vessels which might be sent out to look for the submarine. Provision has been made, however, for the contingency of such damage to the submarine as may prevent the lifeboat cylinder from rising to the surface and cause the detention of the crew at the bottom of the sea. Within the cylinder are two other compartments, which can be opened to the sea by a convenient gear. These contain buoys which, rising to the surface, carry with them air-tubes, electric light and telephone wires. The buoys are so shaped that they ride on the waves and keep a free air-vent, and on the exhaust pipe of one buoy there is fitted a siren. By pumping fresh air in through the other buoy and the foul air out again through this one, the siren is worked, and the attention of passing or search-vessels called to the spot. In proximity to the siren is a plate covering a telephone transmitter, which can be broken by the rescue party, and communication thus established with the men imprisoned below. If the salvage operations are likely to take some time, arrangements can be made for passing liquid food down the air-pipe, as has been done in the case of miners buried alive under a fall of earth, but with whom communication has been established pending their being dug out. The inventor maintains, however, if his ideas are properly carried out, the crew would be able to stay at the bottom for a very considerable time, as the lockers under the seat in the cylinder are supposed to be kept stocked with provisions, in readiness for such an emergency, and there is a tank which is to be kept filled with fresh water. In one locker there is an electric battery, to give light to the imprisoned men, and in another is compressed oxygen, in case of need. There is also an inner chamber round the boat, filled with compressed ordinary air, which can be used if required. Round the fresh-water tank is another tank, in which sea-water can be admitted by a valve, to be used as ballast, if necessary, and this tank is also to be used as a lavatory and a means of keeping the boat pure and clean—a great consideration if life is to be maintained indefinitely.

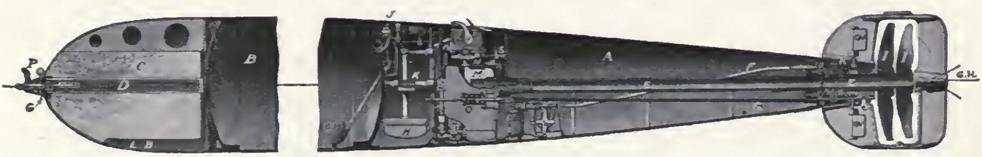
Chapter XLII.

THE MODERN AUTOMOBILE TORPEDO

The Story of a Great Invention

BY ROBERT G. SKERRETT

FROM the modest 14-inch torpedo of 1864, with its limited range and speed, we have reached to-day a weapon weighing more than 1,600 pounds and capable of covering ranges up to 7,000 yards—traversing this distance in the remarkably short period of less than seven minutes. This particular torpedo is the invention of Lieut. Hardcastle of the British Navy. In our own service we do not claim the same long range—4,000 yards being the maximum upon which we now place a military value, and the remaining speed at the end of this run is in the neighborhood of 28 knots. The explosive charge of the present-day automobile torpedo varies from 140 to 250 pounds of guncotton. The destructive force of a blow of this sort has been amply demonstrated recently by practical tests against the under-water bodies of fighting ships. To-day, the builder of battleships can hope only to restrict the area of under-water damage by subdividing his ship below the waterline into numerous water-tight compartments. One torpedo will probably not be able to sink a dreadnought, but it will be likely to so impair her military efficiency as to make her an easy mark for deliberate annihilation either by gun-fire or further torpedo attack.

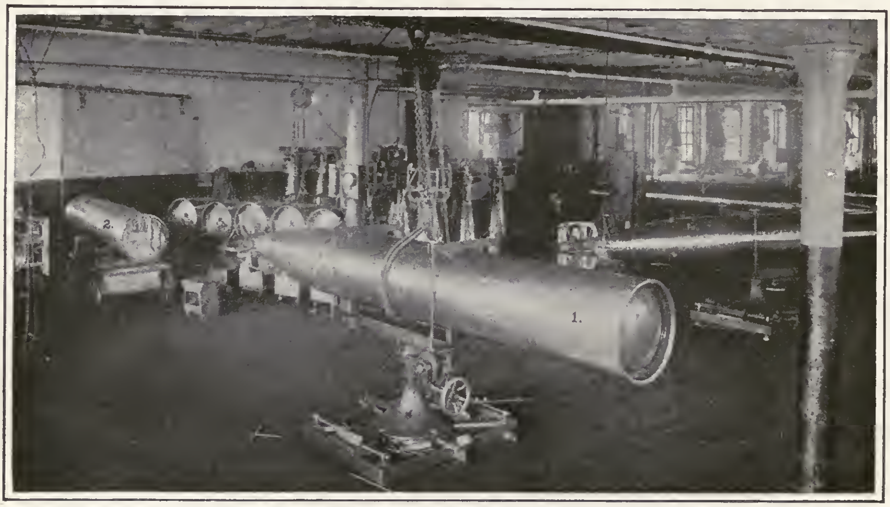


A LONGITUDINAL SECTION THROUGH A BLISS-LEAVITT TORPEDO, SHOWING THE DISPOSITION OF THE EXPLOSIVE, THE DRIVING MACHINERY, AND THE PROPELLERS. P, PLUNGER OR STRIKING ROD. G, SAFETY-PIN. C, GUNCOTTON CHARGE. D, DETONATING CHARGE. B, AIR FLASK. J, CHARGING VALVE. K, HYDROSTATIC VALVE. H, PENDULUM. M, TURBINE. N, SUBMERGENCE CONTROL MECHANISM. S, SUBMERGENCE VALVE. S H, SUPERHEATER. X, VALVE CASE. Y, AIR LEVER. O, IMMERSION SERVO-MOTOR. L, PRESSURE REGULATOR. V, GYROSCOPE. T, GYROSCOPE IMPULSE. U, SERVO-MOTOR. G, V, RUDDERS FOR HORIZONTAL CONTROL. G, H, RUDDERS FOR VERTICAL CONTROL. F AND G, RUDDER CONTROLS. E, E, PROPELLER SHAFT. I. I. PROPELLER. R, SHAFT GEARING. A, AFTER-BODY. L, B, BALLAST

Only a few years ago, comparatively speaking, the lateral course of the torpedo was decidedly uncertain, to put it mildly. The range and speed had been greatly improved, but the torpedo still had a way of departing suddenly and mysteriously from its intended course—sometimes coming back at the vessel from which it was sent to the no small dismay of all hands. This was not a pleasant thing to contemplate in time of war when the head of the weapon would be loaded with its violently destructive charge. At this critical stage in the history of the torpedo, the Obry gear was invented. Briefly, the Obry gear consisted of a gyroscope placed within the torpedo and so connected by intermediate power mechanisms with the directive rudders that the weapon could be held to a fairly straight course or, more properly, to a sinuous one consisting of a series of flattened curves alternating from right to left. The original Obry gear had a spring impulse, its directive force rapidly diminishing from the instant of starting, and it became quite useless after the torpedo had run something over a thousand yards. Realizing the value of the gyroscope, however, other minds promptly set about improving this instrument of lateral guidance. To begin with, the adoption of ball-bearings, nicer balancing, and the refining of various moving parts made it possible to lengthen the directive period of the gyroscope as well as to increase its sensitiveness—thus insuring a more reliable run and a speedier one by flattening the sinuous course. The next developments introduced an air-impulse, turbine-driven gyroscope, and then an electrically-driven Obry followed. These have done away with the shock of the original spring impulse and have naturally greatly increased the directive value of the gear, besides making it possible to fire the torpedo from a broadside and cause it to swing automatically through an angle of 90 degrees toward a target dead ahead. From a weapon that was a menace to friend and foe alike, the installing of the gyroscope has revolutionized the automobile torpedo, making it under some conditions even more certain of hitting its mark than that possible with the biggest of our modern guns.

For years the wonderfully compact and efficient three-cylinder Brotherhood engine was the best available motor for the automobile torpedo; but even with its progressive developments it had the inherent limitations or drawbacks of the reciprocating engine, and it was only logical that the torpedo builder should cast about him for a motor capable of utilizing still better the power stored in the air flask. The turbine was the natural solution of the difficulty.

All the while that the torpedo was improving in military value, the range of modern guns on shipboard was likewise undergoing substantial increment—making it possible for ships to fight at greater distances, and the torpedo expert realized, despite all that had been done to make his weapon more effective, that both the range and speed of the torpedo must be further increased if it were to meet properly the changed conditions. This was a staggering realization, because there were difficulties in the way of making a larger torpedo susceptible of easy handling, and it was not practicable to add much either to the capacity of the air flask or to the pressure of the energy stored therein. At this critical stage, American inventive skill found a way to surmount the obstacle. Mr. Frank M. Leavitt of the E. W. Bliss Company made the startling proposal to heat the air stored in the flask, and thus to cause its expansion and multiply its propulsive capacity. The first American development of the superheater for this purpose consisted of means by which alcohol could be burned within the



TESTING STAND USED IN ASCERTAINING THE ACCURACY OF THE GYROSCOPE'S CONTROL WHICH HAS REVOLUTIONIZED THE AUTOMATIC TORPEDO. NO. 1 SHOWS THE TORPEDO WITHOUT THE HEAD ATTACHED. NO. 2 SHOWS THE MIDDLE BODY AND THE AFTER END OF THE AIR FLASK WITH SUPERHEATER FLASKS IN POSITION air flask—the heated air passing thence through the valve system to the engine or turbine and, while still relatively warm, passing outboard through the exhaust. Apart from propulsive advantages, superheating obviated another objectionable feature of the older system in which the changes of temperature were so great—due to the rapid expansion of the compressed air—that the exhaust was frequently far below the freezing point. This caused the lubricants to congeal and, in turn, impaired the action of moving parts. The British development of the superheater omitted the alcohol flame from within the air flask and put it between the reducing valve and the motor. This was an advantage in some ways: it did not require the heated air to pass through the delicate valve system, it fed into the engine the air at its most efficient temperature, and it made possible a nicer control of the pressure at the engine or turbine. However, like all good things, it had a drawback from a military point of view. When the air flask of one of our torpedoes is fully charged, the actual weight of that compressed air amounts to something like 191 pounds. The reducing valve, which regulates the pressure and supply of air to the motor—standing sentinel between the air flask and the propulsive mechanism—is designed to maintain a feed pressure of 300 pounds for the turbine impulse. When the pressure in the air flask approaches 300 pounds, the run of the torpedo is substantially at an end so far as its useful military speed is concerned. As the air in the air flask expands due to its gradual escape to feed the motor, the temperature is lowered sometimes even to below zero, and this remaining air is incapable of expelling itself from the flask for the purpose of effecting the propulsion of the torpedo. It has been found that when the superheater is outside of the air flask, of the total weight of 191 pounds of stored energy, not more than about 148 pounds are utilized. Again Mr. Leavitt's ingenuity has supplied a remedy. Instead of heating the air within the flask during the entire run of the torpedo as he first did, he, too, heats the impulse supply

DISCHARGING A TORPEDO FROM A DESTROYER'S DECK TUBE outside and between the reducing valve and turbine, but, in order to make use of more of the stored air than possible heretofore, he causes the ignition of an alcohol flame inside the flask toward the latter part of the run. By this means he is able to use to good effect 174 pounds of the original 191 pounds of the compressed air—thus increasing the range and the maintenance of higher speeds throughout the longer run.

A TORPEDO BOAT ATTACKING A SUBMARINE

Chapter XLIII.

ATTACK AND DEFENSE BY SUBMARINE MINES

The Most Easily Prepared and Most Dreaded Form of Naval Warfare

BECAUSE of its absolute invisibility, the submarine mine in its present state of development is the most deadly form of naval warfare. Certainly it has to its credit the greatest disasters to ships of the first class and the greatest number of such disasters during the past decade of naval history. During the operations on Port Arthur it was the floating mine which sent to the bottom two of the finest battleships of the Japanese fleet. It was a floating mine also which sank the "Petropavlovsk," when Admiral Makaroff was leading the Russian fleet out of Port Arthur, in which disaster the admiral and nearly all of the officers and crew of the ship, together with the Russian artist Verestchagin, went down with the ship.

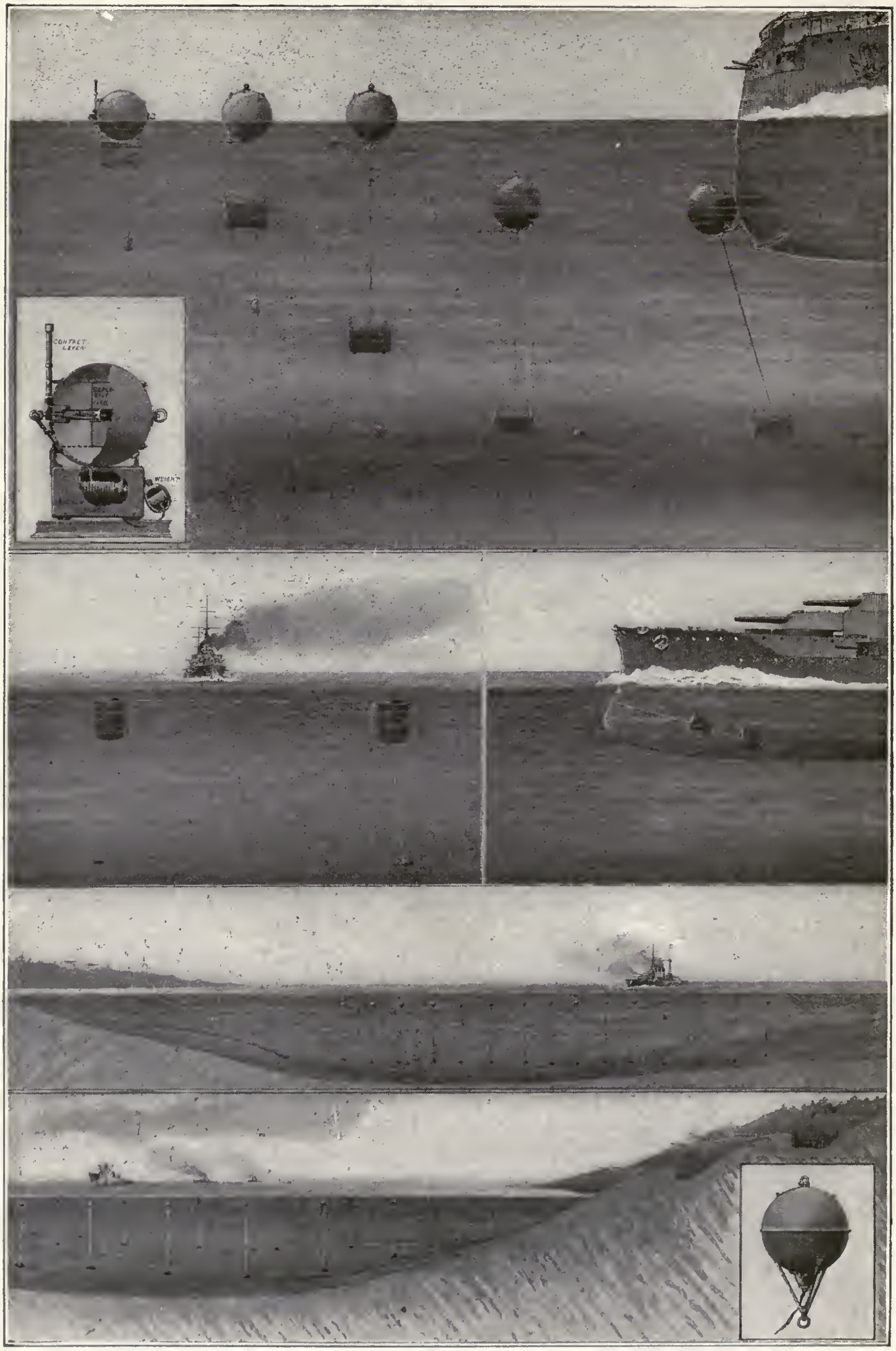
As compared with torpedo attack, mining has the advantage of greater secrecy and invisibility; and this is true even when the torpedo is launched from the submarine. For effective attack, torpedoes must be fired either from battleships, cruisers or destroyers, or submarines.

In the case of each class of vessel, a ship, from the moment it sights the enemy, knows that within certain ranges it is liable to torpedo attack; and even in the case of the submarine, which must come occasionally to the surface and during most of the period of attack must occasionally have its periscope above the surface, there is a reasonable expectation that with a careful watch, some signs of the approaching danger will be detected.

In the case of the submarine mine, however, the element of secrecy is so perfect that, if it so happens that the mine field has not been previously located, a fleet under way has no possible means of knowing when or where it may encounter these deadly machines. It is true that, when the mine field has been located, or in waters where its presence is to be expected, mines may be removed by the operation known as "sweeping," as will be explained later in the present article; but no amount of sweeping, nor the most extensive scouting, can rid the harbors and high seas which form the scheme of naval operation of this most deadly menace.

Another element which renders the mine of such deadly character is the fact that its explosive charge is not limited in amount as it is in the case of the torpedo, which generally does not carry much over 200 pounds of guncotton. The mines can be made of any desired size, and charges of as high as 500 pounds of guncotton may be contained within them. A modern dreadnought, with its extensive system of subdivision and its interior bulkheads placed so as to limit the explosive effect of a torpedo, can receive the blows of several torpedoes without being sent to the bottom. But the detonation of a single mine of large size against the side or bottom of the large dreadnought might conceivably be sufficient to send it to the bottom; particularly if, as has so frequently happened, the shock and heat of the detonated mine has been sufficient to set off the whole of a ship's magazine.

Although the broad principle of operation of the various types is similar, submarine mines may be classified under three divisions.



THE MOST COMMON TYPE OF ANCHORED MINE IS PROVIDED WITH A MECHANISM WHICH AUTOMATICALLY CAUSES THE SPHERE CONTAINING THE EXPLOSIVE TO FLOAT AT A PREDETERMINED DEPTH OF ABOUT FIFTEEN FEET

ANCHORED MINES, CONNECTED IN PAIRS BY CABLE, WHICH, CAUGHT BY THE SHIP, ENSURES A TWOFOLD EXPLOSION

A GROUP OF MINES FOR THE DEFENSE OF A HARBOR CHANNEL

SYSTEM OF MINING USED IN THE NARROWS, NEW YORK HARBOR, DURING THE SPANISH WAR

First, coast defense mines which are permanently anchored at a certain depth and are arranged, through electrical connections, to be exploded at will by an observer in a concealed station on shore; second, floating mines arranged to explode on contact with a ship, which are strewn broadcast by minelaying vessels over those waters which are likely to be traversed by the ships of the enemy; third, contact mines, which are anchored in selected waters where the depth is not excessive, and are provided with an automatic mechanism that causes the mines to float at a predetermined depth, generally about fifteen feet below the surface of the sea.

The first type, harbor defense mines, is shown in two of the accompanying illustrations. The lower cut represents the methods of mining adopted during the Spanish American war as a defense to the entrances to New York harbor such, for instance, as was used in the Narrows. In this case the mines were anchored by lengths of cable, corresponding to the depths of the channel, to heavy anchorage weights placed on the bottom, the buoyant spherical mine itself which contained the explosive, floating at a depth of ten to fifteen feet below the surface. They were laid in successive rows, transversely to the channel, and connected by electric cables with a concealed observation station on shore. In some cases mines of this type are detonated from shore when a ship is judged to be within effective range of the explosion. In other cases they are arranged to be self-firing when struck by a ship. They can also be arranged as electrical contact mines, which, on being struck by a ship, give notice by the ringing of a bell to an operator on shore, who, by the throw of a switch, fires the mine. In shallow water the mine may be laid directly on the bottom, when it is known as a ground mine; but where the depth is so great as to interfere with the destructive force of the detonation, the explosive is carried in a buoyant cylinder or sphere in the manner shown in the illustration.

