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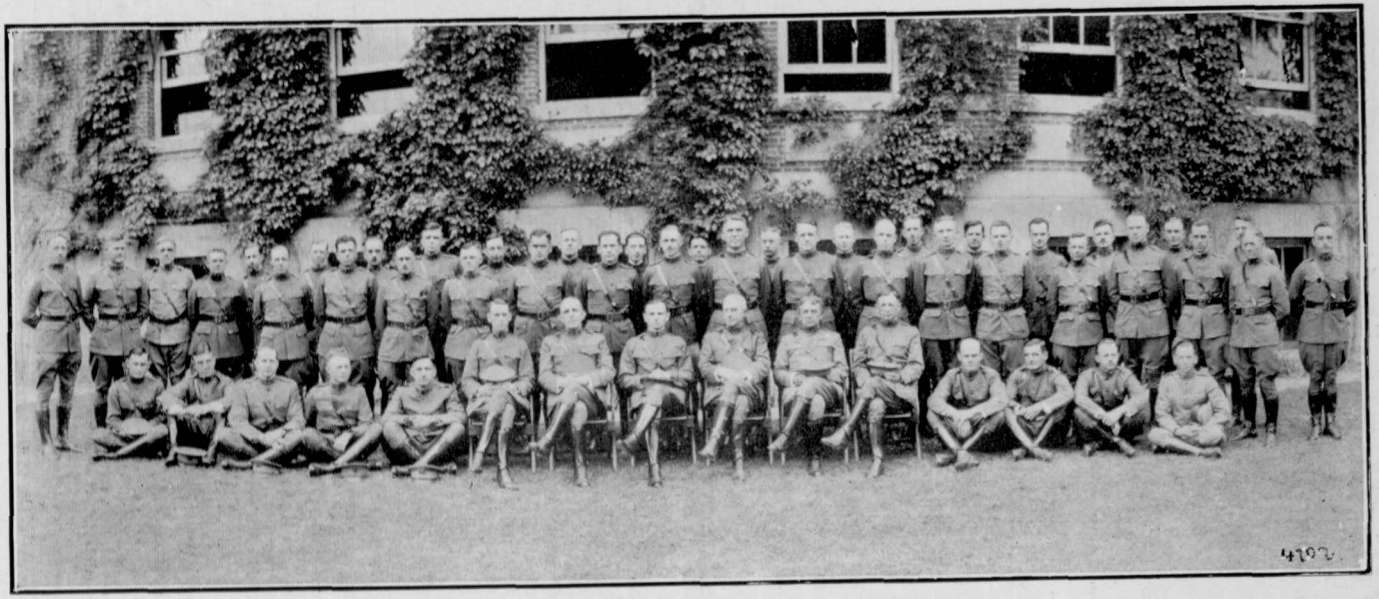

BATTERY OFFICERS' CLASS, COAST ARTILLERY SCHOOL, 1922

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Journal of the United States Artillery

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Second Prize, Essay Competition, 1921

The Test System of Instruction

By Major Paul D. Bunker, C. A. C.

I

THIS is not a learned dissertation on pedagogy, indeed it may betray a profound ignorance of that art. It is merely the exposition of what is believed to be a new system in the business of instructing enlisted men in their duties as soldiers.

Most of us are familiar with the common or garden type of drill schedule. Usually it states in general terms that the month of May will be devoted to the school of the squad or that the first drill period will be devoted until further orders to the usual tracking drill, or to drill in the emplacements, or what not. Sometimes the subject matter of a particular drill is more closely prescribed than that, but under the old system of instruction this might have the disadvantage of holding back men who are bright and quick at learning in order that the slower men shall not be hurried through the drill. It might also infringe upon the initiative which, whenever possible, should be allowed the organization commanders.

A schedule which is laid down in such indefinite terms has another disadvantage; it has a psychological effect upon the soldier's (and also upon the officer's) mind which might be translated somewhat as follows:—"I see we are going to have squad movements for the infantry drill, next month. Well, I s'pose we can fill out a month with that just as well as with anything else. And there's no use in hurrying to get the thing down pat; there's no war on, and if we do get perfect in the squad movements they'll simply get up something else to drill us at. There's no end to infantry drill anyway, and we'll have to go over and over the same old stuff as long as we're in the service. So why worry?"

I believe that it is this lack of a definite objective which prevents faster progress and damps aspirations in the instruction of our men. They see no goal ahead; the road looks like a hard, straight boulevard stretching away over the horizon with the destination out of sight, a road which must be covered, but a deadly dull, uninteresting road at that, a sort of necessary evil because it must be traversed in order to get to the other end. The experiences of the late war seem to prove my assertion. Look how quickly men were whipped into shape in 1917, not only to fill the rank and file but also as officers. They may not have been thoroughly trained; few men, if any, can be found who will maintain that our hurridly trained levies were the equal of the "old soldier"—but that is not the point. The point is, that with the goal of getting to France in sight, with the bait of "something doing" ahead of them, men made progress in instruction which was nothing short of phenomenal when compared with the progress which those same men would have made in piping times of peace. In the olden days they used to say that it took two years to make a cavalryman. Not to be outdone, we maintained that it took three years to make an artilleryman. On the other hand, there are men who seem to believe that either or both can be made overnight. It is evident that the truth must lie somewhere between these limits, and must always be a factor of the man himself, his intelligence and capabilities, and also must be profoundly affected by the presence or absence of an incentive. The man who maintains that it takes years to make a soldier is unconsciously using the ordinary peace-time conditions as his major premise; the man who maintains that an army can be created overnight is just plain imbecile or demagogue, or a dangerous mixture of both. A soldier *can* be turned out in less than three years, but he cannot be turned out overnight. If we can furnish the proper incentive, something that will fill the place, as far as possible, of the spirit of 1917, then and only then will we turn out trained soldiers at our maximum rate of production. And, if we are to do our duty by the country, it will not be by getting together the best possible unit, be it company or regiment, but by attaining this maximun of production, by sending back into civil life the greatest possible number of youths well trained in the ideals and standards of the Army.

Of course, considered in one light, the soldier always has an incentive before him, the possibility of promotion. But that is too indefinite and intangible. There is no telling how long he must strive before reaping the reward of a non-com's warrant; what he wants is something definite and immediate, something which forms a goal for the specific task or drill which lies before him at the moment. He needs something which will act as a substitute for the overseas motive, something that will make him really *want* to speed up his learning processes and make him plunge into a drill with the desire to master it and become an instructor of others.

Assuredly, such an incentive is hard to contrive in peace-times. What will appeal to some men will not appeal to others, and doubtless it would be impossible to frame an arbitrary set of rewards which would fit an entire company, let alone a larger organization. In the cases of some men we might be led or forced to the belief that there is no incentive which could possible appeal to them. In the words of Elbert Hubbard,—"A first mate with a knotted club seems necessary; and the dread of getting 'the bounce' Saturday night holds many a worker to his place." In other words, there are men who simply will not try. They are in the Army not through any high ideals but simply for their three square meals a day. We have met them in the past, in our companies, and we will always have them in the future. But it is good to know that they are the exceptions and that the great bulk of our men have the inherent desire to improve. This desire may not be a very active one, it cannot possibly be the equal of the burning urge that formed the driving impulse at the outbreak of the World War. All of those who saw the let-down at the Armistice can appreciate the difference.