The type in general use in the coast defenses in this country is the electro-contact mine, and the first of the group of four illustrations shows a "grand group" of several mines, with its cables connected to the firing station on shore. The mines are planted in successive rows across the channel to be defended, and they are "staggered," so that if a vessel should pass through the first row, it must inevitably strike one or more in the later rows. They are planted in what is known as "grand groups," which consist of twenty-one mines in groups of three. Some distance in the rear of the line of mines, there lies on the bottom of the channel a grand junction box, from which seven cables spread, each leading to a triple junction box, which in turn controls its small group of three mines. From the grand junction box, also, the multiple cable winds its way to the switchboard connection in the operating room on shore.

The grand junction box is placed at the center of the line of mines and about 100 feet to the rear. The triple junction boxes are laid in a straight line at intervals of 300 feet; from each of these boxes separate cables lead to each of three mines, the mines, twenty-one in all, being spaced 100 feet apart, in a line which extends for 2,000 feet across the channel. Each mine is anchored by a cable to an anchor, the length of the cables beng such that each mine will float at a depth of 10 or 12 feet below the surface of the water.

Now, it can readily be seen that since the modern warship is from 80 to nearly 100 feet in width, it would be impossible for an enemy's vessel to pass through two or three successive lines of mines, disposed as above, without coming in contact with at least two or three.

By an ingenious arrangement, one, three, or the whole grand group of mines can be fired, either from the operating room ashore or by contact with a ship, all at the will of the operator. It is believed that for quick execution, reliability, and absolute destructive power, there is nothing equal to our Coast Defense Submarine Mine System of laying and operation.

No mine field is complete, or can ever be thoroughly effective, unless it is protected by rapid-fire guns. It is possible for small boats, launches, etc., to be sent forward ahead of the ships, and set off the mines by exploding large charges of dynamite in the mine field. If the mines are within the "sympathetic radius" of the explosives they will be exploded by the shock. The most effective protection against such countermining, or against "sweeping," as it is called, is by flanking the field with batteries of rapid-fire guns.

We present several detailed and general illustrations of the type of contact mine which is in most extensive use. The views

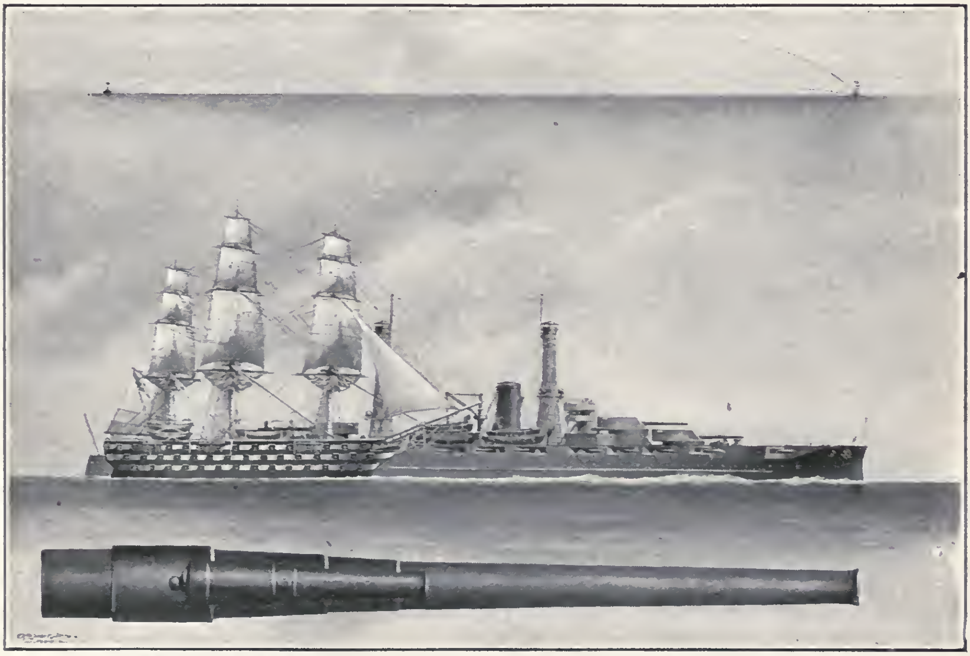
DESTROYERS SWEEPING FOR MINES BY DRAGGING A LENGTH OF CHAIN CABLE THROUGH THE MINE FIELD

have been redrawn from sketches which appeared in a recent edition of *The Sphere*. The mine itself, containing the explosive charge, is a hollow steel sphere filled with explosive and provided with a detonating charge and a trigger which serves on being struck by a ship to explode the mine. From the bottom of the spherical mine a length of cable passes to an anchor chamber, where it is wound upon a windlass; and, extending below the anchor chamber, is a plummet weight which assists in bringing the spherical mine to rest at the required depth. Before the mine is dropped from the mine ship, the plummet line is unwound until the plummet hangs at a depth below the anchor chamber equal to the depth at which the spherical line is to float below the surface of the sea. The anchor chamber and its plummet begin to sink at once; but the spherical case, being buoyant, remains at the surface. During the sinking, the cable between the spherical mine and the anchor box is unwound until a depth is reached at which the plummet rests on the botton, when, the strain on the plummet line being taken off, a pawl to which it is attached engages the windlass and prevents any further unwinding of the cable from the anchor box to the spherical mine. The anchor box being heavier than the buoyancy of the spherical mine, continues to sink until it rests on the bottom, with the mine above it floating at the predetermined depth of from ten to fifteen feet below the surface of the water.

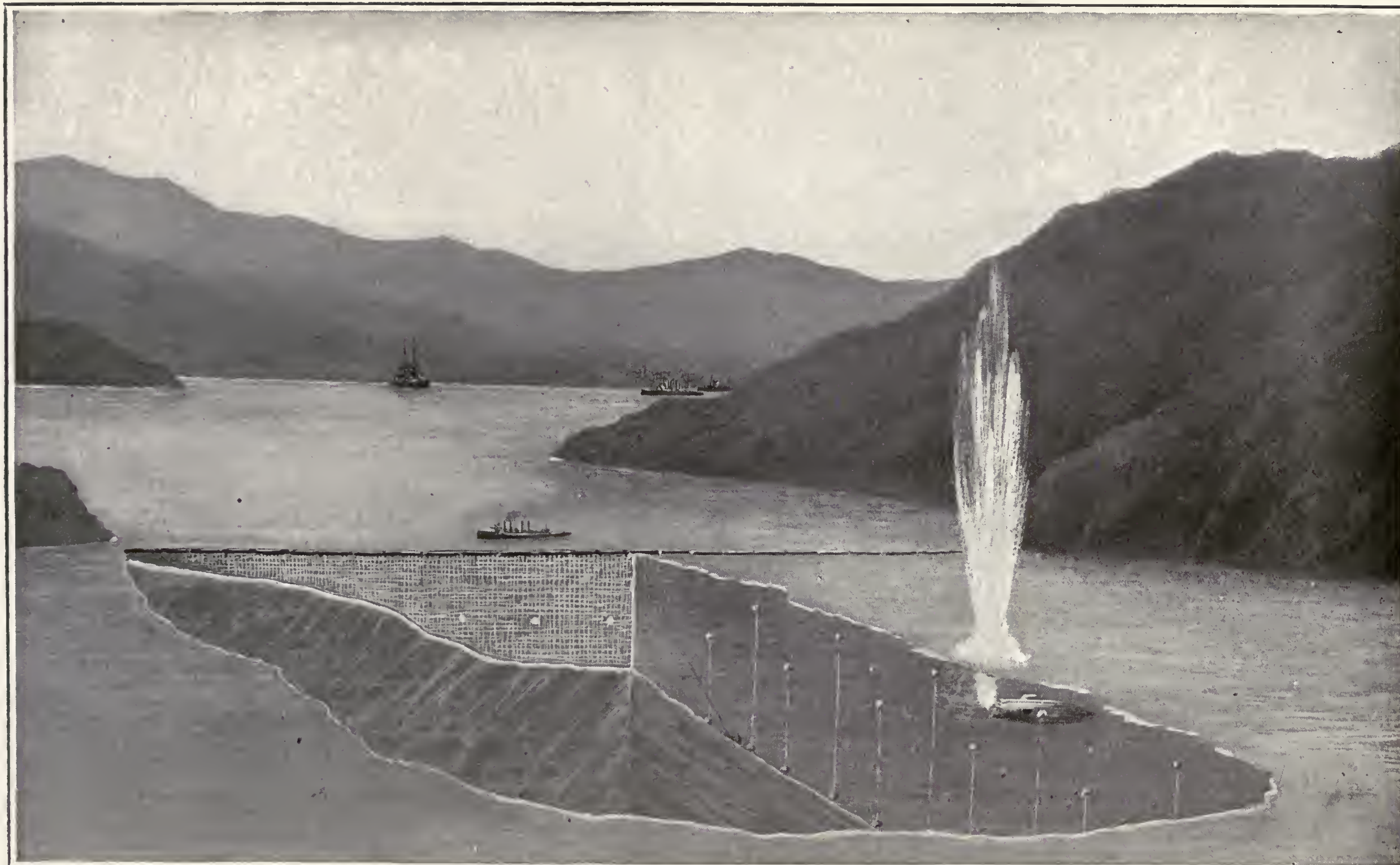
When a ship strikes the spherical mine, the latter is rotated and the contact lever is brought into touch with the hull of the ship, and by its action detonates the mine. In order to reduce the chances of a ship's passing unscathed through a mine field, the mines are sometimes laid in pairs, each pair being connected by a length of cable supported by floats, as shown in our illustration. In this case, when the bow of a ship engages the connecting cable, the two mines are drawn inwardly against the side of the ship, the effect, of course, being doubly destructive.

The only possible defenses against mines are countermining and sweeping. In the former case the attempt is made to set off the mines by detonating high explosives among them. The more effective method is to remove the mines altogether by "sweeping" operations, which are carried out as follows: Two vessels of light draft, such, for instance, as torpedo-boat destroyers or tugs, or (as in the case of sweeping operations carried out by the English in the North Sea) steam trawlers, proceed through the mine field abreast of each other, say, from 100 to 200 yards apart, and drag over the bottom of the mine field a length of heavy chain, which is connected at its ends to the two mine-sweeping vessels. The chain as it is dragged over the bottom engages such mines as lie in its path, which are destroyed by contact with each other or by a few well-directed shots from the vessels of the mine-sweeping fleet.

Operations of this character can be carried out only in the open sea or in waters that are not protected by the fire of shore batteries. In the case of mine fields protecting the channel entrances to harbors, dockyards, etc., the fields are covered by the fire of rapid-fire batteries, conveniently located on either shore.



THE OLD AND NEW "PENNSYLVANIA." COMPARISON OF SHIPS AND GUNS



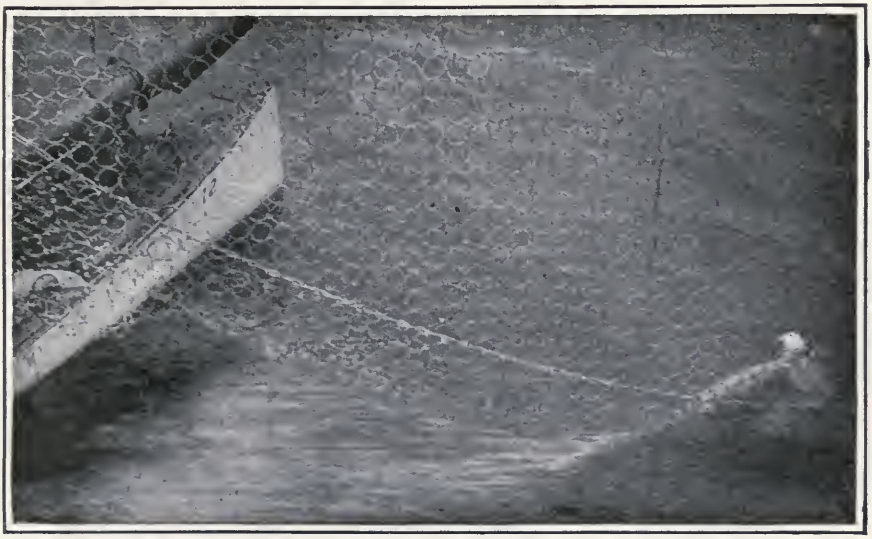
HARBOR DEFENSE CONSISTING OF A MINE FIELD SUPPLEMENTED BY A HEAVY STEEL NET HUNG FROM SOLID LOG BOOMS—AN EXCELLENT DEFENSE AGAINST SUBMARINES, ONE OF WHICH IS SHOWN IN CONTACT WITH A MINE

Chapter XLIV.

GUARDING AGAINST UNDER-WATER ATTACK

Ingenious Devices for Protecting Harbors and Shipping

A STUDY of the history of naval and military attack and defense shows that every new means of attack has been met by a more or less effective form of defense. Thus, in the past half century of naval warfare, the ever-increasing power of the gun has been met by a fairly commensurate improvement in armor, the iron plating of the French ships in the Crimean war being followed, successively, by the compound plates of steel and iron, the homogeneous all steel plate, the Harveyized plate with its carbonized surface, and lastly, the gas-hardened Krupp plate with the various later improvements of the Krupp system. The Whitehead torpedo carried on the swift torpedo boat found its answer in the high-velocity rapid-fire rifle and in the more minute sub-division of the hull of the warship. Bomb-dropping from aeroplanes and airships has its answer in high-angle rifle fire and in the covering of the magazines and other vulnerable portions of the ship by screens of horizontal armor.



THIS PHOTOGRAPH SHOWS A TORPEDO CAUGHT BY ITS PROPELLER IN A BATTLESHIP TORPEDO NET

The latest, and in certain conditions of warfare, the most deadly means of attack, the submarine, still awaits an effective answer, as the successful exploits of the Ger-

DEFENSES AT ENTRANCE TO A BRITISH HARBOR, CONSISTING OF PAIRS OF HEAVY SUPERIMPOSED CABLES, LOOPED TOGETHER WITH LIGHTER CABLES

man submarine flotilla have most conclusively proved.

Long before the great European war, it had been recognized that the submarine was essentially the weapon of the weaker power, and therefore of what might be called the offensive-defensive. Ten years ago, when the speed, range, and sea-keeping qualities of the submarine were very limited, it was considered that its rôle would be confined to harbor defense, and that, even in this restricted sphere, its value would be moral rather than material. That is to say, the dread of unseen attack would at once prevent a close blockade by the enemy and would have a wearing-down effect on the *morale* of the officers and men.

So rapid has been the development of the past decade, that the largest of the German submarines has a displacement of 800 tons, a surface speed of about 17 knots, a speed submerged of about 10 knots, and a theoretical radius of action on the surface of 3,000 to 3,500 miles. One of the United States submarines has remained submerged, with the crew aboard, for twenty-four hours; and, in the opinion of our submarine officers, it would be possible, by the use of chemical purification of the air and by drawing on the air supply of the submerging and trimming tanks, for one of our submarines to remain submerged for several days.

The living quarters of the largest vessels are sufficiently commodious for a fair degree of comfort, and the cooking, washing, and toilet refuse can be discharged in diluted form by force-pumps. The range of the submarine is limited not so much to the capacity of the fuel tanks as by the endurance of the crew. If the weather is fine and the submarine can proceed, undetected, at the surface, the cruise might extend to one or two thousand miles, without a return to port. In surface cruising in rough weather, the watch is continually drenched, and the lack of means to dry the clothing and other discomforts would render an earlier return to port a physical necessity.

So far, no single effective means of defense, such as that of armor against the gun and the gun against the destroyer, has been devised against the submarine. Protection must be sought in the co-operation of several precautions, which, in their aggregate effect, should afford, and doubtless are affording, a fair measure of security. Among these may be mentioned: Through sub-division of the hull; interior armor; a careful lookout from the ships and by aeroplane scouts; a high cruising speed and frequent changes of course; instant ramming by destroyers; and the rapid-fire gun. The above defenses are effective if the fleet is under way. If the fleet is at anchor in a roadstead or harbor, protection may be afforded against the submarine by mine-fields, heavy chain cable entanglements and netting.

The best protection against the submarine, so far as the absolute loss of a ship is concerned, is a thorough system of sub-division. Large ships such as the "Cressy," "Hogue," and "Aboukir," which went down rapidly after being torpedoed, were of an older type, built at a date when sub-division, judged by present-day ideas, was comparatively limited. In later ships of the largest size, such as battleships and battle-cruisers, sub-division has been made so minute, that it is believed a ship of the type of our "Pennsylvania" could take the blows of two or even three torpedoes, without going to the bottom. The pre-dreadnoughts of the "Connecticut" class have over five hundred separate watertight compartments, big and little, below the protective deck.

Of late years great attention has been given to the question of working into the hull a certain amount of longitudinal armor, for the purpose of meeting the force of the torpedo explosive on the outer skin, or of confining its effects to the outer portion of the hull and preserving intact the vitals. Thus, the flagship of the British fleet, the "Iron Duke," is generally credited with having thin armor extending below the main belt down to the bilges, this armor being applied externally. A more common method is to run a longitudinal wall of armor about two inches in thickness, along the inner side of the series of torpedo compartments, near the outer skin, with which all capital ships are provided. The main object of such armor is to protect the magazines, which, if they be reached by the shock and heat of the torpedo explosion, are liable to be set off and the ship nstantly and absolutely destroyed.

RENO PLAN OF CATCHING SUBMARINES BY TRAILIJNG ROPES ATTACHED TO SUBMERGED RINGS, THE ROPES FOUL THE PROPELLERS. HER DISTRESS WILL BE NOTICED BY COSTON LIGHTS IGNITED AT THE SURFACE

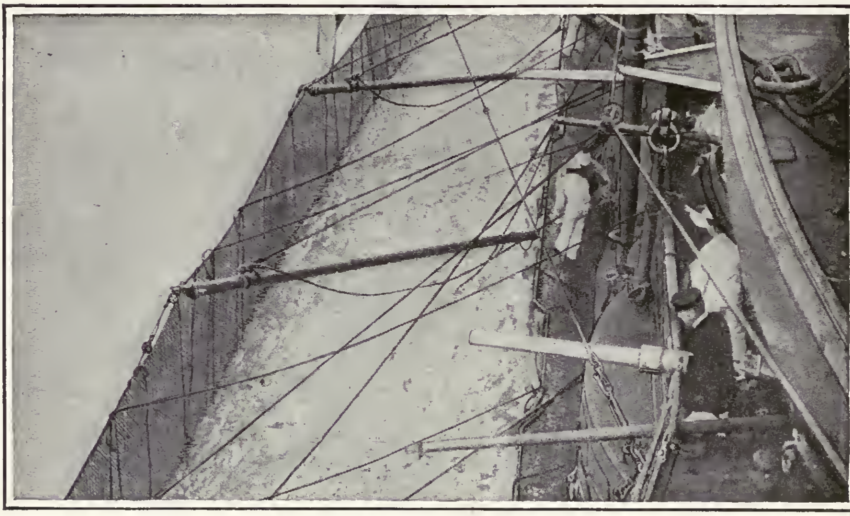
In calm weather it is surprising at what a distance the periscope of a submarine can be detected by a good look-out. In rough weather, however, it is difficult to make out even the wash of the periscope until the submarine is within point blank range. Experimental work done by our army aviators has proved that in clear and calm weather it is possible to detect a submarine even at a considerable depth, when the aviator flies at a height, say, of about 2,000 feet. In rough water it is more difficult so to detect the submarine, although, if it were running with its periscope exposed, a hydro-aeroplane searching around a ship that was steaming slowly on patrol duty would probably detect the approach of the enemy in time for the cruiser to make a change of course.

PROTECTION BY RAMMING AND THE RAPID-FIRE GUN.

The tactics used when an attack is expected are for the scouts and destroyers to attempt to sink the submarine by putting on full speed and making a rush for its periscope in the hope of hitting that, or even the hull itself. If the submarine were ever so lightly touched by the sharp forefoot of a destroyer running at high speed, it would be ruptured and the vessel sunk; also if the periscope were broken off or bent, there would probably be leaking around the stuffing boxes, and disablement would follow.

PROTECTION BY HIGH SPEED AND CHANGE OF COURSE.