There is something, however, outside *esprit de corps*, which makes the Army continually strive for improvement. It is indeed fortunate for the Nation that the strongest sentiment in the Army is contempt for the incompetent. The blunders of the recruit are looked upon with good-humored amusement because, in the free-masonry of the soldier, he "isn't expected to know any better." But let an old-timer make a slip and he will realize for a long time that soldier wit carries a punch in both hands. If a mounted officer involuntary describes the arc of a parabola from his horse as an origin the performance used to cost him the champagne for the crowd. Quite an incentive, one would say, for excellence in horsemanship. And the green recruit, little relishing the opprobrious title of "rookie," strives to shed the cognomen by buckling down to his drill, the earlier to be turned in for straight duty with his bunkies. The man who gives a foolish answer at gunners' instruction is heckled to death by ribald comrades proclaiming his woodenness to the wide, wide world. And it is so throughout the Army, little sympathy for the blunderer, and absolutely none if he makes the same blunder a second time. And, if we might so term it, it is a mighty healthy symptom, constituting as it does, a powerful incentive for efficiency and progress.

But this incentive is not sufficiently strong to make the men progress as fast as they can in the every-day drills and instruction. As long as they "get by" with a drill it is usually all that they desire; a knowledge of the minutiae of the drill or the consciousness that they know the drill well enough to instruct others is something which they feel is not for them. They rarely realize that you never learn so much about a thing as when you attempt to teach it to others.

II

The scheme of instruction outlined in this paper does not pretend to be a cure-all in the matter of this all-important incentive. But it does furnish a definite goal for each successive task which is put before the soldier. Let us take, for the purpose of illustration, the subject of infantry drill. Instead of confronting the man with the appalling prospect of the drill as a whole we ask him merely to learn the position of the soldier—at least that is all that it seems to him. Instead of telling him that he shall spend so much time learning the School of the Soldier, we take this part of the drill and analyze it, resolving it into its component parts, and then arrange these parts in their logical sequence. We call each one of these parts a "test," disguise it as a game and virtually dare the man to prove that he can play that game. When he has accepted the challenge and performed a "test" satisfactorily he wins, and the fact is published. He then passes on to the next test, and so on, until, the first thing he knows, he has finished the School of the Soldier. But before he can leave this series of tests (each series is called a "course") he must demonstrate his proficiency therein, not only by performing the movements himself, but also by drilling some one else. This may be done by acting as drillmaster to another man, explaining the tests, demonstrating them and, in short, proving to his captain's satisfaction that he has thoroughly absorbed the course. Or it may be possible for him to bring in to his captain a recruit whom he has trained, and thereby give proof of his ability. This is a scheme in force among the Boy Scouts, and it is a most admirable one where it can be worked.

This system contemplates that after a man has demonstrated his proficiency in a test or in a course his drilling in that test or course shall thereafter be limited to the minimum, and that he shall be advanced to other instruction. Take the case under discussion—there is nothing to be gained after the man has finished the School of the Squad, in repeating over and over, the facing movements or other elementary exercises. The disciplinary value of the close order drill can be obtained in other ways. Of course if the man, while pursuing advanced instruction, shows that he has become slovenly in the execution of previous tests or has forgotten some of their points, he can and should be required to requalify. But ordinarily when he has passed a test it can be almost eliminated from his curriculum thereafter, drilling in that particular course being restricted to the amount necessary to freshen him up occasionally, and to keep up his ability as a drill instructor. In other words, the man's goal is the passing of that particular test in which at that moment he is receiving instruction. As soon as he passes that test successfully he is *through*; that much is behind him and he does not go back to it—except incidentally, as just described.

A vital part of this system is a graphic chart, posted on the company

bulletin board or other conspicuous place, showing the status of every man in the company. The make-up of this chart will be described later. This chart furnishes an element of competition within the company. In addition to this, it is contemplated that when a man finishes a course and especially if he demonstrates his ability as a drillmaster, the fact shall be noted under "Remarks" on his service record thus:—"Qual First Aid 21 Jan 1922" or "Qual Instructor Semaphore 3 June 1922." The advantages of such a notation are too apparent to need comment.

To furnish an incentive to the company officers and to give the post commander an idea of the relative efficiency of the various company commanders, a graph or table should be published monthly at Post Headquarters showing the number of men in each of the companies who are qualified in the different subjects, and perhaps, the number qualified during the past month, the percentage qualified, etc. Probably a system of relative weights could be applied to the various subjects of instruction and a numerical value evolved monthly which would represent, as nearly as might be, the relative efficiency of the organizations. Considering the pride which every officer feels in his organization, this should furnish an appreciable incentive.

The writer is not so simple as to think that the average soldier is going to work his head off simply to have his name on the company bulletin board or to have a remark made on his service record. These things help, but they must form only a part of a well-knit whole. Other incentives must be found and applied. Company commanders can devise others with very little trouble, and with benefit to their organizations and to themselves. They might have it understood among their men that qualification in certain courses is a pre-requisite to furloughs, and that furloughs would surely result from such qualification, that only men who qualified in certain of the courses would be considered for appointment as corporals or for promotion to sergeants. Other rewards or privileges would suggest themselves from time to time depending upon the circumstances surrounding that particular organization.

But the great privilege which the writer hopes to see realized some day from this system of instruction—a very ambitious and, perhaps, unwarranted hope—is the privilege to be granted by the War Department of a special discharge, at the request of the soldier, upon qualification as a finished product,—that is, upon successfully passing all of a set of courses prescribed by the War Department as comprising the training necessary to make a "graduate" soldier. I have always believed that a man *can* be made into an acceptable soldier in a year and I believe that this system of instruction would produce that result. The ordinary system of instruction would not. Moreover, there are thousands of our youths, the very best of them, who will not enlist because they feel that they cannot spare three years out of a life which

they feel (rightly or not) is going to mean something to their community. They are the stuff from which our foremost citizens are made, our engineers, our bankers, our merchants, our leaders in every profession and trade, the men who tomorrow will shape the destinies of the Nation. They are the recruits whom the Army needs, and it is not too much to say that it is the Army that they themselves really need before they climb to the high places which are their birthright. They, in their youth, need the respect for law and order, the obedience and loyalty to authority, the appreciation of the value of team-work, the faithfulness to a trust, and the ability to think which is taught in the great school of the Army as in no other institution. And this special discharge certificate, showing that they have successfully pursued the Army course of training in a comparatively short time, that they have been weighed in the huge, impartial balances of the Army and have come up to the full standard,—in short, that they are *men*,—will not this certificate in a short time come to be looked upon as a *sine qua non* among the rising manhood of our country? There is no doubt in my own mind that such a certificate of merit could be made to fill just that niche in public opinion—as something of intrinsic worth far exceeding a diploma from any other institution. And do not forget, whatever comes, this must be our primary objective—to train the youth of our land—not as soldiers alone, but as prospective members of the body politic, as voters and men of affairs.

This is an ambitious vision, but I really believe that no matter what requirements within reason might be prescribed as necessary to the earning of such a discharge, the complexion of our army would soon be changed by the great number of wide-awake and energetic young men who enlist for the purpose of earning such a discharge in the shortest possible time, and thereby proving their manhood. With the lessons of the last war (and other wars) before us, it would be well for us to provide for the training of sergeants-major, company clerks, and the like, as well as platoon leaders and company commanders, but that is a minor point when compared with the basic idea of getting an army of men eager to make the maximum in progress and improvement.

III

The average company commander may say that the schedule which forms a part of this paper would not be suited to his company because his men have already been in some of the elementary subjects. This stand, however, is not well taken, because the best of us forget some of the finer points in time and must review them in order firmly to keep them in mind. And if the men really know these elementray subjects they will qualify all the more quickly when this system is applied to the company. It must continually be borne in mind that we are not merely training our men so they can barely scrape through

the drills, but we are endeavoring to supply the nation with a corps of men who can act as instructors for the horde of untrained men to be called to the colors in time of war. It is necessary that such instructors not only know the drill, they must *know* that they know it. They must have the self-confidence which is an essential part of the qualifications of a good instructor. It is, then, necessary that they demonstrate in a practical way—by actually instructing—their proficiency in each test and its method of instruction. This demonstration usually forms the last test in each of the courses shown in the schedules below.

As this system is based upon standardization, it follows that the company commander must be satisfied that his assistants will instruct along approved lines and methods. It will, then, be necessary for him to "qualify" these assistants, officers or men, before they may be given classes to instruct. He should afterward check them at their work in order to make sure that slip-shod and incorrect methods do not creep in, and to give these assistants the incentive of knowing that he is interested in their work and is keeping track of it.

As men are not alike in their mental attributes it follows that some of them will go ahead faster than others. In order to let them progress as fast as their abilities permit, it will become necessary to organize the instructions on a class basis, selecting the men who are forging ahead of the others for an "advanced class," and continuing the weeding out process as dictated by the circumstances and as limited by the number of trained instructors available. This shows the advantage of having a large number of trained assistants and the average company commander would do well to bend his every effort towards building up his corps of instructors before attempting much on other lines. In a company with plenty of well trained non-coms (apparently a rarity these days) this system works almost automatically; in a company composed principally of green men the captain must expect in this, as well as in any other system of instruction, to do most of the training at first himself. After he has built up his corps of instructors he will have little to do except check up their work and assure himself that they are instructing "as ordered." Even while he is engaged in the arduous task of acquiring and training his assistants this "test" system greatly reduces the amount of work he personally would have to do if he followed the usual type of schedule, because it systematizes the work, and gives these assistants perfectly definite tasks to perform and standards to meet. The system does not dodge any work that is really necessary, it cuts out the unnecessary work.

It is, perhaps, in its application to incoming recruits that the advantages of this system become most clearly apparent. Indeed, the infantry drill schedule, below, is an adaptation of the drill schedule formulated by Colonel Thomas B. Dugan, Cavalry, while in command of the recruit depot at Fort Slocum. But however more easily the

benefits of this system may be discerned when applied to recruits under a detail of experienced non-coms, these benefits are no less real though perhaps less readily seen at a glance, when the system is applied to the average company containing more experienced men. These benefits work especially in favor of the company commander, already overworked, and even those benefits derived by the men react almost immediately to the advantage of the company commander.

IV

The method of imparting this instruction is important. You can take a company onto the parade ground and drill it all day, and yet the men may know very little more about it when they come in than when they started. It is notorious that much time is wasted in "squads east and west." But if a company goes out with the idea that they are going to master the movement of "squads right" (admittedly one of the hardest of movements to execute precisely) they will bid fair to accomplish their purpose, especially if they realize that once they have perfected themselves in the movement their subsequent acquaintance with it will be but accidental.

The standard method of instruction should be adhered to in all strictness. The instructor should first explain the movement to be executed. If it is an infantry movement he can never do better than explain it in the words of the book, they cannot be improved upon by the average instructor. He may afterwards explain things in the vernacular should he so desire, but the "book" comes first. He should then demonstrate the movement, showing the men by his own actions how it should be performed. If the exercise is, for instance, one in the manual of arms, he should have the men perform it informally several times in order to get the "feel" of the rifle and how it is manipulated. If it is a movement in close order he should move the men a step at a time in order to permit them to become acquainted with the looks of the formation at all stages. These operations should be repeated until perfection is obtained. In the case of slow men it may become necessary to alternate them with other movements in order to prevent the men from losing interest through the monotony of the instruction.

Periods of instruction should not be long. For ordinary drills such as infantry close order, about 35 minutes is as long as you can command the interest and attention of the men and nothing is gained—in fact, much may be lost—by continuing a drill beyond the point where the men begin to lose interest. But if short periods are to be used, they should be *used* and not wasted. Officers should not be permitted to congregate in the shade and smoke and gossip while the men are drilling; they must be right with their men, closely supervising the drill. Instructors with a tendency to "dead-beat" should be prevented from

frittering away the drill period in "rests." There is nothing about infantry close order which should unduly exhaust the men, no matter how tired their performances may make the drillmaster. It has been proved at various times and places that a 30-minute infantry drill without a rest is not only possible, but perfectly practicable. While the instructor is explaining new movements, etc., the men may stand at ease, and this gives them more than the amount of relaxation necessary. The command of "Rest," given with no other object in view, should not be in a 30-minute infantry drill under normal weather conditions.

In this connection it may be well to explain that this system, insofar as infantry drill is concerned, contemplates the use of Colonel Koehler's scheme of giving commands which is so well expounded in Lentz's "Cadence System." This idea—the men giving their own commands—speeds up the instruction, holds the men's interest and gives them self confidence. Its use should be insisted upon in all drills (e. g., physical drill) where cadence is either essential or even possible.

V

The keynote of this system of instruction is not speed but thoroughness. If the system is properly applied the company commander can rest assured that his men are well trained in whatever ground they have covered. The Post Commander can also be sure of this, just as sure as he is of the abilities and conscientiousness of his company commanders. I am not prepared to argue upon the suitability of this system to wartime conditions where speed is the main essential, although, since the schedules themselves may be pruned to include the bare essentials, the system would seem to be suited alike to peace and to war conditions.

But speed of progress, while ostensibly forced into the background, is far from being ignored, it is more in the nature of a "by product." Lost motion being eliminated, the men will naturally progress faster than they would under the old style schedules. The spirit of competition being sharpened also serves to increase the rate of progress.

But our main reliance for progress is placed in the basic principle of the system. This principle is well illustrated in civil life where work is removed from a "work-by-the-day" basis and placed on a "piece-work" status accompanied by the usual bonus payments. The speeding up of production under such circumstances is familiar to all students of economics. That is what this system accomplishes; it takes the soldier out of the class of day laborer, paid a certain amount no matter how much or how little work he actually performs, and elevates him to the grade of piece-worker, whose production is carefully inspected but who is rewarded according to his abilities and performance. When you come right down to it, doesn't it seem the depth of inefficiency to keep a man three years on a job when you can get him through in one?

VI

In designing a schedule for, let us say, the Coast Artillery, we would proceed somewhat after this fashion:—

1. Compile a list of the subjects in which instruction is required. Let us suppose this list reads,—

a. Coast Artillery Drill, etc.
b. Infantry Drill.
c. Hygiene, First Aid, and Sanitation.
d. Signalling.
e. Guard Duty.

2. Take one subject of this list and determine how much of it the men should be required to know—how far the instruction in that subject should be carried. Let us take, for an example, the subject of infantry drill. Coast Artillery Memorandum No. 1, War Department, March 26, 1921 prescribes that infantry drill "will be limited to that necessary for disciplinary training, to insure proficiency in ceremonies, and the proper performances of riot duty. It will also include small arms and machine-gun practice, and problems involving the local protection of the batteries."

Suppose we assume from this that the soldier must be taken through the close order part of the drill to include the school of the company, leaving the subject of ceremonies to be included in another course or as required by proper authority. Small arms and machine-gun practice require careful preparation and each is worthy of a separate course.

3. We now take the subject of infantry drill and resolve it into its components,—school of the soldier and of the squad (logically inseparable), school of the platoon, and school of the company. Let us designate each of these parts as a "course."