Although the surface speed of the latest submarines runs from 15 to 17 knots, this speed is not available during attack. A submarine must submerge, and in the submerged condition the speed is only from, say, seven to nine, or perhaps ten knots. The best protection, therefore, for a patrolling fleet, is never to let the speed drop below about fifteen knots; for where there is a difference of five knots in the speed, the submarine's only chance of getting within range will come when it finds itself in or near the course of



TORPEDO NET SUSPENDED BY BOOMS AND CABLES FROM THE SIDE OF A BATTLESHIP

VIEW AT BOW OF "MOLTKE" (SISTER TO "GOEBEN"), SHOWING CREW SEATED ON TORPEDO NET, WHICH IS ROLLED UP AGAINST SIDE OF SHIP a hostile ship that is bearing down upon it. Hence, for self-protection, cruisers on patrol or scout duty should not only maintain a good rate of speed, but they should make a frequent change of course.

A great naval campaign can be brought to a decisive conclusion only when the battleship fleets have met and fought it out in a general engagement.

The fleets of a weaker power usually take positions in various harbors and roadsteads, entrances to which are blocked by mine-fields, by heavy booms, and by netting and cables. Behind this protection, the ships themselves are safeguarded by torpedo netting, which is boomed out from the vessel, and extends like a curtain for nearly the full depth of the hull.

We present several illustrations showing the methods by which a harbor with its contained fleet may be rendered secure against the insidious attacks of the submarines. No submarine of the standard type would attempt to pass through a mine-field, particularly if the mines were anchored at varying depths, as shown in our illustration. Contact with one or other of the mines, either by a direct blow or by becoming entangled in the cables, would be inevitable if an attempt were made to break through.

Simon Lake, it is true, worked out a method by which a submarine could move over the floor of a channel as has been described. Should a submarine manage to get through the mine-field, however, it might find itself opposed by entanglements consisting of heavy steel netting, or of interlaced cables hung in the manner shown in our illustrations of an actual device of this kind, as installed in one of the British harbors. Several enemy submarines have been caught in this manner.

FANS TO DISTRIBUTE ASPHYXIATING GASES. INTRODUCED SINCE CHAPTER XXVI. WAS WRITTEN

Chapter XLV.

AERIAL TORPEDOES AND TORPEDO MINES

Using the Aeroplane to Launch Torpedo on Its Death-dealing Journey

IF the modern automobile torpedo can only thrust its nose against the side of a warship, that ship ceases to exist as a fighting unit of the fleet; instantly it is put out of action, and probably it will go to the bottom. The blow of a single modern torpedo, carrying from 200 to 300 pounds of explosive in its warhead, can send any one of the older warships to the bottom in quick time, as witness the loss of the "Aboukir," "Cressy," and "Hogue"; and it is pretty well certain that the blow of two torpedoes would do the same for the most modern dreadnought.

That the torpedo will cripple or sink the enemy, if it once gets home, is an absolute certainty; but the great problem is to bring the gun-platform from which the torpedo is fired sufficiently close to the target to make sure of this overwhelmingly destructive weapon hitting the mark.

As matters now stand, there are three methods of bringing the torpedo within hitting range—the hitting range in the most powerful modern torpedoes being 10,000 yards. First, they may be fired from battleship-cruisers and other large surface vessels through under-water tubes; second, they may be fired from tubes carried upon the decks of torpedo-boat destroyers; and third, they may be fired from submarines. Aimed attack from under-water tubes on large warships is not likely to be very effective, for the reason that such ships will fight at long ranges, which, in the case of armored vessels, will probably be from 8,000 to 10,000 yards. Torpedo attack from destroyers must also, usually, be carried out at considerable ranges—this for the reason that the anti-torpedo, rapid-fire battery can concentrate such an overwhelming fire that the chances of the destroyers getting within point-blank range, at least in the daytime, are very remote. Torpedo attack from submarines is not limited to distant ranges; since it is possible for a submarine to approach, undetected, within a few hundred yards of its prey. The limitations of submarine attacks are due to the slow speed, both on the surface and submerged, of the submarine as compared with the ship attacked. At the surface the submarine must keep outside of the range of torpedo-defense guns, and, if it submerges, it at once becomes blind and its slow speed renders it very improbable that it can get within striking distance of an enemy that is moving rapidly.

To render torpedo attack absolutely effective, the torpedoes should be launched at a distance of between 1,500 and 2,000 yards, at which ranges the torpedo officer can estimate the speed of the ship aimed at so closely that the torpedo with its high speed of 35 to 40 knots is certain of finding its quarry.

The problem of delivering torpedo attack at this close range has been worked out along novel and promising lines by Admiral Bradley A. Fiske of the United States Navy, who has conceived the bold idea of using a swift and powerful aeroplane for bringing the torpedo within the point-blank zone of fire and delivering the attack at distances which will make a hit inevitable. Admiral Fiske's method, as illustrated, is to attach the torpedo below the body of the aeroplane in such a way that its axis will coincide with the longitudinal axis of the machine. The attachment is such that the airman, by pulling a lever, can release the torpedo at the moment when it is alined on the proper course rise to an altitude of from 2,000 to 2,500 feet, and approach until it was within striking distance, when it would descend in a sharp spiral within a short distance of the water.

Drawn by Edwin F. Bayha DELIVERING TORPEDO ATTACK BY AEROPLANE Copyright

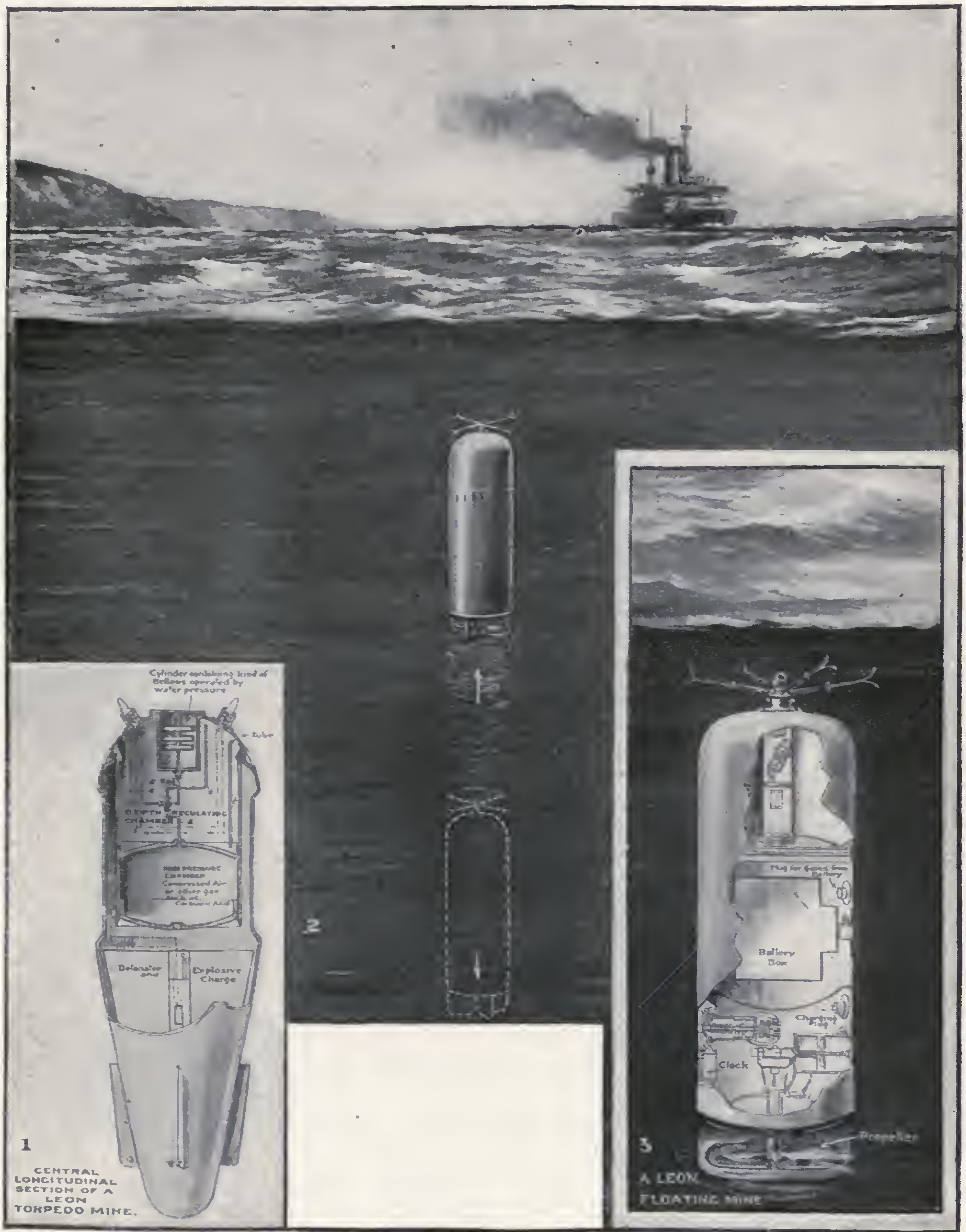
to make a hit. Once it has dropped into the water, its automatic mechanism will submerge it to the required depth of about fifteen feet and steer it unerringly to the target.

In making the attack, the aeroplane would The airman would now steady his machine for an instant, until it and its torpedo were pointing on the true line of fire, when the attack would be delivered by the simple pulling of the lever above mentioned.

The preferred time of attack would be on a clear night on which the dark mass of the ship to be attacked would be plainly discernible from above. The chances of discovery by the searchlights of an enemy before the aerpolane was within firing distance would be remote; and even in case of discovery, it would be difficult for the ship's guns to hit a fast-flying machine that was descending in rapid spirals of small diameter.

Torpedo Mines—A New Invention

THE French battleship "Bouvet" was stated by the British Admiralty to have been "blown up by a drifting mine" in the Dardanelles; while H.M.S. "Irresistible," "having probably struck a drifting mine," and H.M.S. "Ocean" "also having struck a



By courtesy of "The Illustrated London News"

THE LATEST TYPE OF LEON TORPEDO MINE. SHOWING HOW IT OSCILLATES IN THE WATER mine, both vessels sank in deep water." It has since been reported, unofficially, that the type of drifting mine used by the Turks is believed to have been the Leon torpedo, two forms of which are illustrated herewith. That on the left (Fig. 1) is the earlier of the two, patented in 1907. Fig. 3 represents its latest development, and Fig. 2 shows how it oscillates vertically in the water. This mine was invented by Capt. Karl Oskar Leon of Karlskrona, Sweden. A torpedo mine is so called because it can be ejected from a tube like a torpedo. It does not, however, move horizontally like a torpedo by its own power, but it can be set to oscillate more or less vertically beneath the surface at any desired depth. In the type shown in Fig. 1, the oscillating mechanism is regulated by means of compressed air in a chamber within the mine. The bellows are extended by increase of water pressure and contracted by its decrease. Water is admitted to the depth regulating chamber and expelled from it through the tube *t*, which communicates with the water surrounding the mine. The explosion of the mine is caused by impact with the two spring-pressed horns seen projecting at the top in Fig. 1. The mine shown in Fig. 3 floats almost vertically in the water. It sinks to a certain prearranged depth at which the propeller is automatically actuated to drive it up again. The action of the propeller can be made to begin and cease at any depth desired. The time during which the mine is to float can be regulated so as to reach objective at moment desired.—[*Drawings copyrighted in the United States and Canada by the Illustrated London News.*]

Courtesy of "Illustrated London News"

A ZEPPELIN PURSUED BY A FRENCH BIPLANE

Chapter XLVI.

THE IMPORTANCE OF THE COMMAND OF THE SEA*

A Resumè of the Results Achieved Through Holding It

THE contest between Italy and Turkey has a double interest. It illustrates on the one hand the gradual, yet perpetual, process by which a higher civilization impinges upon a lower; that is, upon one that is lower in virile efficiency, however in some instances it may have been higher in acquired material comfort, or even in literary and artistic achievement. This tendency can neither be regulated by law, nor brought to the bar of law, without injury to the progress of the world toward better universal conditions, to which end it is essential that the efficient supplant the inefficient. On the other hand, this collision illustrates the importance of the command of the sea. This also, it should be noted, has been incidental and determinative in the progress of the world. Through having this command, Italy thus far has been able to localize the land fighting in Tripoli, and probably can continue to do so; to the great relief of her own resources, and that of a watching and anxious Europe.

It is to this second consideration that I am here limited by my subject—"The Importance of the Command of the Sea"—with a somewhat special reference to that importance as touching the United States. The United States in her turn, after having achieved national efficiency, by the quenching of internal discord in a bitter and bloody contest, has found herself compelled inevitably into the same path of seeming aggression upon less efficient social and political communities; to bear her part of "the white man's burden," as it has been styled. For in essence this process is not one of aggrandizement, but of responsibility; responsibility not to law, which always lags behind conditions, but to moral obligation entailed by the particular circumstances of the moment of action.

This moral side of the question is not irrelevant to the military one of the importance of commanding the sea; for granting the end—the moral obligation—the means, if not themselves immoral, follow as a matter of course. Of such means, command of the sea is one. Napoleon said that *morale* dominates war; and it is correspondingly true that a sense of right powerfully reinforces the stability of national attitude and the steadfastness of national purpose. If we have been right, morally, step by step, in the forward march of the past few years, we are morally bound to sustain the position attained, by measures which will provide the necessary means. Of these an adequate navy is among the first; probably, in our case, the chief of all.

Here, as always, it is necessary to recur to experience—to the past—in order to comprehend the present and to protect the future. Why do English innate political conceptions of popular representative government, of the balance of law and liberty, prevail in North America from the Arctic Circle to the Gulf of Mexico, from the Atlantic to the Pacific? Because the command of the sea at the de-

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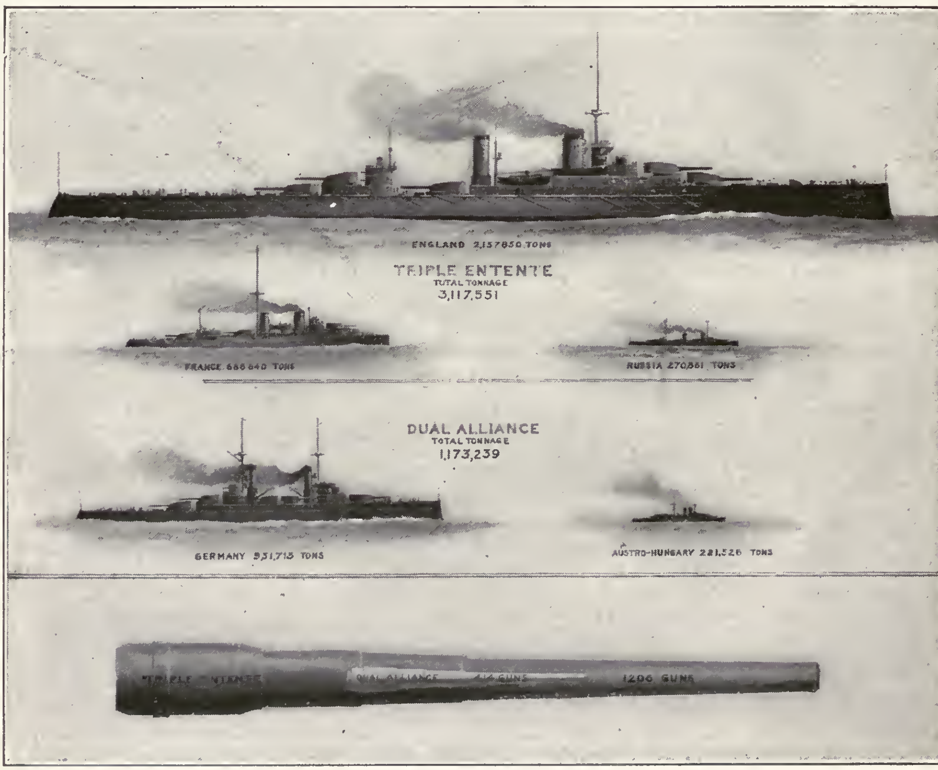
* This article was written by the late Rear-Admiral Mahan in December, 1911, and is of interest as showing the prophetic vision of the late authority on "Command of the Sea."

cisive era belonged to Great Britain. In India and Egypt, administrative efficiency has taken the place of a welter of tyranny, feudal struggle, and bloodshed, achieving thereby the comparative welfare of the once harried populations. What underlies this administrative efficieney? The British navy, assuring in the first instance British control instead of French and thereafter communication with the home country, whence the local power without which administration everywhere is futile. What, at the moment the Monroe Doctrine was proclaimed, insured beyond peradventure the immunity from foreign oppression of the Spanish-American colonies in their struggle for independence? The command of the sea by Great Britain, backed by the feeble navy but imposing strategic situation of the United States, with her swarm of potential commerce-destroyers, which a decade before had harassed the trade of even the mistress of the seas.

Less conspicuously, but no less truly, to what do Algiers and Tunis, and to what eventually will Morocco, own redemption from conditions barely, if at all, above the barbarous? To the command of the sea by the nation which already has restored the former two, to be fruitful members of the world community. That South Africa is now a united commonwealth, instead of two opposing communities, such as the North and South of our own country might have been, is due to the same cause; a local preponderance of force insured by sea power. It may safely be claimed that to the navy of the United States chiefly is owing the present Union, instead of the existence of two rival nations vying, or trying to vie, with each other in military preparations, like the nations of Europe. The four years' struggle of the Confederate States might not have ended in exhaustion, had it not been for the blockade, which shut in their cotton and shut out their supplies.



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RELATIVE STRENGTH OF COMPLETE NAVIES OF TRIPLE ENTENTE AND DUAL ALLIANCE, SHOWN BY RELATIVE LENGTH OF SHIPS AND GUNS AT THE OUTBREAK OF THE WAR

Contrast this impressive exhibit, where the command of the sea has been operative, with the history and achievement of those great States which have not possessed it. Contrast Bosnia and Herzegovina for Austria, Alsace and Lorraine for Germany, with the expansion of France, Great Britain, Holland, and with that which Spain once possessed; now lost through inefficiency, one of the first symptoms of which was the decay of her navy. The magnificent efficiency of the present German Empire strives now, against almost hopeless disadvantage, for the opportunity to exercise that efficiency outside its European limits. Opportunity was lost through the absence of naval force in the past centuries, when the maritime countries were occupying, and, in accordance with their respective political aptitudes, were determining the future of immense tracts of the world. Much time must elapse before we shall know the inside history of the still unarranged dispute with France about Morocco; but there is reason to believe that the consciousness of the British navy at the back of France has been one of the large factors in the negotiations. At least it is apparent that bitterness against Great Britain has been even more marked than against France.

The lesson of the United States is plain. In the strategic position before mentioned, in remoteness from Europe, in the rivalries of European nations, we still have a local and international advantage for preponderance in American waters; but it is not so great as to confer certainty without reasonable provision for insuring command of the sea. In the Pacific, which is equally our coast line, and to which the future mostly looks, we have no similar advantage. Much as I dislike and reject the phrase "supremacy in the Pacific," it is true that we there have duties which in case of disputes will require the presence of naval force adequate to command. Duty to the mutual support of our two chief coasts dictates full control of the Panama Canal, which from the military standpoint is the key to any broadly-planned system of preparation for national defense.

But obligation is no less on account of the Philippine Islands. Having assumed control of these under imperative circumstances, we are bound in honor to support an undertaking, our fitness for which is attested by results. To them we are responsible for the maintenance of conditions under which material prosperity can advance, and their dissimilar and discordant inhabitants reach a homogeneous civilization and political development which will enable them to govern themselves. To Cuba, though independent, we owe by specific guarantees the maintenance of a like internal security. These national and international functions can be discharged, certainly, only by command of the sea. The Pacific, the Atlantic, and the Caribbean, with the great controlling stations, Porto Rico, Guantanamo, the Canal Zone, and Hawaii, depend upon this command, the exponent of which is the navy, and in which ships and stations are interdependent factors. To place the conclusion concretely and succinctly, the question of command of the sea is one of annual increase in the navy. This question is not "naval," in the restricted sense of the word. It is one of national policy, national security, and national obligation.

A. T. Mahan

Rear-Admiral, U. S. N.

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THE BRITISH SUPER-DREADNOUGHT "QUEEN ELIZABETH." DISPLACEMENT, 27,500 TONS. SPEED, 25 KNOTS. ARMOR: WATERLINE BELT, 13½-INCH; MIDDLE BELT, 10-INCH; UPPER BELT, 8-INCH; UNDER-WATER BELT, 2-INCH. GUNS: EIGHT 15-INCH; SIXTEEN 6-INCH; TWELVE 3-INCH ANTI-AEROPLANE GUNS

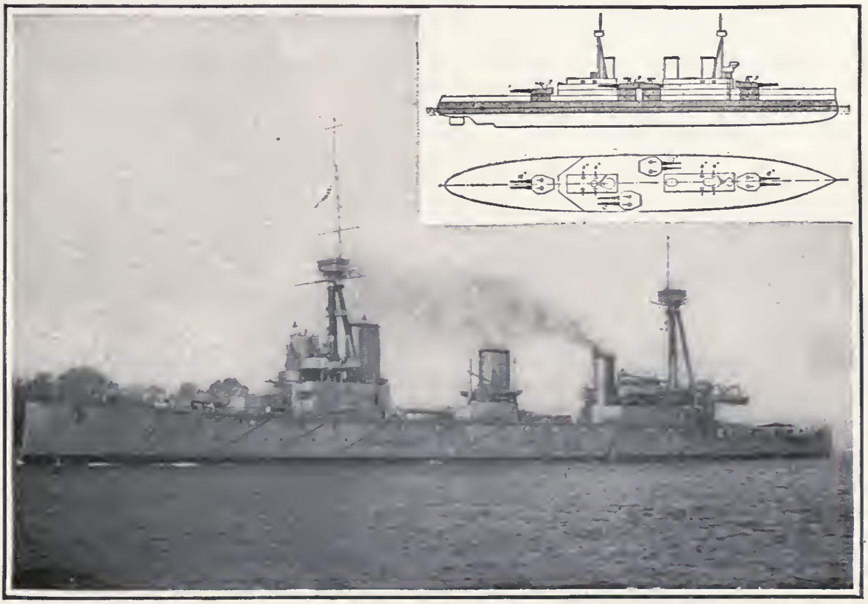
Chapter XLVII.

THE MISTRESS OF THE SEAS

Great Britain's Overpowering Navy

Photos by Stephen Cribb, Symonds & Co., and E. W. C. Hopkins

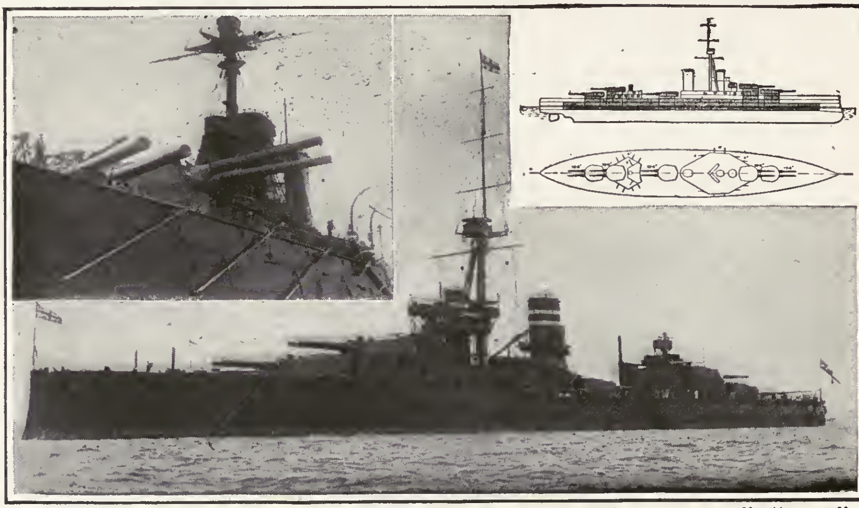
THE British fleet, composed of nearly five hundred ships of an aggregate displacement of about two and one quarter million tons, is the military force which binds together and preserves intact that vast aggregation of countries and peoples known as the British Empire. Great as it is, the British navy is not by any means excessive; it merely measures up to the enormous responsibilities that are laid upon it. So far as the British Isles are concerned, its purpose and scope are exactly the same as those, let us say, of the great German army, namely, to afford complete security from attack by hostile nations.



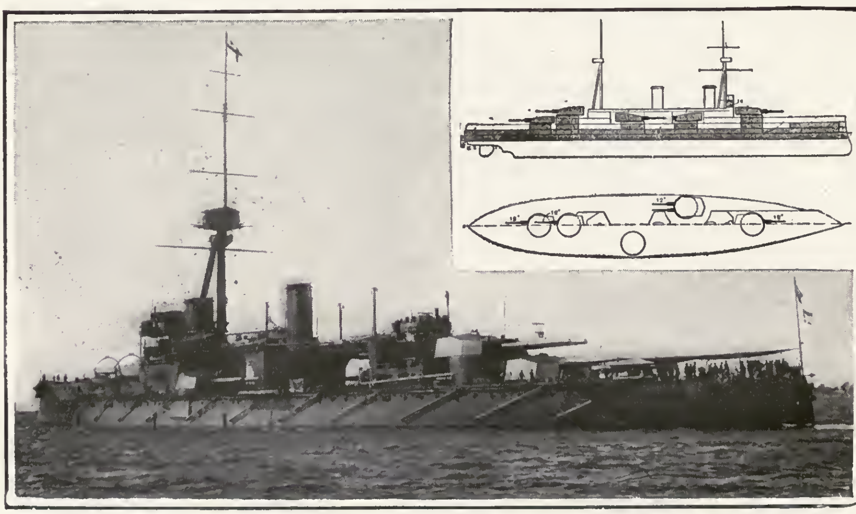
BATTLE-CRUISERS: "INDEFATIGABLE"; "NEW ZEALAND"; "AUSTRALIA"; "INVINCIBLE"; "INFLEXIBLE"; "INDOMITABLE." DATE, 1909-1911. TONS, 17,250-18,750. SPEED, 27-28 KNOTS. GUNS, EIGHT 12-INCH, SIXTEEN 4-INCH. TORPEDO TUBES, 3. SIDE ARMOR, 8-INCH—7-INCH

The duties of the British navy, however, do not end with the mere protection of the British Isles from invasion; for to the navy falls the work of protecting Great Britain's enormous seaborne commerce; and hence we find that the list of her ships includes over one hundred fast and powerful cruisers, to which in the event of war falls the duty of patrolling the ocean lines of travel, seeking out and destroying the cruisers of the enemy, and making it possible for her vast fleet of merchant ships to carry her exports abroad and bring in munitions of war and supplies from foreign nations, of which latter, during hostilities, her greatly needed food supply would form the most valuable part.

The German fleet was forced out of the North Sea and into the shelter of the Baltic and Germany's home ports, but the cruisers and commerce destroyers of the enemy have been driven from the trade routes, so they have ceased to be a menace to British, French, and Russian shipping. Furthermore, so secure does Great Britain feel behind the protecting arm of her fleet, that she sent the whole of her trained army to the Continent, to the field of war without any fear of molestation.

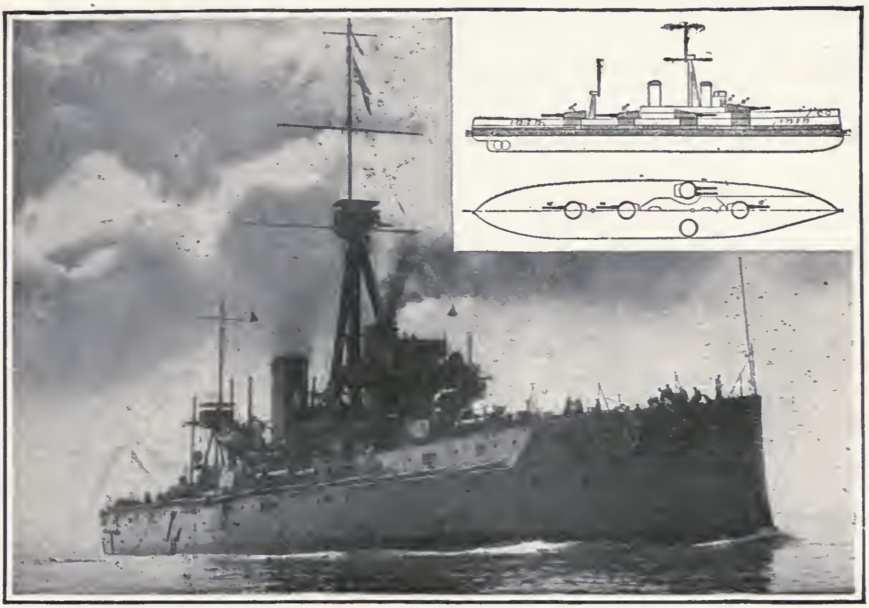


DREADNOUGHTS: "ORION"; "CONQUEROR"; "MONARCH"; "THUNDERER"; "AJAX"; "CENTURION"; "KING GEORGE V." DATE, 1912-1913. TONS, 23,000. SPEED, 22 KNOTS. GUNS, TEN 13.5-INCH, SIXTEEN 4-INCH. TORPEDO TUBES, 3. SIDE ARMOR, 12-INCH, 9-INCH, 8-INCH

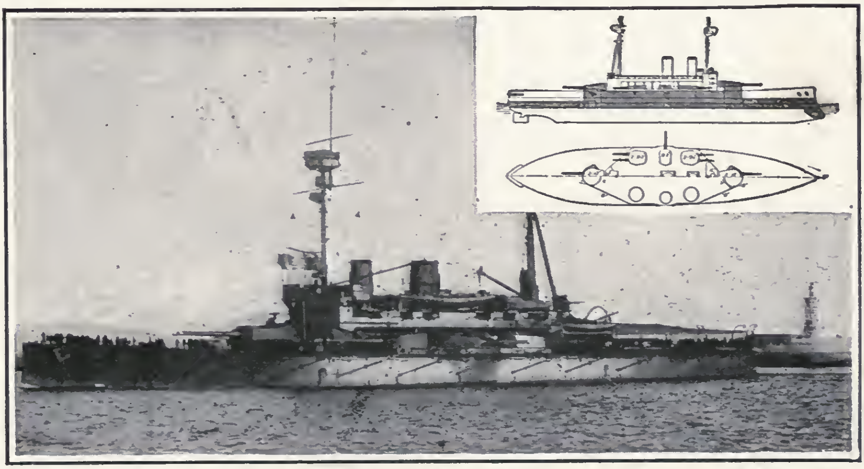


DREADNOUGHTS: "HERCULES"; "NEPTUNE"; "COLOSSUS." DATE, 1911. TONS, 20,000. SPEED, 21.5 KNOTS. GUNS, TEN 12-INCH, SIXTEEN 4-INCH. TORPEDO TUBES, 3. SIDE ARMOR, 11-INCH—8-INCH

The first fighting line of the British navy is made up of no less than thirty-one ships of the dreadnought class, the earliest of which—the original dreadnought—is now not more than nine years old (September, 1915). All of these ships have a speed of from 21½ to 22 knots, and their displacement varies from 18,000 to 25,000 tons. The first seven this of 8-inch armor. Following these, come the three dreadnoughts of the "Hercules" class, of 20,000 tons and 21.5 knots speed. They carry ten 12-inch guns and a torpedo battery of sixteen 4-inch guns, or two less than the

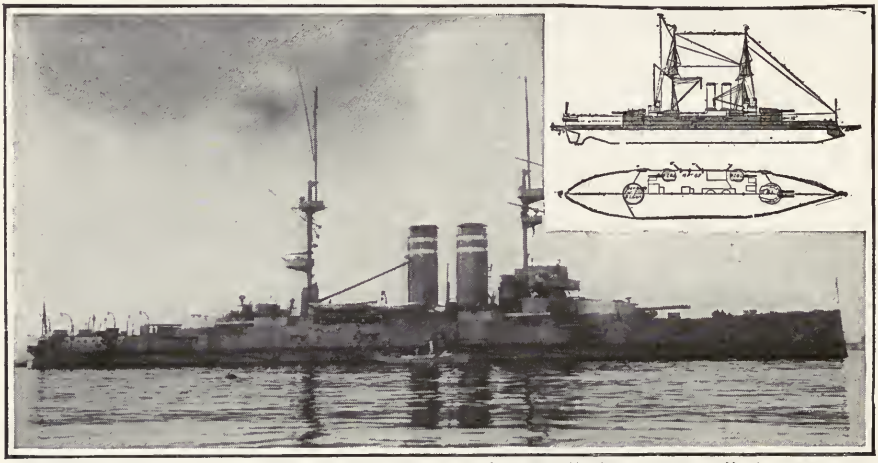


DREADNOUGHTS: "DREADNOUGHT"; "BELLEROPHON"; "TEMERAIRE"; "SUPERB"; "COLLINGWOOD"; "ST. VINCENT"; "VANGUARD." DATE, 1906-1910. TONS, 18,000—19,250. SPEED, 22—21.8 KNOTS. GUNS, TEN 12-INCH, EIGHTEEN 4-INCH; ORIGINAL "DREADNOUGHT," TWENTY-FOUR 3-INCH. TORPEDO TUBES, 3. SIDE ARMOR, 11-INCH, 10-INCH, 8-INCH

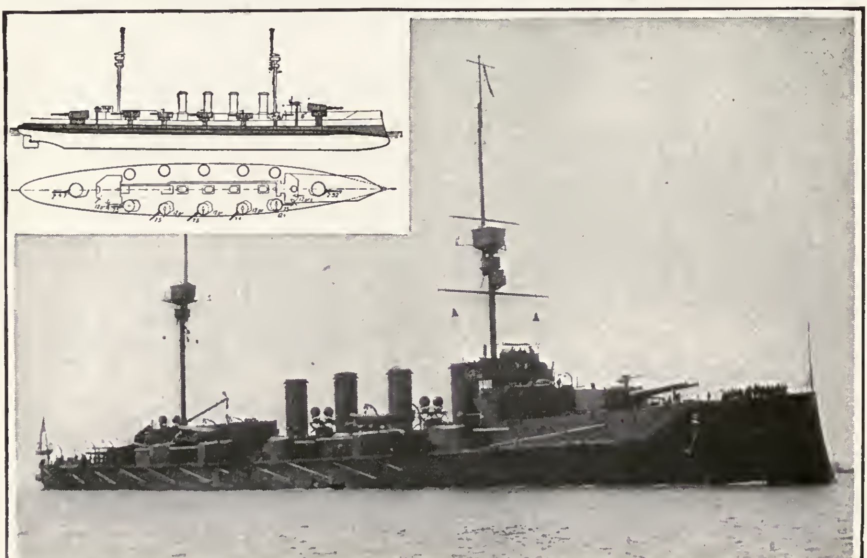


SEMI-DREADNOUGHTS: "LORD NELSON"; "AGAMEMNON." DATE, 1908. TONS, 16,500. SPEED, 19 KNOTS. GUNS, FOUR 12-INCH, TEN 9.2-INCH. TORPEDO TUBES, 5. SIDE ARMOR, 12-INCH—8-INCH

follow the lines of the original "Dreadnought." They were launched between 1906 and 1910. They mount ten 12-inch guns in five turrets, three on the center line and one on each beam. The belt armor is 11 inches in thickness, and there is an upper belt above torpedo battery of the preceding dreadnought ships, which mount for torpedo defense a battery of eighteen 4-inch guns. The turrets are disposed: three on the center line of the ship, and two amidships, placed diagonally. This arrangement gives an end-on fire at bow and stern of six 12's and a broadside of ten 12's. In respect of broadside fire these three ships are superior to the earlier dreadnoughts, above-mentioned, which suffer from the serious defect that one of the broadside turrets with its two guns is masked by the superstructure, leaving only eight guns available on each broadside. To these ships must be added the dreadnought "Osman I.," built for Turkey and taken over by the British government after the declaration of war. This fine vessel, of 27,500 tons and 23 knots speed, carries the unusual battery of fourteen 12-inch guns in seven turrets, all mounted on the center line. She is protected by a 9-inch belt and 6-inch upper belt, and she carries a heavy torpedo-defense battery of twenty 6-inch guns.

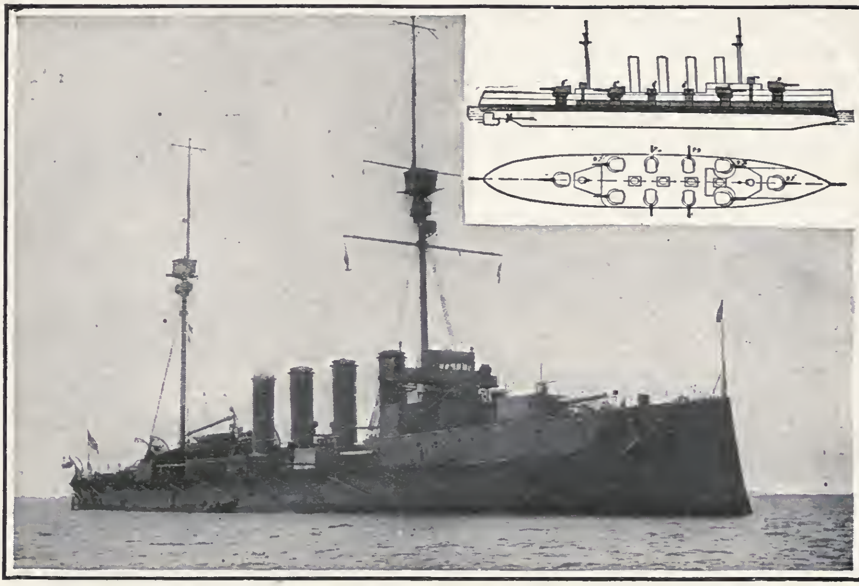


SEMI-DREADNOUGHTS: "KING EDWARD VII"; "AFRICA"; "BRITANNIA"; "COMMONWEALTH"; "DOMINION"; "HIBERNIA"; "HINDUSTAN"; "ZEALANDIA." DATE, 1905-1906. TONS, 16,350. SPEED, 18.5—19.5 KNOTS. GUNS, FOUR 12-INCH, FOUR 9.2-INCH, TEN 6-INCH. TORPEDO TUBES, 5. SIDE ARMOR, 9-INCH, 8-INCH, 7-INCH



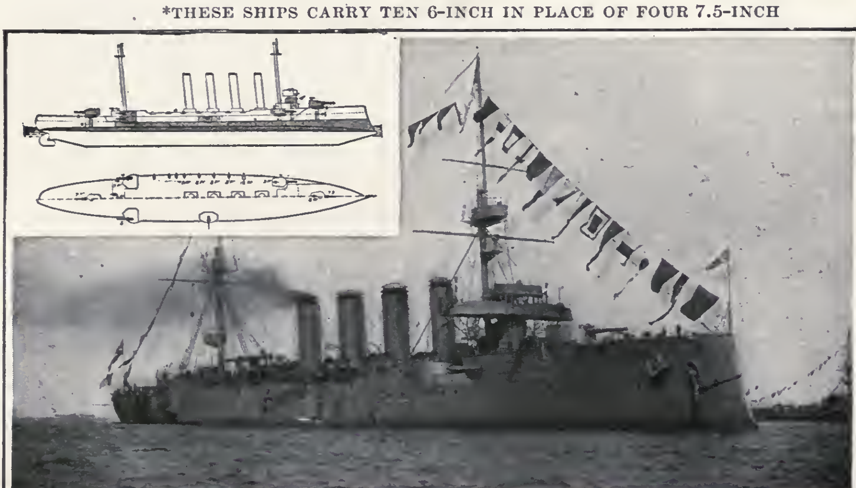
ARMORED CRUISERS: "MINOTAUR"; "DEFENSE"; "SHANNON." DATE, 1908. TONS, 14,600. SPEED, 22.5—23 KNOTS. GUNS, FOUR 9.2-INCH, TEN 7.5-INCH. TORPEDO TUBES, 5. SIDE ARMOR, 6-INCH

In 1912 and 1913 Great Britain completed eight dreadnoughts of 23,000 tons and 22 knots speed, which are armed with ten of the new 13.5-inch guns, mounted in five turrets on the center line. The side armor was increased in extent, consisting of a 12-inch water-line belt, with 9-inch and 8-inch side armor above. These ships marked a great advance upon their predecessors, the shell of the 13.5-inch gun weighing 1,400 pounds as against a weight of 850 pounds for the 12-inch gun, and the energy has gone up from 50,000 tons to 70,000 tons. In the next following ships of the "Iron Duke" class—finished in 1914—the displacement was increased to 25,000 tons. The main armament is the same, namely, ten 13.5-inch guns, and the torpedo defense battery has been increased in power by substituting twelve 6-inch for sixteen 4-inch. The side armor is heavier, consisting of a 12-inch belt with 10 inches of armor from the belt to the upper deck. To these four ships must be added the dreadnought "Reshadieh," built for Turkey and taken over by the British government on the declaration of war, a ship of 23,000 tons and 21 knots speed, carrying ten 13.5-inch guns and sixteen 6-inch guns.