4. Now let us take the first course, the schools of the soldier and squad, and see what we can arrange in the matter of a *progressive* series of lessons, each lesson to be definite and clear-cut, as well adapted as practicable to the half-hour's drill time assumed to be available, and to constitute, when considered with the other lessons, a logical step in advancing towards the goal of proficiency in this part of the drill.

Obviously, the first step is to get our men together in the proper formation for instruction; in other words, to "form the squad." So, instead of stating in our schedule that the first subject to be taken up is something relating to the School of the Soldier, we turn to our Drill Regulations and, finding that paragraph 106 prescribes how to form the squad and, assuming that the men have not been issued their rifles, that it requires practically no knowledge of subjects which are to be taught later, we specify that our schedules shall commence with paragraph 106 IDR.

Now, having formed our squad, and noting that "Eyes Right"

forms a part of this operation, we naturally add the corresponding paragraph, 54, to our first lesson. As it is but logical to tell the men, at this point, something about the formation in which they find themselves, let us also include the general information concerning "the squad" which is contained in paragraph 101 to 105, both inclusive.

As the items we have considered so far would not occupy a half-hour's drill period let us add to them the next logical step, the Position of the Soldier, and also the "Rests." Paragraph 38, explaining the "preparatory" command and the "command of execution" would logically fall into the first lesson.

So our first lesson or "test" is finally enunciated as;—"Test No. 1: Pars. 101-107, 50-54, 38, IDR. Form squad, Attention, Rests, Commands."

5. In a similar manner the next test is evolved, and so on, until we have covered the necessary ground.

It is evident, from what has been said, that the drawing up of a schedule of this kind is no child's play. It is not only a tedious operation but it also requires considerable experience in actually training men in the drill under discussion, and a clear conception of the "specifications" to be fulfilled. The "Minimum Specifications for Trained Infantry" published in War Department Document No. 844 are a great help in formulating a schedule of this kind, but nothing can supplant a practical knowledge of handling the drills themselves. Nevertheless, it is devoutly to be wished that the other arms of the service shall bestir themselves and issue similar specifications.

The best schedule can probably be evolved only by the collaboration of the ablest minds in their respective lines of training. It would therefore be presumptuous on the part of the writer to do other than to leave to experts the task and privilege of formulating the schedules of tests covering the curriculum for a well trained soldier. The following schedules must be considered merely as samples showing one man's opinion on the matter; they are submitted for what they are worth, simply to break the ice and make a start.

VII

SAMPLE SCHEDULES

1. Infantry Drill Courses. (Called Class I Courses)

Course I-1	School of Soldier and Squad	11 Tests
Course I-2	Manual of Arms, Firings, etc.	11 Tests
*Course I-3	Squad in Extended Order	7 Tests
Course I-4	Platoon in Close Order	11 Tests
*Course I-5	Platoon in Extended Order	4 Tests
Course I-6	Company in Close Order	7 Tests
Course I-7	Ceremonies	6 Tests

2. Small Arms Courses. (Called Class SA Courses)
   Course SA-1 U. S. Magazine Rifle, Model 1903.... 8 Tests
   Course SA-2 Target practice with same..... 18 Tests
   Course SA-3 The Automatic Pistol..... 8 Tests
   Course SA-4 Target Practice with same..... 17 Tests
   Course SA-5 The Machine-gun..... Tests
   Course SA-6 Target Practice with same..... Tests
   Course SA-7 The Automatic Rifle (For A-AA Troops)..... Tests
3. Calisthenics and Physical Training Courses. (Class C Courses)
   Course C-1 Rifle Drill, Manual of Physical Training..... 24 Tests
   Course C-2 Calisthenics, Fifth Series, Trained Soldier..... 24 Tests
4. Signalling Courses. (Called Class S Courses)
   Course S-1 Two-arm Semaphore Code..... 14 Tests
   Course S-2 Wig-wag, Continental Morse..... 12 Tests
5. Miscellaneous Courses. (Called Class X Courses.)
   Course X-1 The Infantry Pack and Tent Pitching.. 12 Tests
   Course X-2 Hygiene, First Aid, etc..... 21 Tests
   Course X-3 Military Courtesy..... 24 Tests
   Course X-4 Guard Duty..... 21 Tests

*Omitted for Coast Artillery Troops.

Details of the Courses

1. Infantry Drill Courses

Numbers refer to paragraphs in the Infantry Drill Regulations and also to paragraphs in Chapter I of "Platoon Training," by Waldron.

COURSE I-1:—School of the Soldier and Squad

Test	Description of Test.
1	101-107, 50-54, 38. Form squad; attention; rests; commands.
2	13-14, 55-57. In place halt; as you were; facings; salute.
3	108, 58-65, 70. Guide; marching; mark time; halt.
4	66-71. Half step; side step; back step; by the flank.
5	72-73. To the rear; change step.
6	191-194, 109-110. At ease; route step; take intervals.
7	111-112. Take distance; assemble.
8	116-117. The oblique march.
9	118-119. The turns on fixed and moving pivots.
10	120-122. Turn and halt.
11	Demonstrate your ability as coach in the preceding, to the satisfaction of your company commander.

COURSE I-2: Manual of Arms, Firings, etc.,

1 74-78, 82. General rules; present arms; order arms.
2 79-82. Port arms; present arms; order arms.
3 83-84, 98-100. Right shoulder arms; inspection arms.
4 85-88. Right shoulder combinations.
5 89-90. Left shoulder arms; parade rest.
6 91-94. Trail arms; rifle salute.
7 95-97. Fix and unfix bayonets; charge bayonets.
8 113-115. Stack and take arms.
9 133-142. General rules; load; simulate load; unload.
10 143-150. Set sight; fire by volley and at will; cease firing.
11 Demonstrate your ability as coach and drillmaster in the preceding, to the satisfaction of your company commander.

COURSE I-3: Squad in extended order. (Omit in Coast Artillery)

1 123-127. Follow me; as skirmishers; assemble; change intervals.
2 128-132, Kneel; lie down; rise.
3 151-155. Use of cover; advancing under cover, crawling.
4 41-42. Bugle and whistle signals.
5 Pp 22-4. Arm signals to include "Range."
6 Pp 25-6. Remaining arm signals.
7 Demonstrate your ability as drillmaster in the preceding, to the satisfaction of your company commander.

COURSE I-4: Platoon in close order.

1 75 Forward march and halt, etc., under arms.
2 245, 253-257, 162-167, 176-177. Form and dismiss company, etc.
3 168-178. General rules; platoon right; right turn, etc.
4 181-182. Right and left front into line.
5 179-180. Squads right column left; column right.
6 183-184. On right into line; sections column right.
7 185-187. Line of sections; change directions, etc.
8 188-190. Form column of squads; march to rear.
9 195-199. Right by twos; right by file; etc.
10 Chap. III Platoon Inspection.
11 Demonstrate your ability as an instructor in the preceding by drilling a platoon, explaining movements, etc., to the satisfaction of your company commander.

COURSE I-5: Platoon Extended Order. (Omit for Coast Artillery)

1 210, 217, 200-203. General Rules; as skirmishers; etc.
2 204-206, 213-216. General rules; squad and section columns.
3 211-212. Other deployments.
4 Demonstrate your proficiency as instructor in the preceding by drilling a platoon, explaining movements, etc., to the satisfaction of your company commander.

COURSE I-6: Company in Close Order.

1 246-252, 255-257. General Rules; rectifying lines, etc.
2 258-259. On right into line; right front into line.
3 260-261. Column of platoons from columns of squads, etc.
4 262-264. Change direction in close column or line.
5 265-266. Closing in mass; extending.
6 267-269, 271. Close column and line movements; assembly.
7 Demonstrate your ability as instructor in the preceding by drilling the company and explaining the movements to the satisfaction of your company commander.