ARMORED CRUISERS: "COCHRANE"; "ACHILLES"; "NATAL"; "WARRIOR"; "DUKE OF EDINBOROUGH";* "BLACK PRINCE."* DATE, 1906-1907. TONS, 13,550. SPEED, 23.3 KNOTS. GUNS, SIX 9.2-INCH, FOUR 7.5-INCH. TORPEDO TUBES, 3. SIDE ARMOR, 6-INCH

*THESE SHIPS CARRY TEN 6-INCH IN PLACE OF FOUR 7.5-INCH

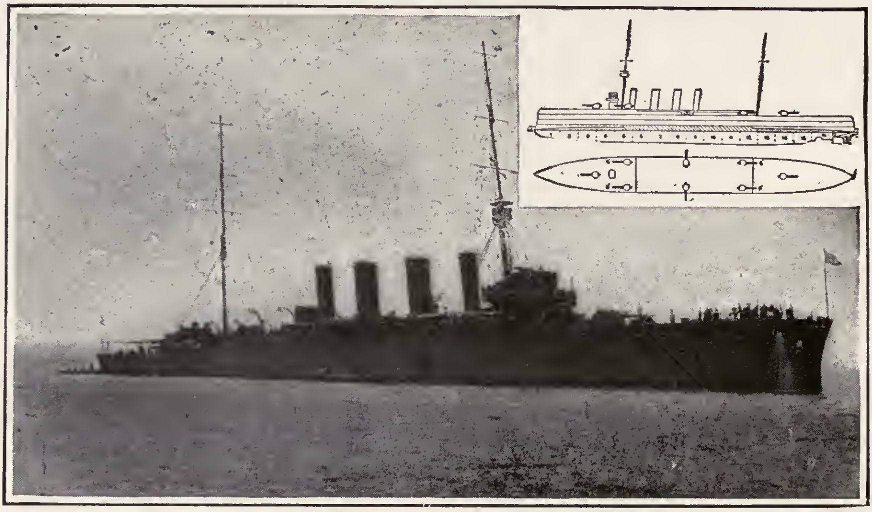


ARMORED CRUISERS: "ANTRIM"; "DEVONSHIRE"; "ARGYLL"; "CARNARVON"; "HAMPSHIRE"; "ROXBURGH." DATE, 1905-1906. TONS, 10,850. SPEED, 22-23.5 KNOTS. GUNS, FOUR 7.5-INCH, SIX 6-INCH. TORPEDO TUBES, 2. SIDE ARMOR, 6-INCH

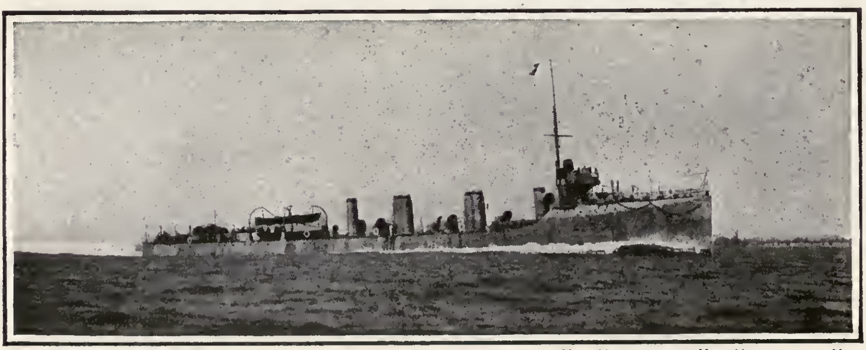
In addition to the dreadnoughts above mentioned, there are six battle-cruisers of the "Indefatigable" type, ships of from 17,250 tons to 18,750 tons and having speeds of from 27 to 28 knots, and side armor from 8 to 7 inches in thickness. Each of these ships carries eight 12-inch guns in four turrets, one forward and one aft on the center line and one on each broadside, arranged diagonally. The latest ships of the battle-cruiser type are the "Queen Mary," the "Lion," and the "Princess Royal," of 26,350 to 27,000 tons, with a speed of from 28 to 29 knots, and side armor 9 inches in thickness. Each of these ships carries eight 13.5-inch guns in four turrets arranged on the center line.

Summing up then, the first fighting line of the British navy consists of thirty-one ships, fifteen of which are armed with 12-inch guns and sixteen with the 13.5-inch guns.

Next in fighting value to the dreadnoughts are the ten ships of the "Lord Nelson" and "King Edward VII." classes, which ships might justly be termed semi-dreadnoughts, as coming intermediately in gun power between the pre-dreadnoughts and the dreadnoughts. The 16,500-ton "Lord Nelson" and "Agamemnon," completed in 1908, are of 19 knots speed, and carry four 12-inch and ten 9.2-inch guns all in turrets, the 12-inch being mounted in twin-gun turrets forward and aft, and the 9.2's in turrets on the broadside. The eight ships of the "King Edward" class completed in 1905 and 1906 are of 16,350 tons and 18.5 to 19.5 knots speed, and their main armament consists of four 12-inch and four



SCOUT CRUISERS: "CHATHAM"; "SOUTHAMPTON"; "DUBLIN"; "NOTTINGHAM";† "BIRMINGHAM";* "LOWESTOFT."† DATE, 1912-1913. TONS, 5,400. SPEED, 25.5 KNOTS. GUNS, EIGHT 6-INCH. TORPEDO TUBES, 2. ARMOR, 3-INCH DECK
*THESE SHIPS CARRY TEN 6-INCH IN PLACE OF FOUR 7.5-INCH GUNS. †THESE HAVE ALSO 2-INCH SIDE ARMOR



TORPEDO-BOAT DESTROYERS: "MOHAWK"; "AFRIDI"; "COSSACK"; "GHURKA"; "TARTAR." DATE, 1907. TONS, 865. SPEED, 34.5 KNOTS. GUNS, FIVE 3-INCH. TORPEDO TUBES, 2

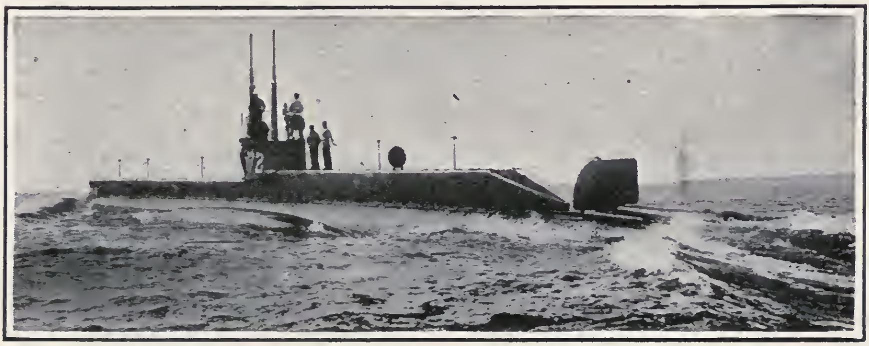
9.2-inch, with a secondary battery of ten 6-inch guns.

The remainder of the battleships of the British navy, thirty in number, are pre-dreadnoughts pure and simple. The latest of these, of the "Duncan" class, are of 14,000 tons, with a speed of 19 knots, and they are armed with four 12-inch and twelve 6-inch guns. They suffer from the defect that their side armor, 7 inches in thickness, is too light for ships of the battleship class. Better vessels are the eight ships of the "London" class, completed between 1901 and 1904. They are of 15,000 tons, with a speed of from 18 to 18½ knots. They are armed with four 12- and twelve 6-inch guns, their side armor being 9 inches in thickness. The illustrations of these two classes, herewith given, will serve to give a fairly correct idea of the other ships of the pre-dreadnought classes as to the disposition of guns.

ers of the unarmored type; that is, vessels which carry no side armor, but depend upon the protective deck at the water-line for keeping shot and shell out of the engine rooms and magazines. To-day, the most important cruisers are those of the fast scout type, represented by the "Chatham." These are vessels of 5,400 tons, having a speed of 25.5 knots, and carrying eight 6-inch guns.

Such scouts as England possesses are not quite as fast as could be wished, and in this respect they are inferior to the German scouts of the "Breslau" type, which are good for 27 to 27½ knots. Great Britain, however, is building a large number of these of from 27 to 30 knots speed, which will become available as the war proceeds.

Of torpedo-boat destroyers the navy possesses 167, and of torpedo boats, 49. We illustrate the "Mohawk," one of the fastest class of destroyers, which showed on trial a speed of 34.5 knots. The British have shown a tendency in later vessels to increase the size and ocean-going qualities, keeping the speed down to 29 or 30 knots.

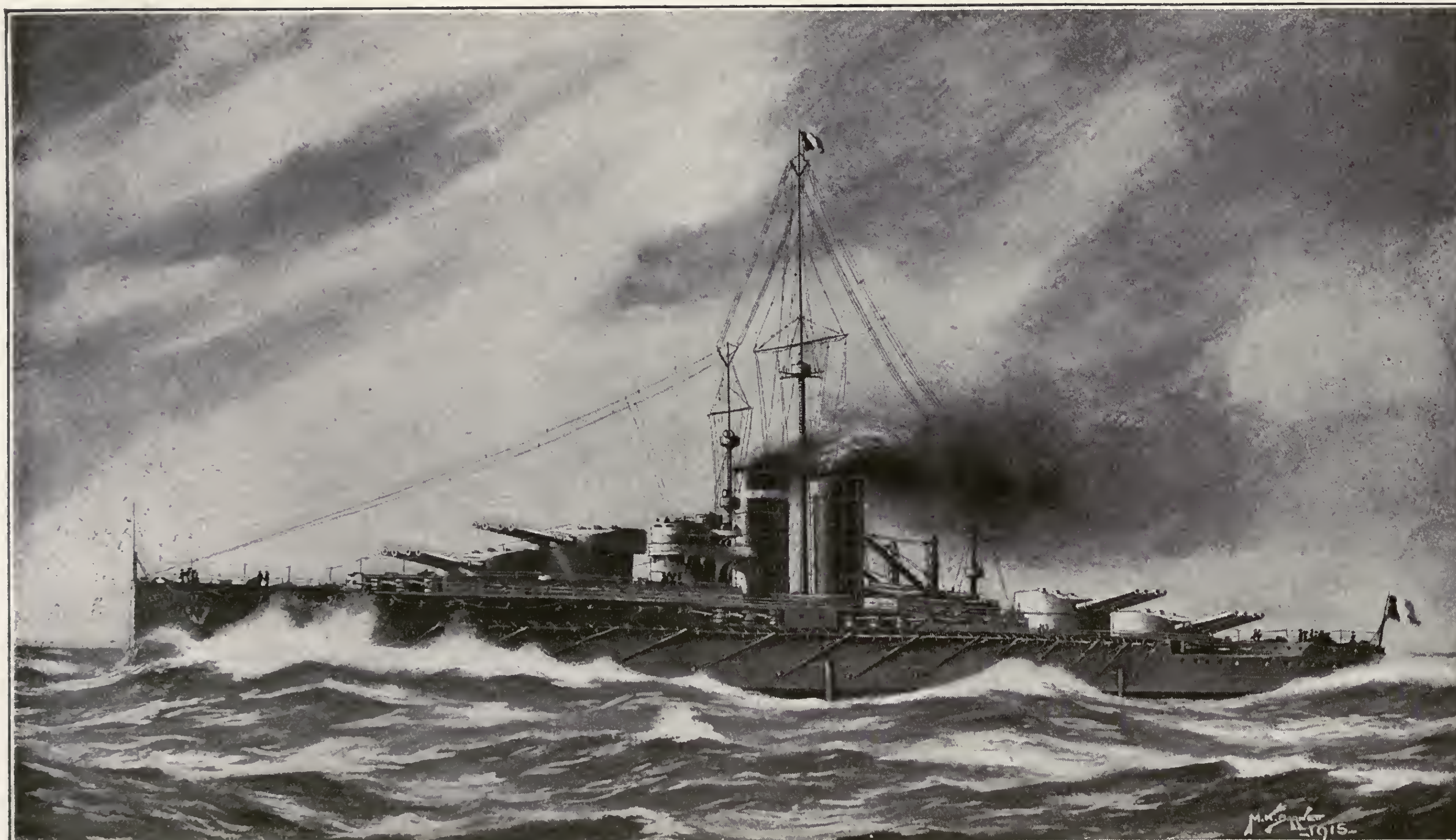


SUBMARINES: THE "D" CLASS OF EIGHT BOATS. DATE, 1911. TONS, 600. SPEED, 16 SURFACE, 10 SUBMERGED KNOTS. TORPEDO TUBES, 3. GUNS, TWO 3-INCH. RADIUS, 4,000 MILES

The British navy is strong in the armored-cruiser class, and we present illustrations of two of the finest types, the "Cochrane," of 13,550 tons and 23.3 knots speed, carrying six 9.2-inch and four 7.5-inch guns; and the "Minotaur" of 14,600 tons, carrying four 9.2-inch and ten 7.5-inch guns. Both are protected with 6-inch belts. There are six ships of the "Cochrane" type and three of the "Minotaur." We also show a view of the "Antrim," representing a class of six armored cruisers of 10,850 tons and 22 to 23.5 knots speed, carrying four 7.5-inch and six 6-inch guns and protected by 6 inches of armor.

Great Britain possesses seventy-four cruis-

Particularly strong is the British navy in submarines. Slow at first to take up the new type of craft, when she was once assured of its value England entered into the work of developing and building submarines with great activity. The one herewith illustrated is of 600 tons displacement and 16 knots surface speed. Vessels of this class are now being built which are to be capable of making 21 knots on the surface and a proportionately high speed (13¼ to 14 knots) when submerged.



THE NEW FRENCH BATTLESHIP "TOURVILLE." THE FIRST DREADNOUGHT TO CARRY SIXTEEN GUNS IN THE MAIN BATTERY
DISPLACEMENT, 29,500 TONS. SPEED, 23 KNOTS. GUNS, SIXTEEN 13.4-INCH, TWENTY-FOUR 5.5-INCH. TORPEDO TUBES, 6

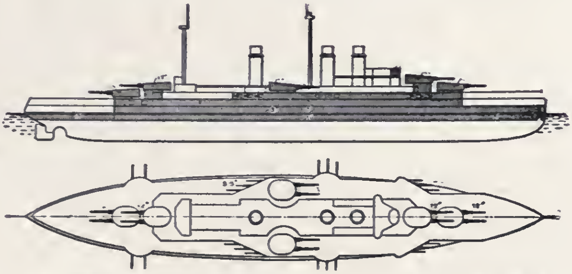
Chapter XLVIII.

THE NAVY OF FRANCE

The Guardian with Italy of the Mediterranean

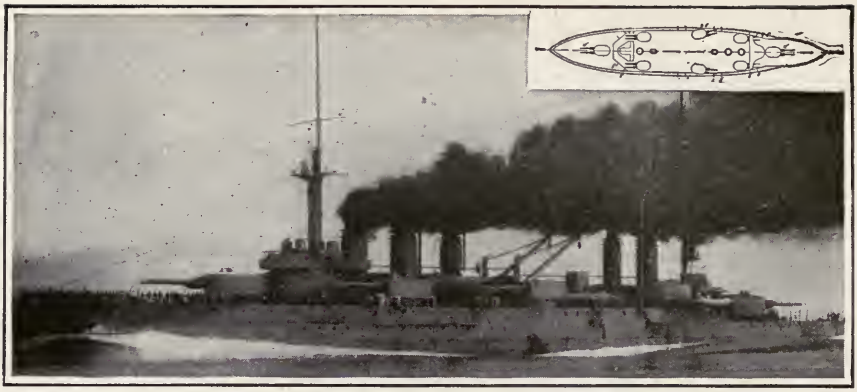
Photos by M. Bar, J. Kuhn, and Stephen Cribb

ALTHOUGH France has a large programme of new construction in hand, she possesses at present only the four dreadnoughts of the "Jean Bart" class, namely, the "Jean Bart," the "Courbet," the "France," and the "Paris." These are formidable ships of 23,500 tons and 21 knots speed, carrying twelve 13.4-inch guns in six turrets. Two of the turrets are arranged on the center line forward and two aft, after the American plan, initiated on our "Michigan." The other two turrets are carried, one on each beam, and this disposition permits of the very heavy end-on fire both forward and aft of no less than eight 13.4-inch guns, and a broadside fire of ten such pieces. The main belt is 11 inches thick, and there is an upper belt of 7-inch armor. These four ships have been completed during the present year.