2. SMALL ARMS COURSES

COURSE SA-1: U. S. Magazine Rifle Model 1903

See WD Doc 1021 "Rifle Markmanship" hereinafter abbreviated as "RM"; also Vol. II, Chap. II of Waldron's "Platoon Training," hereinafter abbreviated as "PT."

TEST	DETAILED DESCRIPTION OF TEST
1	Show how each part of the rifle works. (Pp80-85 PT)
2	Safety Precautions. (Pp 85-86 PT; par 227 RM; par 75 IDR)
3	Name and point out the principal parts. (Par 46 RM)
4	General Knowledge of the rifle. —

Q. What is the name of this rifle? A. US Magazine Rifle Model of 1903.

Q. What caliber is it? A. Caliber 30. Q. What does that mean? A. That the hole in the muzzle is 30/100 of an inch across.

Q. What do you call those little ridges running down the bore? A. Lands.

Q. What are they for? A. To give the bullet a spin, so that it will fly head-on. If the rifle were a smooth bore the bullet would tumble "head-over-heels" and fly crooked.

Q. What is the bullet made of? A. A mixture of lead and tin, with a cupro-nickel jacket.

Q. How do you tell the service, dummy, and guard cartridges apart? A. The new guard cartridge has six dents at the shoulder and the dummy has six grooves along the sides; the service cartridge is smooth.

Q. Where should you aim when using the guard cartridge? A. Use the battle sight and aim at the hips.

Q. Where and when was this rifle made? A. (See stamp near the sight.)

Q. What does the "U" on the upper band mean? A. In putting this band on the rifle this "U" goes toward the muzzle.

5. Strip the bolt in 30 seconds; assemble same in 40 seconds. Strip the magazine in 15 seconds; assemble it in 20 seconds. (Pp 86-90 Vol II PT)
6. Show how to clean your rifle after firing. (Pars 50-58 RM) No candidate will be qualified in this test until his own rifle, especially the bore, is in excellent condition.
7. Demonstrate the removal of metal fouling from your rifle per par. 161 RM. (Co Comdrs provide hose and corks, etc.)
8. Demonstrate your ability to instruct in the foregoing, to the satisfaction of your company commander.

COURSE SA-2: Rifle Practice and preparing for same.

1. In each of five consecutive trials, set announced ranges and windages correctly in 10 seconds or less.
2. Start at Order Arms with a clip of dummies in a buttoned pocket of the belt; in each of five out of seven trials, fill the magazine and load the chamber in six seconds or less.
3. Sighting Bar exercise per par 19 RM. Use 7/8 inch bull.
4. Second sighting exercise per par 20 RM. Use ¼ inch bull at 20′ as this looks nearly the same as an 8″ bull at 200 yards.
5. Sighting triangle per par 21 RM. Use ¼ inch bull as before, ½ inch triangle necessary to qualify.
6. Assume correct positions; prone, sitting, kneeling, standing, with sandbag, vertical edge of door, parapet, etc., per pars. 28-35 RM.
7. Use of gun sling combined with preceding test. Pars 22-25 RM.
8. Holding the breath. Par. 26 RM.
9. Taking positions rapidly; prone, sitting and kneeling from standing. Pars. 36-38 RM.
10. Aiming and trigger squeeze combined. Chap IV RM. With aiming rod call the shots and average 4's.
11. Manipulation exercise. Par 44 RM, see also pars 42-43.
12. Simulate rapid fire; kneel or sit from standing, fire 10 dummies in from 54 to 60 seconds in each of 3 successive trials. See par. 45 RM.
13. Use of score book. Pars. 74-76 RM.
14. Pass the examination described in Chap. VIII RM.
15. Gallery practice in all four of the standard positions.
16. Instruction practice on the range.
17. Record practice on the range.
18. Demonstrate your ability as a coach for another man firing, to the satisfaction of your company commander.

COURSE SA-3: The Automatic Pistol

See WD Doc 1050, "Pistol Markmanship," hereinafter abbreviated "PM," and Vol II, Chap IV, "Platoon Training" by Waldron, hereinafter abbreviated "PT."

1 Operation of the Pistol. Pp 84-85, par 10, PM.
2 Safety precautions. P 84, pars 11, 72, PM.
3 Safety tests. Pars 12-15 PM.
4 Strip and assemble the pistol. Pp 82-84 PM.
5 Name and point out the principal parts. (Par 9 PM.)
6 Perform correctly the manual of the pistol. Pp 17-20; also see Vol. II, Chap IV pars 10-21 PT.
7 Demonstrate the proper care and cleaning of the pistol. Pars. 16-21 PM. No candidate to be passed on this test if his own pistol is in other than excellent condition.
8 Demonstrate your ability as instructor in the foregoing, to the satisfaction of your company commander.

COURSE SA-4: Pistol practice and preparation for same.

1 First sighting exercise. Pars 40, page 38, PM.
2 Second sighting exercise. Par. 41 PM.
3 Third sighting exercise. Par. 42 PM.
4 Assume all positions correctly. Pars 44-51 PM.
5 Trigger squeeze exercise. Pars 52-54 PM.
6 Rapid fire exercise. Pars 55-56 PM.
7 Quick fire exercise. Pars 57-58 PM.
8 Pass the examination described in par 59 PM.
9 Make 60% in slow fire at 15 yards; instruction practice.
10 Same at 25 yards.
11 Make 50% in instruction practice, slow fire, 50 yards.
12 Same at rapid fire, 15 yards.
13 Same at 25 yards.
14 Same at quick fire, 15 yards.
15 Same at 25 yards.
16 Shoot the record course and qualify.
17 Demonstrate to the satisfaction of your company commander your ability as coach in pistol practice.

3. CALISTHENICS AND PHYSICAL TRAINING COURSES

COURSE C-1: Rifle Drill.

(Numbers refer to pages in Manual of Physical Training, 1914.) Use Cadence System.

1 Perform first group, first exercise correctly and smoothly four times. 133, 148, 149.
2 Same for first group, second exercise. 150, 151.

3 Combine the preceding into one exercise; the transition point must be smooth and without hitch.
4 First group, third exercise as in test No. 1. 152, 153.
5 Combine all three exercises as in test No. 2.
6 Execute first group, fourth exercise as in test 1. 154, 155.
7 Execute entire first group as in test 3.
8 Execute second group, first exercise as in test 1. 156, 157.
9 Combine all preceding exercises as in test 3.
10 Execute second group, second exercise as in test 1. 158-159.
11 Combine all preceding exercises as in test 3.
12 Execute second group, third exercise as in test 1. 160, 161.
13 Combine all preceding exercises as in test 3.
14 Execute second group, third exercise as in test 1. 162, 163.
15 Combine first and second groups as in test 3.
16 Execute third group, first exercise as in test 1. 164, 165.
17 Combine all preceding exercises as in test 3.
18 Execute third group, second exercise as in test 1. 166, 167.
19 Combine all preceding exercises as in test 3.
20 Execute third group, third exercise as in test 1. 168, 169.
21 Combine all preceding exercises as in test 3.
22 Execute third group, fourth exercise as in test 1. 170, 171.
23 Execute all three groups as one exercise, swinging smoothly from each exercise and group into the next without halting. Each exercise in each group being executed four times, as in the preceding tests.
24 Demonstrate your ability as instructor in the preceding, to the satisfaction of your company commander.

COURSE C-2: Calisthenics.

This course is composed of the "fifth series, trained soldier instruction," described on pages 67-85, Manual of Physical Training. Being composed of three groups of four exercises each, the course is precisely the same as the preceding.

NOTES:—

"Stereotyped courses of this nature are preferable until experts in the physical training movements are more plentiful than at present.

Post one or two men in front as guides in the movements; make this an honorary position, to be filled by the best trained men.

Learn that some movements must be given a slower count than others; Time your count accordingly and suit the cadence to the movement. Also draw out your count on the slow movements.

The goal to be attained is to have the whole company so adept that it can go through all three groups precisely together simply by having a guide in front and without counting,—in other words, a "silent manual."

4. Signalling Courses.

COURSE S-1: The two-arm Semaphore Code.

1 Letters A-G inclusive.
2 A-H, Z.
3 A-I, X, Z.
4 A-J, P, X, Z.
5 A-K, P, V, X, Z.
6 A-L, P, V, X, Z.
7 A-M, P, S, V, X, Z.
8 A-P, S, V, W, X, Z.
9 A-S, V, W, X, Z.
10 A-T, V-Z.
11 A-Z.
12 Numerals.
13 Artillery Code, par 50, Signal Book.
14 Demonstrate your proficiency in signalling by sending and receiving a message, preferably an advertisement or a coded message.

Note that in this course the letters are grouped as nearly as possible with their opposites. This helps to prevent confusion in learning.

COURSE S-2: Wig-wag, using Continental Morse Code.

1 Letters T, M, O, E, I, S, H.
2 Add A and N to preceding.
3 Add R and K to preceding.
4 Add D and U to the preceding.
5 Add B and V to the preceding.
6 Add F and L to the preceding.
7 Add G and W to the preceding.
8 Add P and X to the preceding.
9 Add C and J to the preceding.
10 Add Q and Y to the preceding.
11 Qualify in entire alphabet, mixed up; numerals added.
12 Artillery Code, paragraph 50 of Signal Book.
13 Qualify by sending a wig-wag message, preferably an advertisement or a coded message.

5. Miscellaneous Courses

COURSE X-1: Infantry pack and Tent Pitching

1 Name and indicate the parts of the field equipment.
2 Strip and assemble the field equipment.
3 Make up the short roll and assemble the equipment.
4 Make up the long roll and assemble the equipment.
5 Adjust the equipment to the body for marching.
6 Sling and unsling the equipment.
7 Lay out the equipment for inspection, per Fig. 11, Vol. I, PT.
8 Detach pack when equipment is slung.

9 Pitch single shelter tent and strike same.
10 Pitch single shelter tent and display equipment. Strike tents.
11 Pitch pyramidal tent in simulated company street.
12 Demonstrate your ability as an instructor in the foregoing, to the satisfaction of your company commander.

COURSE X-2: Hygiene, First Aid, Sanitation.

(Vol I, Chap IX, PT)

1 Describe the make and size of a proper military shoe and how to fit it to the feet. Same for socks.
2 How do you treat blisters? How should nails be trimmed?
3 Why is it customary in all efficient armies to keep the hair short?
4 How should you care for your clothing and blankets in the field?
5 Describe ditching a tent and making a camp bed on ground.
6 Describe latrines:—for 1-night camps, for longer camps. If they are really necessary state reasons.
7 Discuss disposal of kitchen refuse, slops, wash-water, banana peels, garbage. Show how to make a kitchen incinerator.
8 Discuss care of teeth and results of lack of care.
9 How about bathing? Suppose water is scarce, what do you do for a bath?
10 Discuss "cooling off" when sweaty, and resting in wet clothes.
11 In case of exposure to venereal diseases what should be done? When? Is prophylaxis or any other medicine a sure preventative?
12 How about eating uncooked foods and unboiled water?
13 What are the five ways in which you can catch a germ disease? Name one or more of the diseases caught in each way.
14 How do we prevent typhoid in the service? Is it effective? Did typhoid ever amount to anything in the army?
15 Demonstrate the proper use of the first-aid packet.
16 Demonstrate the Schaefer method.
17 Demonstrate the stoppage of bleeding.
18 Demonstrate bandaging, slings, care of fractures.
19 Demonstrate carrying the wounded without litters.
20 Demonstrate placing the wounded on stretchers and carrying same.
21 Demonstrate your ability to instruct in this course to the satisfaction of your company commander.

COURSE X-3: Military Courtesy

(See WD Doc 864)

1 Post Orders relating to passes, grade lists, etc.
2 Lesson 1, WD Doc 864.
3 Lesson 2, same.
4 Lesson 3, same.
5 Lesson 4, same.
6 Lesson 5, same.

7 Lesson 6, same.
8 Lesson 7, same.
9 Lesson 8, same.
10 Lesson 9, same.
11 Lesson 10, same.
12 Lesson 11, same.
13 Lesson 12, same.
14 Lesson 13, same.
15 Lesson 14, same.
16 Lesson 15, same.
17 Lesson 16, same.
18 Lesson 17, same.
19 Lesson 18, same.
20 Lesson, same.
21 Explain necessity for utter impartiality—no favorites—no "familiarity" as described in last part of "The Fort Sill Course" in this subject.
22 Demonstrate ability as instructor, to satisfaction of company commander.

COURSE X-4: Guard duty

(Numbers are references to paragraphs, MIGD)

1 155-156.
2 199-200.
3 154-168.
4 169-177.
5 178-185.
6 186-198.
7 199-208.
8 Practical, sentinel on post.
9 Practical, riot duty.
10 209-221.
11 222-237.
12 238-256.
13 299.
14 300-307.
15 349-356.
16 357-367.
17 140-154.
18 108-113.
19 114-122.
20 123-137.
21 Demonstrate proficiency as instructor in this course.

VIII

To start the instruction in any organization, the company commander first prepares a chart, upon which is to be recorded the progress and status of every member of his company. One copy of this chart is posted on the company bulletin board and kept up to date. The other copy is kept in a secure place by the company commander. A part of such a chart is shown below:—

Down the left margin of the sheet is typed the roster of the company. Opposite each man's name is a line of squares, each headed with the number of the test to which it refers. (A labor-saving expedient is to use paper with quadrille ruling four or, preferably, six lines to the inch.) When a man is assigned to instruction in a certain test that fact is denoted by placing a pencil dot in the appropriate square; when his instructor has declared him proficient and ready for examination in that test a diagonal line is drawn in that square; when the man has successfully passed an examination in that test the opposite diagonal is drawn in the corresponding square. Others may be devised by the company commanders to show other desirable information, such as unusual proficiency or ability, etc.

(Sample of Graphic Chart)

STATUS OF INSTRUCTION OF FIRST COMPANY, KEY WEST
COURSE I-1: School of Soldier and Squad

RANK	NAMES	NUMBERS OF TESTS									
		1	2	3	4	5	6	7	8	9	etc.
1st Sgt	Doran, Patrick,										
Sgt	Goodwin, Carey,										
* *	* * *	*	*	*	*	*	*	*	*	*	*
Corp	Dugan, Charles,										
Pvt. 1cl	Barfoot, Clyde,										
Pvt 1cl	Green, Thomas,										
Pvt	Rowe, John E.										
Pvt	Rowe, George,										
	etc.										
*	* *	*	*	*	*	*	*	*	*	*	
INSTRUCTORS:—											
Sgt	Ducrot.....										
Sgt	Riordan.....										
Sgt	Ruhl.....										
	etc.										

The instructor may advise the captain of the candidate's alleged proficiency in any one of several ways. He may await the termination of the drill and then report to the captain all of the men whom he deems proficient or he may send the man immediately to the captain with a penciled note. The precise method to be followed is a point for the captain himself to settle.