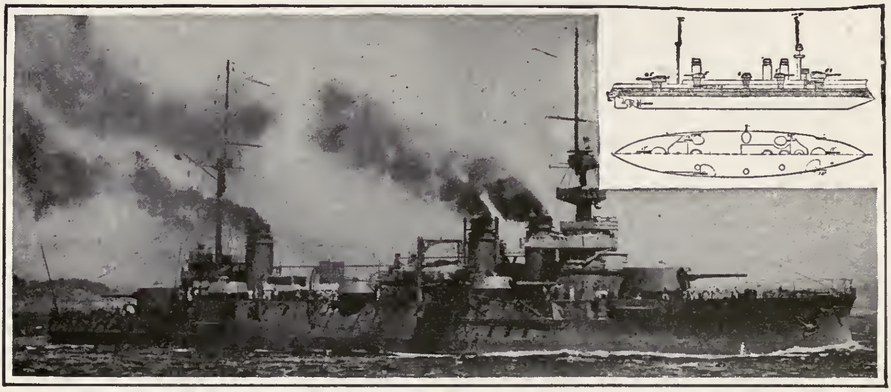


DREADNOUGHTS: "JEAN BART"; "COURBET"; "FRANCE"; "PARIS." DATE, 1914. TONS, 23,500. SPEED, 21 KNOTS. GUNS, TWELVE 13.4-INCH, TWENTY-TWO 5.5-INCH. TORPEDO TUBES, 4. SIDE ARMOR, 11-INCH—7-INCH

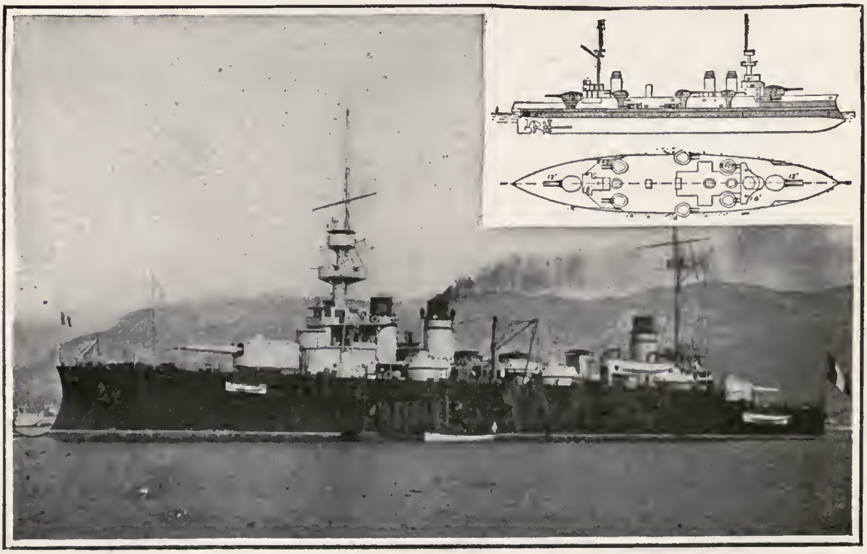
In 1911 France added to her navy six ships of the "Voltaire" semi-dreadnought class. These are of 18,400 tons displacement, with a speed of from 19½ to 20½ knots. They carry four 12-inch guns in two turrets forward and aft, and the heavy broadside battery of twelve 9.4-inch guns is mounted in six turrets. The side armor is 10 and 9 inches in thickness. The "Jean Barts" and "Voltaires" would be more than a match for the three Austrian dreadnoughts of the "Viribus Unitis" class and the three semi-dreadnoughts of the "Franz Ferdinand" class, which are described in the chapter on the Austrian navy. Of the remaining twelve French pre-dreadnoughts, the most important ships are those of the "Justice" and the "Republique" classes. These are of about 14,800 tons displacement and 19 knots speed. The "Justice" carries four 12-inch guns forward and aft and ten 7.6-inch guns on the broadside, six of them in single gun turrets and four in casemates. The "Republique" and "Patrie" are armed with four 12-inch guns and eighteen 6.4-inch, the latter being



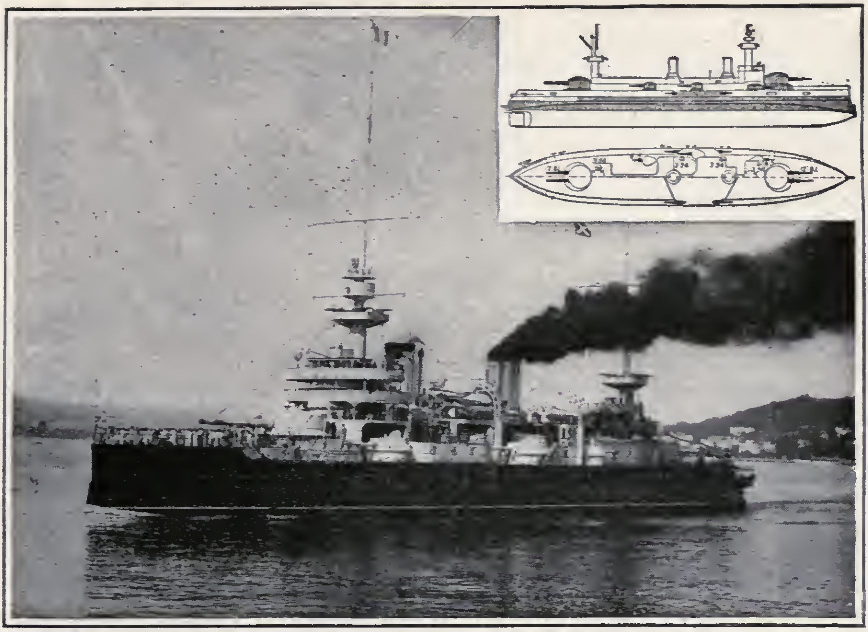
SEMI-DREADNOUGHTS: "VOLTAIRE"; "DANTON"; "CONDORCET"; "DIDEROT"; "MIRABEAU"; "VERGNIAUD." DATE, 1911. TONS, 18,400. SPEED, 19.5—20.5 KNOTS. GUNS, FOUR 12-INCH, TWELVE 9.4-INCH. TORPEDO TUBES, 2. SIDE ARMOR, 10-INCH—9-INCH



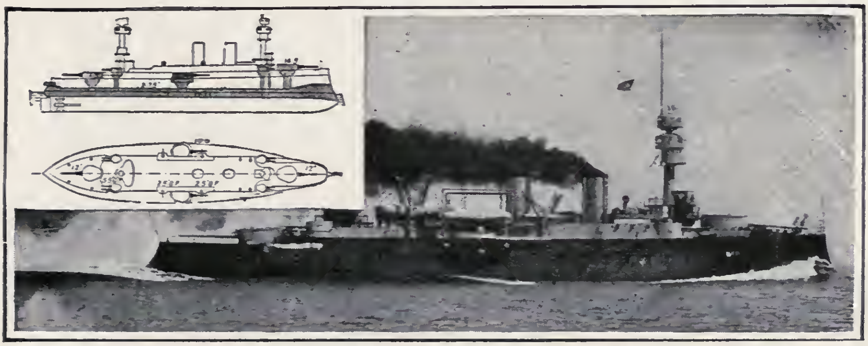
PRE-DREADNOUGHTS: "JUSTICE"; "DEMOCRATIC"; "VERITE." DATE, 1907-1908. TONS, 14,900. SPEED, 19.4 KNOTS. GUNS, FOUR 12-INCH, TEN 7.6-INCH. TORPEDO TUBES, 4. SIDE ARMOR, 11-INCH



PRE-DREADNOUGHTS: "REPUBLIQUE"; "PATRIE." DATE, 1906. TONS, 14,700. SPEED, 19 KNOTS. GUNS, FOUR 12-INCH, EIGHTEEN 6.4-INCH. TORPEDO TUBES, 5. SIDE ARMOR, 11-INCH



PRE-DREADNOUGHT: "SUFFREN." DATE, 1903. TONS, 12,750. SPEED, 18 KNOTS. GUNS, FOUR 12-INCH, TEN 6.5-INCH. TORPEDO TUBES, 4. SIDE ARMOR. 12-INCH—5¼-INCH



PRE-DREADNOUGHT: "JAUREGUIBERRY." DATE, 1893. TONS, 11,900. SPEED, 17.8 KNOTS. GUNS, TWO 12-INCH, TWO 10.8-INCH, EIGHT 5.5-INCH. TORPEDO TUBES, 2. SIDE ARMOR, 17¾-INCH—9¾-INCH

ARMORED CRUISERS: "VICTOR HUGO"; "JULES FERRY." DATE, 1906. TONS, 12,400. SPEED, 23 KNOTS. GUNS, FOUR 7.6-INCH, SIXTEEN 6.4-INCH. TORPEDO TUBES, 5. SIDE ARMOR, 6¾-INCH mounted on the broadside in six armored turrets. These five ships have water-line protection of 11 inches of armor.

The earlier pre-dreadnoughts, such as the "Suffren," "Boudet," and "Jaureguiberry," carry a main armament of two 12-inch and two 10.8-inch guns, with broadside secondary batteries and 5.5- and 6.5-inch pieces.

Unquestionably the most picturesque feature of the French navy is the armored cruisers, some of which, like the "Edgar Quintet," have no less than six smokestacks, which, though they may be attractive to the public eye, would present an equally attractive target to the enemy. The "Edgar Quinet" and "Waldeck Rousseau" are the finest of the twenty ships of the armored-cruiser class. They are of 14,000 tons and about 24 knots speed, and are protected by 6¾ inches of belt armor. In these, as in all the French armored cruisers, the battery is rather light, the 7.6-inch gun being the heaviest piece carried. Except in this particular, however, the French armored cruisers are very serviceable ships, well protected and showing a good turn of speed.

In the protected-cruiser class, the French navy is rather weak, possessing only nine ships of this type.

When we come to the torpedo-boat destroyer and submarine service, however, we find that the French navy is remarkably well equipped, possessing 84 destroyers and no less than 135 torpedo boats. On the average, the French destroyers are smaller than those of the other nations, although of late years the French have been building in larger sizes and have turned out for their navy some of the fastest vessels of this class afloat.

TORPEDO-BOAT DESTROYER: "FANION." DATE, 1908. TONS, 430. SPEED, 28 KNOTS. GUNS, ONE 9-POUNDER, SIX 3-POUNDERS. TORPEDO TUBES. 3

The submarine fleet of the French navy is very large, consisting of 64 boats, and we believe that this service is highly efficient.

Chapter XLIX.

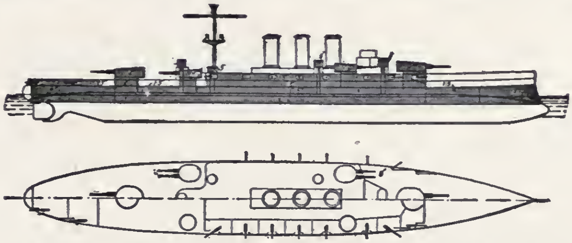
THE RUSSIAN NAVY

The Great Strength of Her Torpedo Fleet a Valuable Asset

Photos by Symonds & Co.

THE great War of the Nations came two or three years too soon for the Russian navy, which, so far as its first fighting line is concerned, is still in the making. The Japanese war practically wiped out the capital ships of the Russian fleet, and it was only in 1909 that she set about the re-creation of her navy upon modern lines. In that year she laid down four dreadnoughts, of 23,300 tons, which are to steam 23 knots, and will mount a battery of twelve 12-inch guns in four three-gun turrets. In 1912 she laid down four huge armored cruisers of 32,000 tons and 27 knots speed, which are to carry a battery of twelve 14-inch guns. Three dreadnoughts, of 22,500 tons, carrying ten 12-inch guns, are being built in the Black Sea.

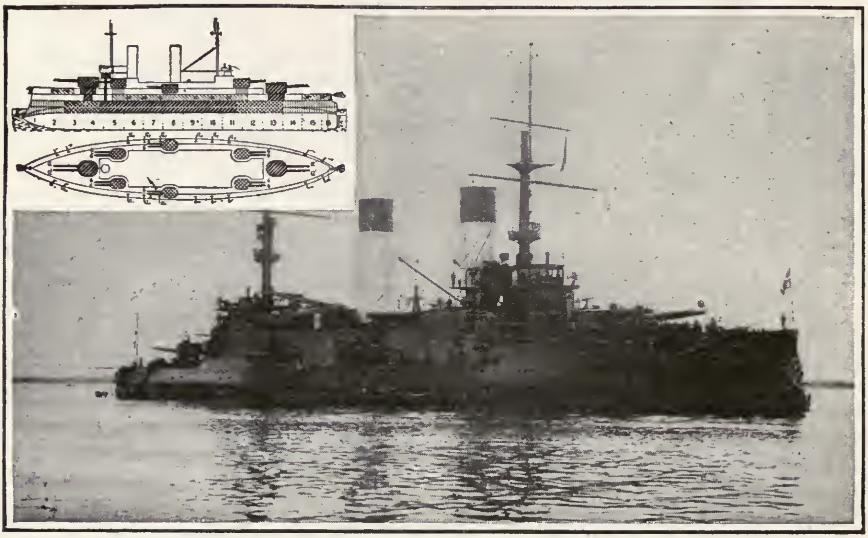
Of battleships, Russia has in commission in the Baltic only four pre-dreadnoughts. The two most modern of these are the "Imperator Pavel" and the "Andrei Pervoswanni," which were laid down in 1903 and completed in 1911. They are improved "Slavas," and they embody improvements suggested by the Japanese war. They are of 17,400 tons and 18 knots speed. The belt is 8½ inches, the upper belt 5 inches, and the rapid-fire battery protection is 3 inches thick. The armament consists of four 12-inch and no less than fourteen 8-inch and twelve 4.7-inch in the intermediate battery. The other two battleships are the "Slava" and "Tsarevitch," of 13.500 tons and 18 knots, protected by a 7¾—10-inch belt, and carrying four 12's and twelve 6's in turrets.



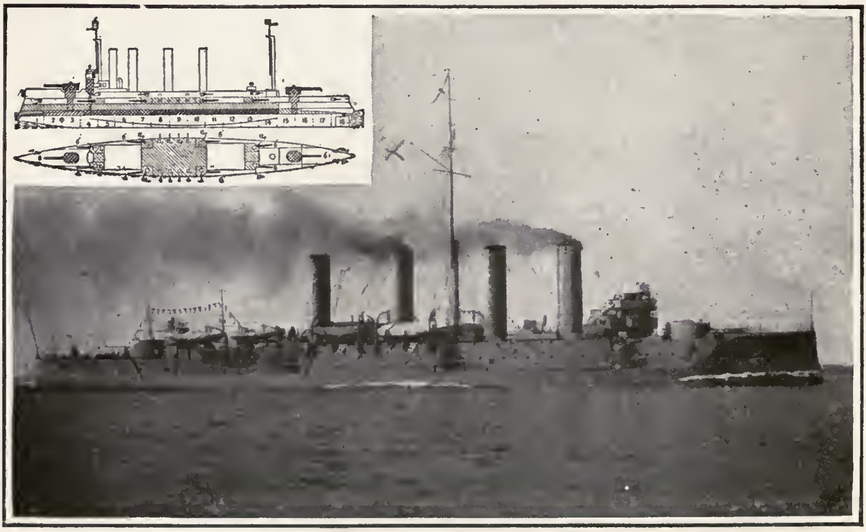
ARMORED CRUISER: "RURIK." DATE, 1907. TONS, 15,000. SPEED, 21.5 KNOTS. GUNS, FOUR 10-INCH, EIGHT 8-INCH, TWENTY 4.7-INCH. TORPEDO TUBES, TWO. SIDE ARMOR, 6-INCH—3-INCH

The most important of the armored cruisers is the "Rurik," of 15,000 tons and 21.5 knots, with a 6-inch belt, carrying a powerful armament of four 10's and eight 8's in the turrets, and twenty 4.7's behind 3-inch armor. The armored vessels of the "Admiral Makaroff" class are of 7,775 tons and 22.5 knots, with 7-inch side armor. They mount two 8's in turrets and eight 6's on the broadside. The "Gromoboi," 13,200 tons, and the "Rossiya," 12,500 tons, carry, respectively, a 6-inch and a 10-inch belt. Their speed is 20 knots, and each mounts four 8-inch and twenty-two 6-inch guns. They were completed in 1901 and 1898.

Of protected cruisers, Russia has in the Baltic two fast scouts, the "Moraviev" and the "Nevdskoy," of 4,500 tons and 27.5 knots, mounting eight 5-inch guns, and six older vessels, the "Juntchug," 3,050 tons and 24 knots; "Askold," 6,500 tons, 23 knots; "Bogatyr" and "Olef," 6,650 tons, 23 knots; and "Diana" and "Aurora," 7,600 tons, 20 knots per hour.



PRE-DREADNOUGHTS: "SLAVA"; "TSAREVITCH." DATE. 1905. TONS, 13,500. SPEED, 18 KNOTS. GUNS, FOUR 12-INCH, TWELVE 6-INCH. TORPEDO TUBES, 4. SIDE ARMOR, 7¾-INCH



ARMORED CRUISERS: "ADMIRAL MAKAROFF"; "BAYAN." DATE, 1907. TONS, 7,700. SPEED, 22.5 KNOTS. GUNS, TWO 8-INCH, EIGHT 6-INCH. TORPEDO TUBES, 2. SIDE ARMOR, 7-INCH—3¼-INCH

The most valuable asset of Russia in the Baltic is her torpedo fleet, consisting of 80 destroyers and 13 submarines. The earlier destroyers, built between 1895 and 1905, average about 370 tons displacement, and their speed is from 26 to 28 knots. The later boats, twenty in all, are from 500 to 650 tons, with speeds of 26 and 27 knots. A notable destroyer in size and speed is the "Novik," of 1,260 tons and 36 knots speed. Thirty-six new boats of this "Novik" class are being built. The Baltic fleet also includes 16 torpedo boats of from 120 to 200 tons and from 21 to 30 knots speed.

The submarines built between 1904 and 1909 vary from 150 to 500 tons in displacement, with surface speed of from 9½ to 15 knots. A dozen new boats are being built, of large size and high speed.

PROTECTED CRUISERS: "OLEJ"; "BOGATYR." DATE, 1902-04. TONS, 6,675. SPEED, 23-24 KNOTS. GUNS, TWELVE 6-INCH, TWELVE 3-INCH. TORPEDO TUBES, 4. ARMOR, 3-INCH DECK

TORPEDO-BOAT DESTROYERS: "KONDRATENKO"; "OKHOTNIK"; "POGRANITSCHNIK"; "SIBERSKIJ-STRELOK." DATE, 1905. TONS, 625. SPEED, 26 KNOTS. GUNS, TWO 3-INCH, SIX 6-POUNDERS. TORPEDO TUBES, 3

DREADNOUGHT "GUILIO CESARE" AND CLASS. DISPLACEMENT, 22,000 TONS. SPEED, 23 KNOTS. GUNS, THIRTEEN 12-INCH EIGHTEEN 4.7-INCH. BELT 9¾-INCH

Chapter L.

THE ITALIAN NAVY

The First Navy to Set Afloat Ships Combining High Speed With Heavy Guns

ALTHOUGH the Italian navy ranks as sixth in power among the leading navies of the world, it is absolutely first class in quality and its *personnel* is believed to be thoroughly efficient. Italian naval constructors have a reputation for originality and skill. Over a quarter of a century ago they launched two remarkable ships which were undoubtedly the forerunners of the modern battle-cruiser. They were known as the "Italia" and "Lepanto." They had the then unprecedented displacement of 14,400 tons and the then unrivaled speed for heavy-gunned ships of over eighteen knots. Each carried four 17-inch 100-ton breech-loading guns, and the bases of the smokestacks and the main battery were protected by armor of from 16 to 19 inches in thickness. A quarter of a century later it was that distinguished Italian naval officer, Cuniberti, who made the earliest, or one of the earliest, plans for a dreadnought battleship of large displacement, carrying an armament of big guns only.

SUBMARINE "G. PULLINO." DISPLACEMENT, 400 TONS, SPEED, 13 SURFACE KNOTS, 9 SUBMERGED KNOTS. TORPEDO TUBES, 2

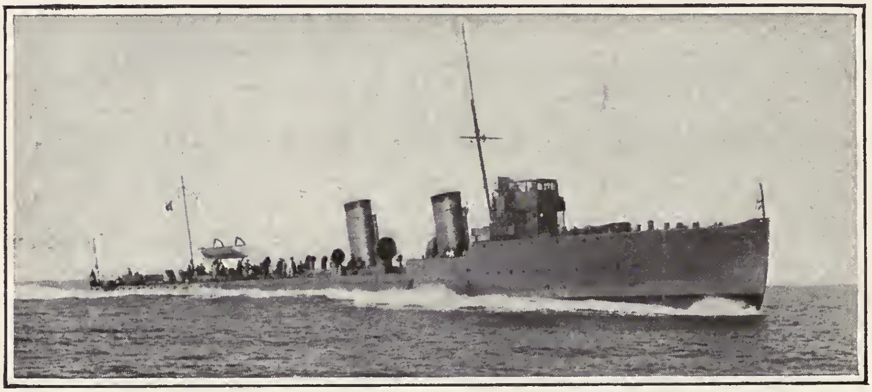
Commencing with the most important class of ships, the dreadnought, we find that Italy completed, in 1912, her first dreadnought, the "Dante Alighieri," a ship of 18,500 tons, designed for a speed of 23 knots, and carrying a main battery of twelve 12-inch 46-caliber guns and a torpedo battery of twenty 4.7-inch. The main battery is mounted in four three-gun turrets, all on the center line. The armor protection in this, as in all Italian dreadnoughts, is rather light, consisting of a 9⅞-inch belt and a 9- to 9½-inch protection for the main batteries.