A man should be rated as having passed a test only after examination by his captain or other officer detailed by the captain for this purpose. Ordinarily, no non-com should be detailed to this duty. It may happen that the captain is unable to have the man examined immediately upon his being reported as proficient. In such a case, the man should be advanced, *tentatively*, to the next test on the schedule, pending examination. It is important that these examinations be not unduly delayed.

Honorable Mention, Essay Competition, 1921

The Future of Our Minor Armament

By Major Fred M. Green, C. A. C.

Materiel

THE recent order which eliminated from our seacoast service a number of types of obsolete or otherwise unsatisfactory artillery, such as the Armstrong guns, the 3-inch Model 1898, the 4-inch barbette, and the 5-inch balanced pillar mount, has been the first instance of general elimination since the disposal of the old muzzle-loaders some twenty years ago. As in the case of every system involving a "Class B," it is but natural to look about with curiosity and speculate on the identity of the next victim. The choice of many officers would probably fall on the remaining 3-inch seacoast guns on the ground of their well known deficiency in range and hitting power. With all respect for the opinions of many officers of wider experience than his own, the writer desires to advance his views on the uses of this type and to express his conviction that its value should not be underestimated.

Certainly the 3-inch gun of present pattern is at best but a short range weapon. Beyond about four or five thousand yards, its angle of fall becomes so steep that the danger-space for a vertical target with freeboard no greater than that of a destroyer becomes very small. Of course, too, the probability of a hit is still further reduced by the increased dispersion at the longer ranges. If the variation in the error of coincidence range-finders be neglected and the probability of hitting be assumed to vary directly as the danger-space and inversely as the probable error at any range, the following table, based on the best available data for the dispersion of the 3-inch short-pointed projectile, exhibits the relative probability of hitting:

RANGE (yards)	PROBABILITY (DS/PE)	RANGE (yards)	PROBABILITY (DS/PE)
1000	13.2	6000	0.3
2000	4.4	7000	0.2
3000	2.0	8000	0.1
4000	1.0	9000	0.1
5000	0.6	10000	0.0

It is convenient to remember that in general the addition of each thousand yards to the range reduces the probability of hitting by about one half. Such comparison serves to bring home the fact which we all realize in

a general way, that guns of this type are effective only where the use of narrow channels is to be denied, or for other short-range purposes, and that expecting such batteries to cover more distant approaches from seaward or to prevent the passage of wide entrances is "setting a boy to do a man's work". The utility of a 3-inch battery must be judged with reference to its mission and the extent of the adjacent water-areas, bearing in mind that the maximum graduation on its range-drums does not necessarily denote the effective radius of a battery's fire.

The writer is not aware whether or not it is intended to send the Model 1902 and 1903 guns to follow the Model 1898 on the path to elimination. Unquestionably, an order to this effect would be regarded by many as a progressive step. The unexpected endurance of a modern destroyer —its surprising ability to withstand gunfire and even dismemberment from collision without sinking—was forcibly illustrated during the recent war. Some of the more remarkable of these instances furnish admirable arguments for those who contend that the day of the 3-inch gun has passed. That the navy long since passed to the 5-inch gun for torpedo defense, and regards the 3-inch as wholly inadequate, is often quoted. Unquestionably, the larger gun is not only accurate at a greater range, but is far more destructive at all ranges. If anyone has a kind word for the little 15-pounder, it seems about time for it to be said.

Value of Minor Armament

Though he trespass on a form of statement commonly reserved for the Hibernian orator, the writer ventures to assert that the best argument for the retention of the 3-inch guns is that *we have them.* In this era of extreme Congressional economy as regards military appropriations, it is surely a point well deserving of consideration that in nearly every fort there can be found one or more batteries of them—the guns, emplacements, accessories, and a good stock of ammunition. An old gun ready for use is certainly worth any number of new ones, no matter how perfect, that are on the long road from the blueprint stage, down through the phase where glowing accounts of their test and their life-like portraits in the Journal of the U. S. Artillery charm our fancy, on through the shadowy period where we learn that the guns are completed but that due to the exhaustion of funds cannot be shipped to the Coast Defenses of Mud River until after the first of July, down to the heart-breaking hour when after mounting the guns it appears that they must again be placed out of commission to undergo some modification. No, the possibilities of an old gun, with its peculiarities well known to those assigned to it and the reliability of its performance well established by some years of use, should not be held too lightly. It is said that most of the batteries at the Dardanelles had no telescopic sights, but were equipped with the old-fashioned tangent sight only. This

is surely indicative of their antiquity, but what these guns accomplished against the British and French fleets is a matter of historical record.

Familiarity and present availability are not the only claims upon our attention which the 3-inch battery has. Granting that a 6-inch or 155-mm. shell will work far more mischief to the inward parts of a destroyer if it can but be burst there, there is yet something to be said for the smaller caliber. We all know that a rifle bullet would make a much larger and deeper hole in an individual enemy than would a single buckshot, yet who would not prefer a riot gun with its greater volume of fire—its greater area searched—for a close range encounter, especially in the dark? The greater rapidity of fire and more ample ammunition supply of the smaller caliber serve to make the comparison fairly parallel. "Yes," says the objector, "but a single buckshot will disable a man, and look at the punishment a destroyer can stand." The answer is that a naval ship, no less than a man, furnishes a very complicated target with areas of differing vulnerability. What might be but annoying in one region may well prove fatal in another. The complexities of the problem are such as to defeat all mathematical calculations of a ship's endurance to gunfire. Before Jutland, who would have credited a prophesy of the almost instantaneous destruction of the *Indefatigable*, *Queen Mary*, and *Invincible* from a small number of hits, when other ships had withstood a greater number of impacts without serious injury? Who would have believed that the "Seydlitz" could sustain twenty-eight major caliber hits and survive? The luckily—or unluckily—placed shot may readily upset all formulas.

And is it altogether reasonable to assume that the destroyer furnishes the only probable target for minor armament? At maneuvers, and in the use of the Coast Artillery War Game, we have cultivated a feeling of personal hatred for this type of boat, due to their propensity for making smoke screens and for raiding base-ends and the searchlights adjacent thereto. The latter are so conspicuous when "in action" that perhaps the absence of more serious attempts to hide them can be understood, but everyone knows that the pagoda-like structure of our earlier fire-control stations, and the skylined roofs and smooth, geometrically-sloped parapets of many of the later ones, have sufficiently advertised their location to every passing ship. The ends which may be gained thereby are so great that it is generally anticipated that raids on these elements will precede any naval attack in force. Before the World War, both in the War Game and at maneuvers, the classic method was to send divisions of destroyers on such missions, and from force of habit it is natural to assume that destroyers will be used hereafter for this purpose. This is not as certain as it may appear. Considered in the light of naval development during the last few years, the future selection of destroyers for this purpose in actual war seems less assured.

The gun-carrying submarine appears a far more efficient weapon for such work, for unlike the destroyer it is in no danger during its advance to and withdrawal from the very close position which must be occupied for any reasonable prospect of success in its mission. Even while in action, it presents but a relatively difficult target to hit. Its employment in raiding will probably be in the nature of a series of harassing attacks, appearing at short range, indulging in a brief burst of fire, and submerging again as soon as the rapid fire batteries have been manned and appear to be getting adjustment. Searchlights and fire-control stations located near shore and within easy range of channels deep enough to admit of such a maneuver seem especially likely to suffer from such attacks. Against such operations the 3-inch batteries should be very effective; their lack of power is more than atoned for by the promptness with which they can open fire, the volume of fire they can maintain, and the fact that due to the very small manning party required for their service a relief can be kept constantly on the guns without drawing too heavily upon the strength of the command.