In 1914 the three dreadnoughts, "Conte di Cavour," "Guilio Cesare" and "Leonardo da Vinci," were added to the fleet. These ships, of a speed of 23 knots and 22,000 tons displacement, are remarkable as being the first dreadnoughts to mount more than a dozen heavy guns, the main armament consisting of thirteen 46-caliber 12-inch guns, all mounted on the center line, as follows: Forward is a three-gun turret, astern of which and firing above its roof is a two-gun turret. Amidships between the two smokestacks is a three-gun turret, and aft are respectively, a two-gun turret and three-gun turret, the former firing above the roof of the latter. The belt and main gun position armor is, respectively, 9¾ inches and 9½ inches in thickness.

Italy is also generally credited with having completed two other ships of this class, the "Caio Duilio" and the "Andrea Doria." If the two last-named ships are completed, and it is probable that they are, Italy possesses a homogeneous squadron of six dreadnoughts, combining a great offensive power with high speed. Well handled and properly fought, they should be capable of overwhelming the four Austrian dreadnoughts of the "Viribus Unitis" class.

Italy has laid down and is doubtless now pushing along to completion with all her available forces a class of four 25-knot battleships of the "Queen Elizabeth" class. The first of these, the "Christopher Colombo," gives her name to the class. They are to be of 30,000 tons and 25 knots speed, and the battery will consist of eight 15-inch and sixteen 6-inch guns. Particulars as to the armor protection have not been made public.

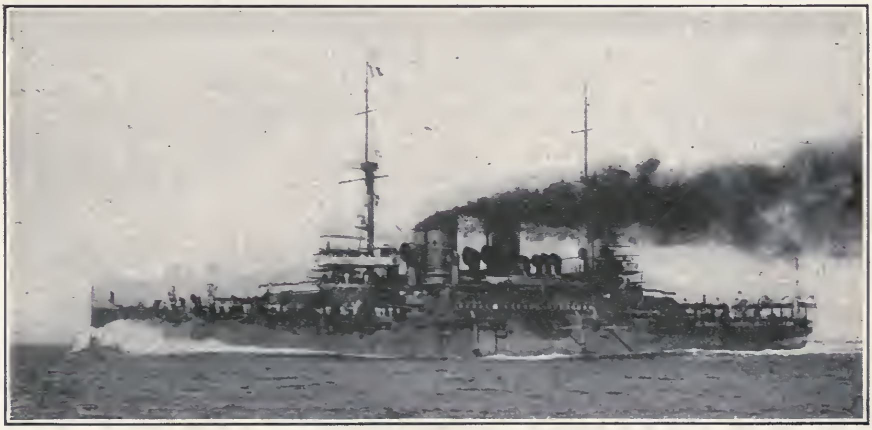
The Italian navy differs from any other in respect of its pre-dreadnought battleships; for the limited size, rather light armor protection, and comparatively light gun-fire of these ships would seem to place them more in the class of the armored cruisers than of the pre-dreadnought battleship. Most important of these are the four ships of the "San Giorgio" and "Pisa" classes, vessels of about 10,000 tons and 23 to 24 knots, protected with 8 inches of armor on the belt and main gun positions, and carrying four 10-inch and eight 7.5-inch guns, all mounted in two-gun turrets. These four ships were completed in 1909 and 1910. They could hardly stand up against the three semi-dreadnoughts of the "Ferdinand" class in the Austrian navy, which carry four 12-inch and eight 9.4-inch guns, but they would be a good match for the three ships of the "Karl" class, which



DESTROYER "AUDACE." DISPLACEMENT, 700 TONS. SPEED ON TRIAL, 36 KNOTS. GUNS, ONE 4.7-INCH, FOUR 3-INCH. TORPEDO TUBES, 2

PRE-DREADNOUGHT "PISA." DISPLACEMENT, 11,000 TONS. SPEED, 22 KNOTS. GUNS, FOUR 10-INCH, EIGHT 7.5-INCH. BELT, 8-INCH mount four 9.4-inch and twelve 7.6-inch guns. Next in point of age in the Italian navy are the three armored cruisers (or battleships, if you will) of the "Vittorio Emanuele" class of 12,625 tons and 21 knots speed, mounting two 12-inch 40-caliber and twelve 8-inch 45-caliber guns, the ships being protected by a 10-inch belt, with 8 inches on the main gun positions. These ships were completed in 1907-1908. Preceding these and completed in 1904 were the "Benedetto Brin" and the "Regina Margherita," of 13,500 tons and 20 knots, mounting four 12-inch and eight 8-inch guns, protected by a 6-inch belt and 8 inches on the main gun positions.

PRE-DREADNOUGHT "SAN MARCO." DISPLACEMENT, 10,000 TONS. SPEED, 24 KNOTS. GUNS, FOUR 10-INCH, EIGHT 7.5-INCH. BELT, 8-INCH



PRE-DREADNOUGHT "BENEDETTO BRIN." DISPLACEMENT, 13,500 TONS. SPEED, 20 KNOTS. GUNS, FOUR 12-INCH, FOUR 8-INCH, TWELVE 6-INCH. BELT, 6-INCH

In 1901 the Italians built five armored cruisers of a type which found its way into other navies besides their own. They are readily distinguishable by their possession of a single military mast placed amidships and centrally between the two smokestacks. The first of these, the "St. Bon" and the "Filiberto," completed in 1901, are of 9,800 tons and 18 knots, and they mount four 10-inch in turrets, eight 6-inch in a central battery, and eight 4.7-inch behind shields. They are protected by a belt of 9¾-inch nickel steel, with the same thickness on the barbettes. The other three, "Garibaldi," "Varese" and "Francesco Ferruccio," of 7,400 tons, carry one 10-inch and two 8-inch guns, and have 6 inches of armor on the belt and bow decks.

Of older armored ships built between 1887 and 1891, Italy has three battleships of the "Re Umberto" class, of 13,250 tons, mounting four old 13.5-inch, six old-type 6-inch, and sixteen 4.7-inch guns. They are good only for coast defense or the bombardment of coast fortifications, such as is being done by the other armored ships of the Allies at the Dardanelles.

The "Carlo Alberto" and "Vettor Pisani," completed some sixteen years ago, are armored cruisers of 6,500 tons, mounting twelve 6-inch and six 4.7-inch guns. Their present speed is about 18 knots.

Of fast scouts, Italy possesses four of about 3,500 tons and 28 knots speed, carrying a main armament of six 4.7-inch guns. She has eight or ten light cruisers varying in displacement from 2,200 tons to 3,800 tons, and in speed from 18 to 22 knots. Her navy includes also half a dozen gunboats of from 20 to 23 knots speed.

PRE-DREADNOUGHT "AMALFI." DISPLACEMENT, 11,000 TONS. SPEED, 23½ KNOTS. GUNS, FOUR 10 INCH, EIGHT 7.5-INCH. BELT, 8-INCH

The destroyer fleet of the Italians is first-class in quality and it is believed to be very capably handled. Built and building, it includes about fifty vessels varying in size from 300 to 1,500 tons, and in speed from 28 to 32 knots. The 1,500-ton vessels are under construction, as are also three of 1,000 tons and ten of 770 tons. Of mine layers, Italy possesses three vessels of 850 tons and 20 knots speed.

The Italian submarine fleet includes about a score of vessels completed and, as far as is known, about a dozen under construction. The "Argo" class of about 300 tons displacement are credited with a surface speed of 18 knots and an under-water speed of 14 knots.

The total strength of the Italian navy in officers and men is about 38,000.

Chapter LI.

THE GERMAN NAVY

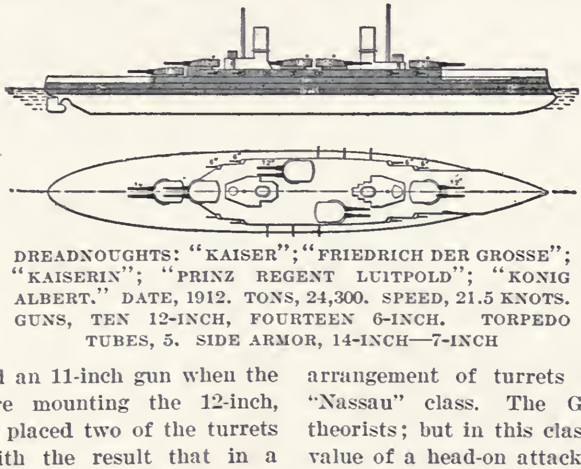
A Modern Navy Copied Largely from British Designs

Photos by A. Renard.

THE original British dreadnought was built in 1905, and in 1906-07, Germany laid down her first four dreadnoughts of the "Nassau" class, of 18,600 tons and 20.5 knots, protected by 11½-inch side armor and carrying a battery of twelve 11-inch and twelve 6-inch guns. In the arming of these ships, the Germans made two very serious mistakes when they mounted an 11-inch gun when the other powers were mounting the 12-inch, and secondly, they placed two of the turrets on each beam, with the result that in a broadside engagement four of the 11-inch guns are out of action, being masked by the opposite turrets on the engaged side.

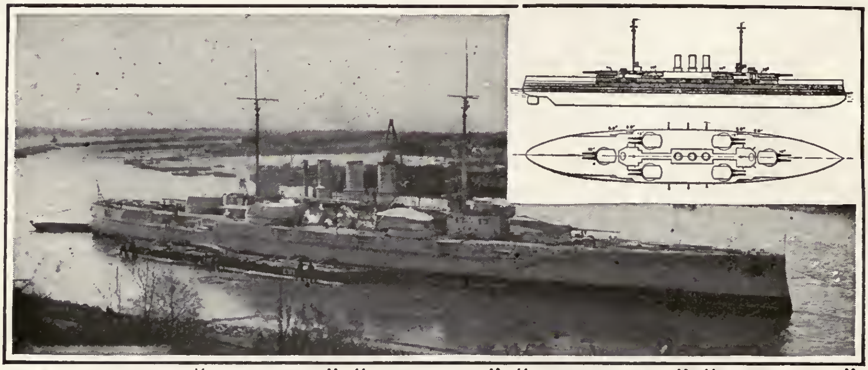
In the four ships of the "Thuringen" class, completed in 1911-12, the mistake made in the "Nassau" class was partly rectified. The comparatively weak 45-caliber 11-inch piece gave way to a 50-caliber 12-inch piece of vastly greater power and efficiency, especially at long ranges. The displacement of these ships is 22,000 tons and the speed 21.5 knots. They are protected by 11½ inches of side armor.

For reasons best known to themselves, the German ordnance officers, or whoever is responsible for the disposition of the armament, deliberately sacrificed a third of the effectiveness of the broadside of the "Thuringen" class, by retaining the quadrilateral arrangement of turrets that exists in the "Nassau" class. The Germans are great theorists; but in this class the theory of the value of a head-on attack, in which the ship can concentrate a fire of six guns, led them in the wrong direction. There is a consensus of opinion among naval men that no wise admiral will expose his ships to the danger of being raked in the end-on position by the 12-inch and 14-inch guns of the enemy. Future battleship engagements will be fought broadside to broadside, at ranges of from 9,000 to 11,000 yards.

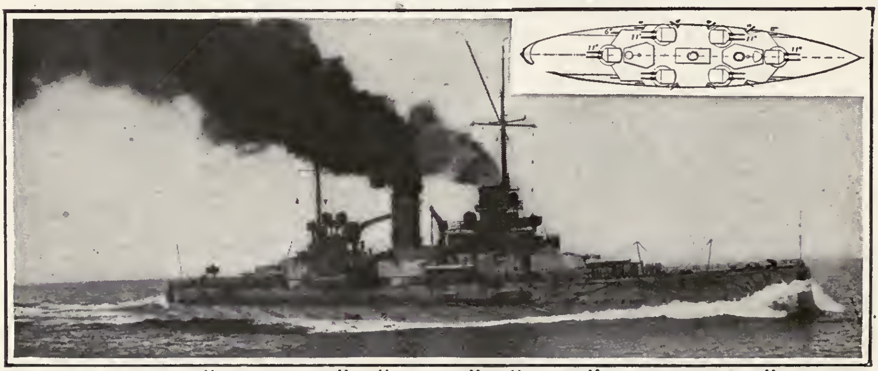


DREADNOUGHTS: "KAISER"; "FRIEDRICH DER GROSSE"; "KAISERIN"; "PRINZ REGENT LUITPOLD"; "KONIG ALBERT." DATE, 1912. TONS, 24,300. SPEED, 21.5 KNOTS. GUNS, TEN 12-INCH, FOURTEEN 6-INCH. TORPEDO TUBES, 5. SIDE ARMOR, 14-INCH—7-INCH

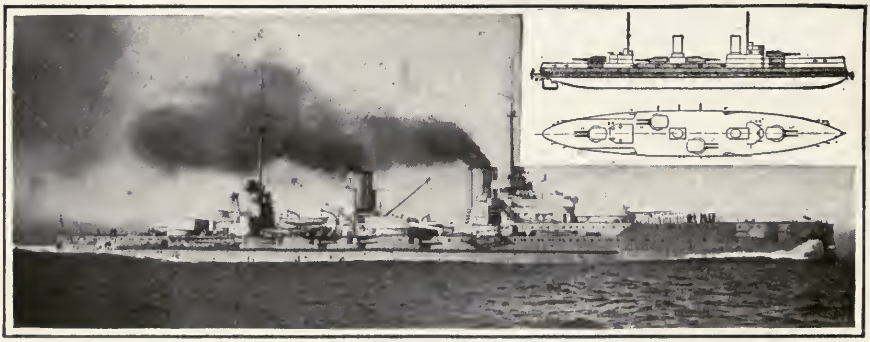
In the five ships of the "Kaiser" class, completed in 1912-13, the Germans rectified their mistake by placing three of the turrets on the center line and the other two diagonally on the broadside, thereby enabling the whole of the battery to train on either beam. This is a better, but not the best, arrangement



DREADNOUGHTS: "THURINGEN"; "HELGOLAND"; "OSTFRIESLAND"; "OLDENBERG." DATE, 1911-12. TONS, 22,000. SPEED, 21.5 KNOTS. GUNS, TWELVE 12-INCH, FOURTEEN 6-INCH. TORPEDO TUBES, 6. SIDE ARMOR, 11½-INCH—6¼-INCH



DREADNOUGHTS: "WESTFALEN"; "NASSAU"; "POSEN"; "RHEINLAND." DATE, 1909-10. TONS, 18,600. SPEED, 20.5 KNOTS. GUNS, TWELVE 11-INCH, TWELVE 6-INCH. TORPEDO TUBES, 6. SIDE ARMOR, 11½-INCH—7-INCH

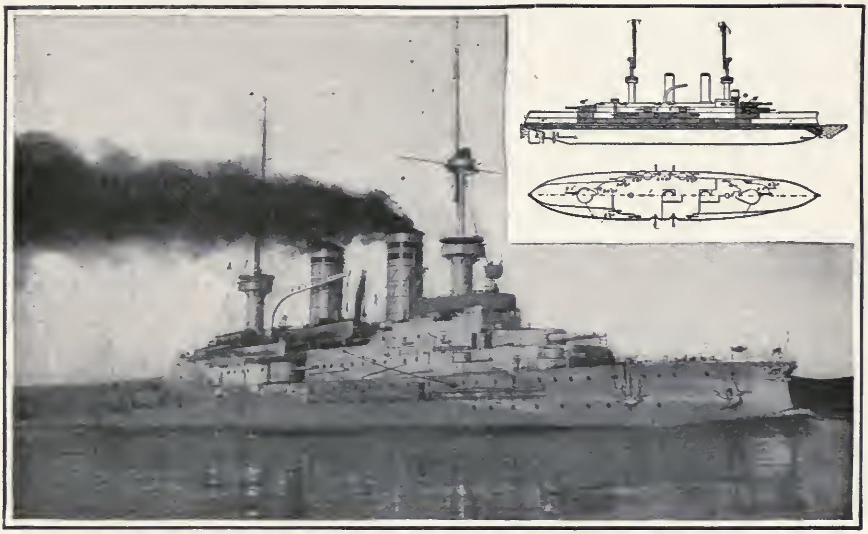


BATTLE-CRUISER: "VON DER TANN." DATE, 1911. TONS, 18,700. SPEED, 27.5 KNOTS. GUNS, EIGHT 11-INCH, TEN 6-INCH. TORPEDO TUBES, 4. SIDE ARMOR, 10-INCH—4½-INCH

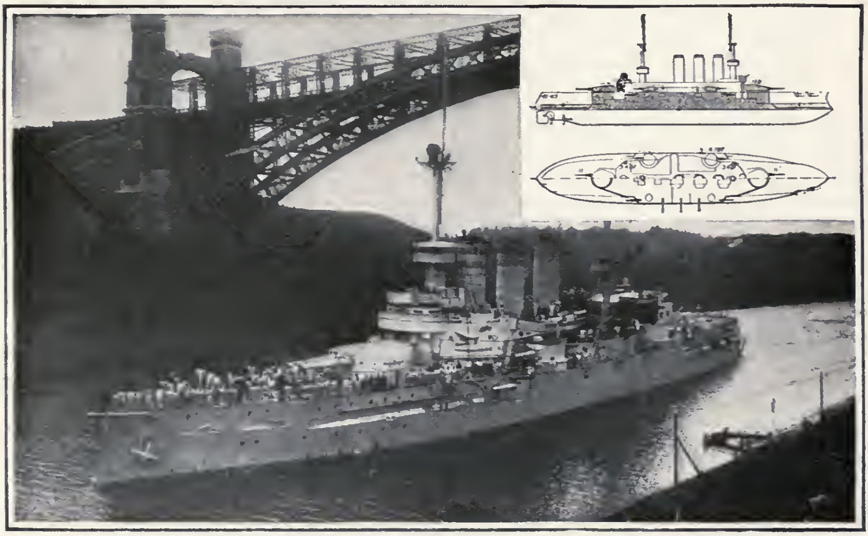
since the midship turrets mask each other throughout a considerable arc of fire.

In their four ships of the "Grosser Kurfurst" type, which are due for completion toward the close of the present year, the Germans have followed the principle (inaugurated by the naval constructors of the U. S. navy) of placing all the turrets on the center line of the ships. The "Kaiser" class are of 24,700 tons displacement and 21.5 knots speed. They are heavily protected with side armor ranging from 14 to 7 inches in thickness. They mount ten 12-inch 50-caliber guns and fourteen 6-inch.

Germany possesses four battle-cruisers of great speed and power, which have the enormous advantage over the armored cruisers of other navies that the side armor is of battleship thickness. This means that they can be placed in the first fighting line and take the protection largely offsets the fact that their main armament of 11-inch guns is much weaker than the armament of the 12's and 13.5's mounted on the battle-cruisers of the British navy.



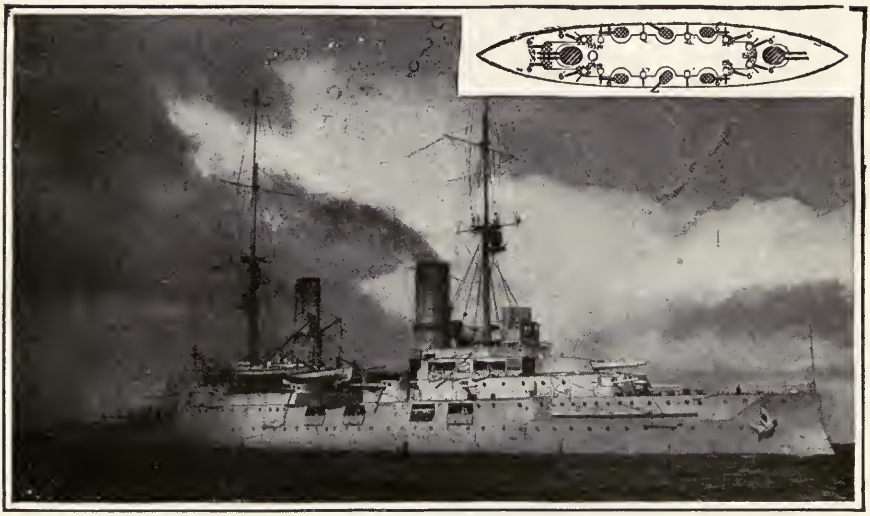
PRE-DREADNOUGHTS: "MECKLENBURG"; "WITTELSBACH"; "SCHWABEN"; "WETTIN"; "ZAHRINGEN." DATE, 1902-03. TONS, 11,600. SPEED, 18-19 KNOTS. GUNS, FOUR 9.4-INCH, EIGHTEEN 6-INCH. TORPEDO TUBES, 6. SIDE ARMOR, 9-INCH



PRE-DREADNOUGHTS: "BRAUNSCHWEIG"; "ELSASS"; "LOTHRINGEN"; "HESSEN"; "PREUSSEN"; "DEUTSCHLAND"; "HANNOVER"; "POMMERN"; "SCHLESWIG-HOLSTEIN"; "SCHLESIEN". (THIS VIEW SHOWS "LOTHRINGEN" IN THE KIEL CANAL.) DATE, 1904-08. TONS, 13,000. SPEED, 20 KNOTS. GUNS, FOUR 11-INCH, FOURTEEN 6.7-INCH. TORPEDO TUBES, 6. SIDE ARMOR, 9-INCH—6-INCH

blow of the heaviest projectiles of the enemy, with the expectation of no greater chance of disablement than the battleship. In this the Germans have shown great forethought, and it must be admitted that this superiority in

The "Von der Tann," completed in 1910, of 18,700 tons displacement and 28 knots speed, has 10 inches of side armor, and mounts eight 11-inch 45-caliber guns in turrets. The "Moltke," completed in 1911, of 23,000 tons and 28 knots speed, is protected with 11 inches of side armor, and carries ten 50-caliber 11-inch guns in turrets. The "Seydlitz," of 25,000 tons, has made 29 knots. She has the same protection and armament as the "Moltke." All of these ships carry powerful torpedo defense batteries of 6-inch guns.



PRE-DREADNOUGHTS: "KAISER WILHELM II"; "KAISER FRIEDERICH III"; "KAISER BARBAROSSA"; "KAISER WILHELM DER GROSSE"; 'KAISER KARL DER GROSSE." DATE, 1898-1901. TONS, 10,800. SPEED, 18 KNOTS. GUNS, FOUR 9.4-INCH, EIGHTEEN 6-INCH. TORPEDO TUBES, 6. SIDE ARMOR, 9-INCH—6-INCH

PROTECTED CRUISERS: "STETTIN"; "STUTTGART." DATE, 1908. TONS, 3,450. SPEED, 23.7-24 KNOTS. GUNS, TEN 4.1-INCH. TORPEDO TUBES, 2. ARMORED DECK, 2-INCH

The pre-dreadnoughts of the German navy, twenty in number, were built in classes of five each, and all of them suffer from the defect of carrying too light a gun in their main batteries. Thus, the ten ships of the "Kaiser Wilhelm II." and "Wittelsbach" classes carry as their main battery four 9.4-inch 40-caliber guns—a piece which would be wofully ineffective at the great ranges at which modern engagements will be fought. In the "Braunschweig" class of five ships, the main battery consists of four 11-inch guns of 40 calibers, and the same thing is true of the five ships of the "Deutschland" class. The remaining energies, even of these 11-inch guns, at a range of 10,000 yards would not be sufficient to effect the penetration of battleship armor.

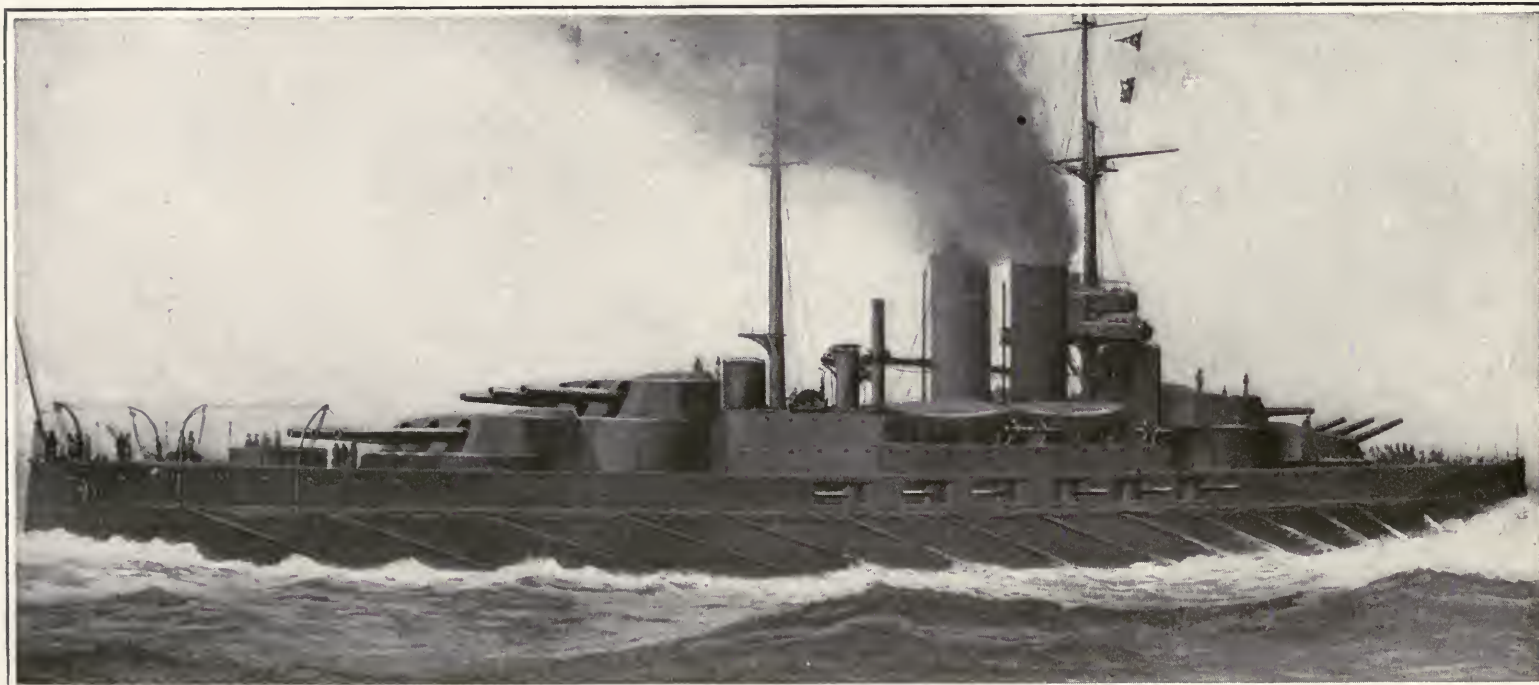
The nine armored cruisers of the German fleet were headed by the "Blücher," a fine ship of 15,500 tons, protected by 6-inch armor and mounting twelve 8.2-inch 45-caliber guns in turrets and a broadside of eight 6-inch guns at the beginning of the war, but Germany lost this vessel, also the "Scharnhorst" and "Gneisenau," completed in 1907, which were of 11,500 tons and 23 to 24 knots speed. They were protected by 6 inches of armor and carried eight 8.2-inch 40-caliber guns and six 6-inch. The "Roon" and "Yorck," completed in 1905-1906, are of 9,050 tons displacement, are protected by a 4-inch belt, and carry four 8.2-inch 40-caliber guns in turrets and ten 6-inch 40-caliber guns on the broadside. Their speed is about 21 knots. The "Prinz Adalbert" and "Friedrich Karl," completed in 1903, are generally similar to the "Roon" class. The "Prinz Heinrich," of 8,900 tons, completed in 1900, carries two 9.4-inch guns in two turrets, forward and aft, and ten 6-inch on the broadside. Her speed is 20 knots, and she is protected with 4 inches of armor. The "Fürst Bismarck," built in 1897, of 10,700 tons, mounts four 9.4-inch guns in two turrets, forward and aft, and twelve 6-inch on the broadside.

The German fleet is strong in protected cruisers and fast scouts, of which she possesses 41. The five ships of the "Freya" class, 19 knots speed, carry two 8.2-inch and six 6-inch guns. They were built in 1898 and reconstructed in 1907.

At the opening of the great European war Germany had 130 destroyers in commission. Her destroyers, especially those built since 1905, are fine vessels of their type, varying from 525 to 820 tons in displacement, and having speeds of from 30 to 32.5 knots. They are excellent sea boats, and Germany has paid particular attention to this arm of her torpedo service.

GROUP OF DESTROYERS MANEUVERING AT FULL SPEED. DATE, 1909. TONS, 650. SPEED, 32.5 KNOTS. GUNS, TWO 24-POUNDERS. TORPEDO TUBES, 3

The Germans were slow to take up the submarine; but as soon as this type of craft had proved its great offensive and defensive values, their naval construction officials paid great attention to its development. Their submerged displacement varies from 250 to 800 tons.



"VIRIBUS UNITIS," "TEGETTHOFF," "SVENT ISTVAN" DISPLACEMENT, 20,000 TONS. SPEED, 20.7 KNOTS. GUNS, TWELVE 12-INCH. TORPEDO TUBES, 4

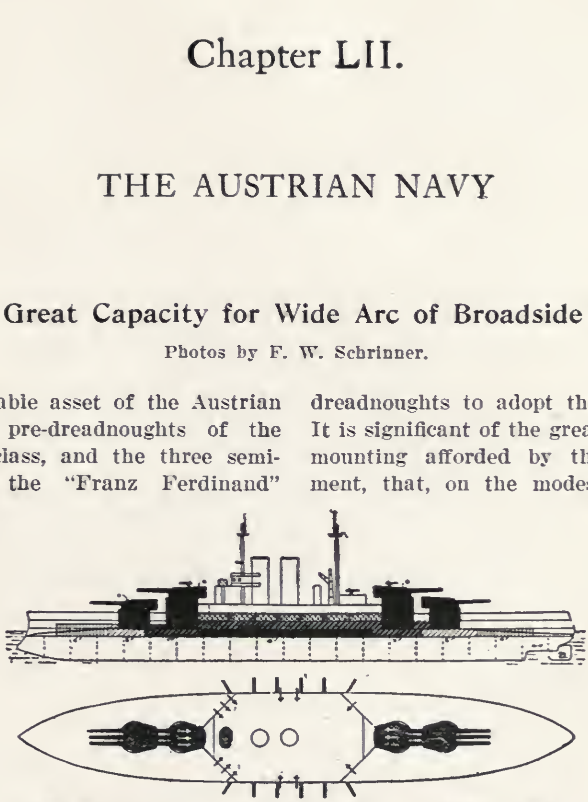
Chapter LII.

THE AUSTRIAN NAVY

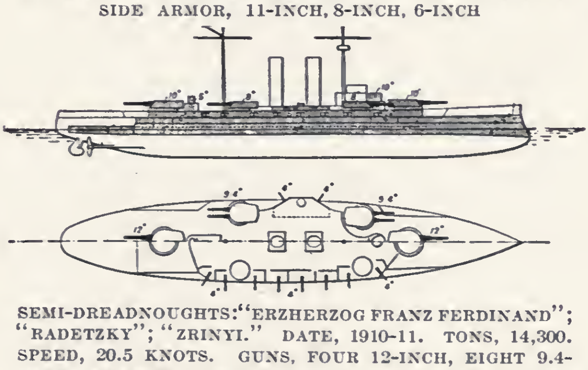
Has Great Capacity for Wide Arc of Broadside Fire

Photos by F. W. Schrinner.

THE most valuable asset of the Austrian fleet is the pre-dreadnoughts of the "Viribus Unitis" class, and the three semi-dreadnoughts of the "Franz Ferdinand" class, all six vessels being of thoroughly modern construction, heavily armed and well-protected.



DREADNOUGHTS: "VIRIBUS UNITIS"; "TEGETTHOFF"; "SVENT ISTVAN." DATE, 1913-14. TONS, 20,000. SPEED, 20.7 KNOTS. GUNS, TWELVE 12-INCH. TORPEDO TUBES, 4. SIDE ARMOR, 11-INCH, 8-INCH, 6-INCH



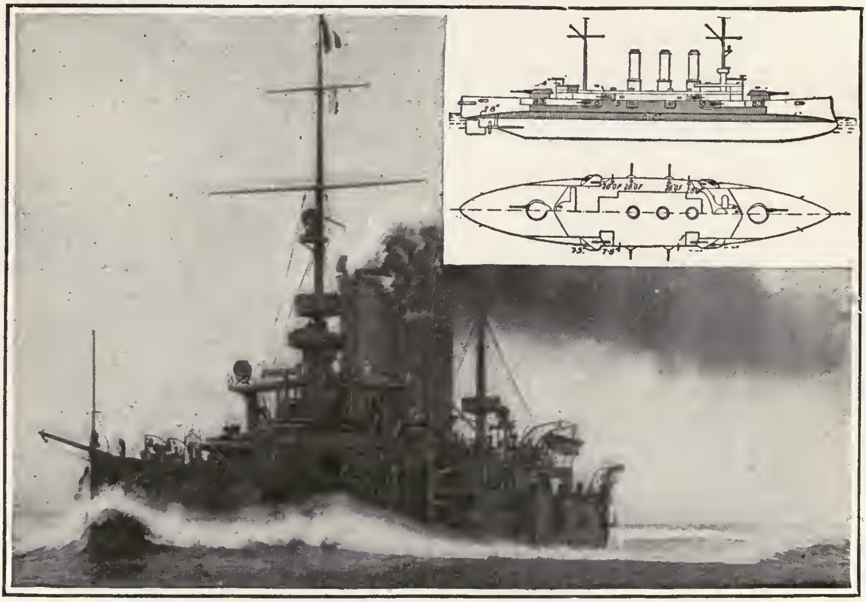
SEMI-DREADNOUGHTS: "ERZHERZOG FRANZ FERDINAND"; "RADETZKY"; "ZRINYI." DATE, 1910-11. TONS, 14,300. SPEED, 20.5 KNOTS. GUNS, FOUR 12-INCH, EIGHT 9.4-INCH, TWENTY 4-INCH. TORPEDO TUBES, 3. SIDE ARMOR, 9-INCH

The "Viribus Unitis" was one of the first dreadnoughts to adopt the three-gun turret. It is significant of the great capacity for gun-mounting afforded by this triple arrangement, that, on the modest displacement of 20,000 tons, the "Viribus Unitis" and her sisters mount no less than twelve 12-inch guns apiece. The four turrets are disposed on what has come to be known as the "Michigan" plan; there being two turrets forward, the guns of the after turret firing above the roof of the fore turret, and two turrets aft having a similar arrangement for gun fire. The advantage of this arrangement is that every gun can be trained through a wide arc of broadside fire, and that there is a possible concentration of guns, dead ahead or dead astern of six 12-inch pieces. The ships, despite their heavy battery, are well protected, carrying side armor of 11-inch thickness at the water-line, above which, between turrets 2 and 3, is side armor of 8 inches thickness, while above this, covering the 6-inch battery, is 6 inches of armor. The speed is 20.7 knots, and each ship carries four torpedo tubes.

Austria possesses three semi-dreadnoughts of 14,500 tons, 20.5 knots speed, protected by side armor whose thickness from the water-line up is, respectively, 9 inches, 6 inches, and 3 inches; and each of them carries three torpedo tubes. The battery is heavy, consisting of four 12-inch and eight 9.4-inch guns, all mounted in turrets. For torpedo defense, each ship carries twenty 4-inch 50-caliber guns.

Of pre-dreadnoughts of battleship size, Austria possesses three of the "Ferdinand Max" type. These would have been more effective ships if the Austrians, influenced no doubt by German practice, had not mounted the 9.4-inch 40-caliber gun as their main armament. Of these the "Ferdinand Max" and class carry each four in two turrets, and there is a heavy broadside battery of twelve 7.6-inch guns. These vessels are of 10,500 tons and 20.5 knots speed. The side armor is from 8¼ to 6 inches.

Important vessels for coast defense are the six ships of the "Hapsburg" and "Wien" classes, the "Hapsburg" of 8,340 tons and 19.5 knots speed, mounts three 9.4-inch guns in turrets and twelve 6's in casemates. The armor is 8¾ inches. The "Hapsburg" class was completed in 1903-04. The "Wien" class carry four 9.4-inch and a battery of six 6-inch on a displacement of 5,600 tons. They were built in 1895 to 1896, and are protected by a 10½-inch belt of armor.

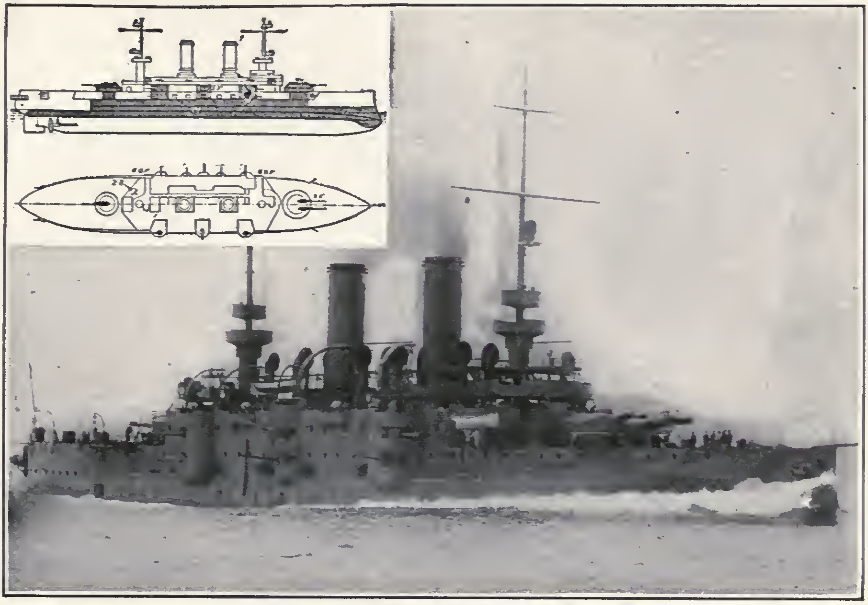


PRE-DREADNOUGHTS: "ERZHERZOG FERDINAND MAX"; "ERZHERZOG KARL"; "ERZHERZOG FREIDRICH." DATE, 1905-07. TONS, 10,500. SPEED, 20-20.5 KNOTS. GUNS, FOUR 9.4-INCH, TWELVE 7.5-INCH. TORPEDO TUBES, 2. SIDE ARMOR, 8¼-INCH

Austria possesses two modern armored cruisers; "Sankt George," 7,400 tons, 22 knots, mounting two 9.4's and five 7.6's; and "Kaiser Karl VI.," 6,300 tons and 20 knots, carrying two 9.4's and eight 6's. Smaller and older vessels are the "Kaiserin Theresia" and the "Kaiserin Elizabeth," of 5,200 and 4,000 tons displacement and 17½ and 19 knots speed, respectively. The "Theresia" carries two 7.6-inch and eight 6-inch guns and the "Elizabeth" six 6-inch guns.

Of the protective cruisers, the most valuable are the four fast scouts, "Saida," "Helgoland," "Novara," and "Admiral Spaun." They are of 3,500 tons and 27 knots speed and mount a battery of 4.1-inch guns, but no torpedo tubes.

Next to her dreadnoughts and semi-dreadnoughts, the most valuable vessels of the Austrian fleet are her 18 destroyers, 39 torpedo boats, and 6 submarines. The destroyers are from 400 to 800 tons and from 28 to 32 knots speed, and the torpedo boats run in displacement from 110 to 250 tons and in speed from 26 to 38 knots.



PRE-DREADNOUGHTS: "HAPSBURG"; "ARPAD"; "BABENBERG." DATE, 1903-04. TONS, 8,340. SPEED, 19.5 KNOTS. GUNS, THREE 9.4-INCH, TWELVE 6-INCH. TORPEDO TUBES, 2. SIDE ARMOR, 8¾-INCH—5-INCH

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