Perhaps it was partly because of the gradual evolution of the destroyer into a more costly and elaborate craft approaching what was formerly called a scout cruiser, or perhaps it was partly due to the necessity for preserving their destroyers to guard capital ships from submarine attack, that in the British plan of attack on Ostende in 1915, as well as in their subsequent plan for landing at a point further west on the Belgian coast in 1917, they selected small open boats (motor launches or a column of ship's boats, equipped with smoke-producing burners) for making smoke screens. (See J. U. S. A., Sept. 1921, pp. 223-231). Their 1917 plan, which was drawn up in the light of their experiences at the Dardanelles, presumably represents the latest thought in naval operations against a coast. The effectiveness of oil-burning destroyers for the purpose of making smoke screens is unquestioned, but it seems that in war even the strongest of naval powers found the use of a simpler, more readily replaced and less expensive means of smoke production advisable when operating against a comparatively immobile enemy on shore. Against craft so small as these, as against landing parties, and as against mine-sweepers or other smaller craft seeking to interrupt our mine defense, the power of the 3-inch gun is still ample.

The Tactical Employment of Heavy Artillery (page 21) points out that situations may arise requiring a barrage fire from seacoast batteries. Few guns other than the 3-inch have the volume of fire, the great accuracy-life, and the ample supply of ammunition which effective barrage fire demands. It is not impossible that our 3-inch anti-aircraft guns, which are capable of fire at low elevations, might in emergency participate in such fire, or in aimed fire against small naval craft close in.

Quite apart from its inherent tactical value, the 3-inch gun is so well adapted for the training and rehearsal of personnel in the observation and adjustment of fire that the retention of at least some batteries of this caliber in each Coast Defense for training purposes seems certain. That such batteries would be allowed to remain idle in battle is unthinkable.

Finally, while the citation of particular cases would be indiscreet, it is certainly admissable to remark that cases do exist where 6-inch and other rapid-fire batteries have been emplaced on such high sites that there exists an inner dead-space into which they cannot fire due to the limit of depression of the carriage. History is full of instances of naval vessels which have run in so close that shore batteries could not reply to their fire because the cannoneers could not sufficiently depress their guns. The example of the *Condor* at Alexandria was followed by our navy in operating against the forts at Santiago and Cavite, and in each instance it was found possible to run a small gunboat so close to shore that she was safe from the fire of the land batteries. The escape of the British submarine which ran ashore on Heligoland in foggy weather, and although immediately discovered could not be attacked by the German batteries due to the limit of depression of their pieces (J. U. S. A., Mar. 1921, pp. 211-2) furnishes an amusing instance of the existance of a similar condition, and a still more laughable incident arose at Battery Irwin during the war, when a burning patrol boat with her nose almost in the parapet could not be sunk. That attempts upon our searchlights and stations by shallow-draught vessels taking advantage of this limitation would stand an excellent chance of success in one of our most important coast defenses is well known to its garrison, and presumably to the foreign power most interested therein. If our remaining 3-inch guns are to be removed from their present positions, ample opportunities exist for their emplacement on low sites where additional armament is urgently needed to guard against these tactics. At the short ranges in question (less than the minimum ranges for the 6-inch guns as now mounted), their accuracy and destructive effect would be sufficient. As compared with the reported armament of the German fortifications at Heligoland and along the Belgian coast, our forts are proportionally much weaker in rapid fire guns, and we must conserve what supply of them we have.

The above have been itemized at some length, but only for the purpose of emphasizing that our existing minor armament is not unworthy of at least some attention from even the most progressive of officers. That the simplicity of its construction, the ease of its upkeep, and the readiness with which its ammunition is served do not indicate any corresponding ease in the direction of the fire of such batteries is appreciated by all who have ever fired a practice with them. For the benefit of the

reader—if one is left by this time—it may now be stated that the remainder of this article will be devoted to the question of the observation and adjustment of the fire of rapid fire batteries in general, and with only such references to existing types of 3-inch armament as are involved in the explanations due to the fact that the following methods were worked out on a battery of that caliber. The means indicated are believed equally applicable to more modern armament of small caliber when employed against targets of the character above considered, and as some writer said in effect in a JOURNAL OF THE U. S. ARTILLERY about twenty five years ago, "Even though our present guns are really obsolete, the best way to be prepared to fire our new armament when we get it is to learn now all we can from firing with what we have."

SEACOAST FIRE CORRECTION

That the technique of adjusting the fire of a seacoast battery on a moving naval target is much more difficult than is the adjustment of fire against a stationary target is obvious. Much that is practicable in the latter case is impossible in the former. Disregarding for the moment the technical side, the tactical aspects of the two cases are no less materially different. On land, a battery taken under effective fire is either destroyed or neutralized. Even though the matériel is not injured, either the personnel will be driven to cover or else the battery must change to another position with all the delays attendant upon reestablishing communications, the orientation, and the ammunition supply even after the guns have completed their movement. In any event, a battery in the field which is brought under a closely adjusted and hence effective fire is at least temporarily eliminated as a military factor, and to attain this important end neither time nor ammunition is spared. Far different is the situation of a naval commander who finds the enemy are getting adjustment on his ships. By slightly altering his course, which will have but a brief disturbing effect upon his own gunnery, he can escape from the adjustment and require the enemy to repeat the process. British reports of the Jutland battle contain frequent references to such action. Range adjustment was naturally the principal source of concern.* So invariably does report of a change of course of one or two points follow upon an entry that the ship was "straddled" by an enemy salvo that there is no possibility of this having been a matter of individual inspiration; undoubtedly it is perfectly

*The light cruiser *Chester*, according to the report of her captain, being taken at a disadvantage by superior German forces, withdrew on a zigzag course, "steering toward the last fall of shot * * * keeping the enemy's salvos falling alternately on either side on account of the constantly changing deflections. This was apparently successful as regards saving the ship from a large amount of further serious damage. In the last few minutes I believe she was seldom hit, but the changes of ship's course rendered it impossible for the after guns to make effective shooting." While this practice is less likely to be encountered than is evasion of range adjustment, it might be used by light ships running directly toward or away from a shore battery.

standard practice in their navy, and it probably is a recognized course of action in the naval service of all nations. Such being the case, the futility of protracting the matter of adjustment in the expectation of making some slight gain in its refinement is evident. The whole problem of adjustment upon naval ships is fundamentally different from that of adjusting upon land targets; it is useless to attempt the same degree of precision, it is necessary to expedite the adjustment to a degree unknown in the case of targets which are relatively if not completely immobile, and finally the adjustment once made cannot be expected to hold for an equal period because of the power of maneuver of the enemy, who can alter at his pleasure not only the basic data (his range and azimuth from the battery) but can also by slight deviations from his general course escape from a fire which is becoming too effective. In preparation of systems of adjustment for seacoast batteries, the full significance of this contrast must be appreciated.

Furthermore, the essential difference between the problems of the major caliber armament and those of the rapid fire guns must be borne in mind when comparing the procedure in these two cases. Discussion of the observation and adjustment of the fire of our major caliber armament is predicted upon the assumption of daylight conditions. This is of necessity, for the possibility of consistently determining deviations at night practice has yet to be proved, and their successful measurement under the more difficult conditions of a night action (where due to the restricted range of illumination several batteries of a fire command must simultaneously open fire on a single ship) is probably impossible. Due to the great cost and limited supply of ammunition for primary armament, and the brief accuracy-life of the guns, it is mandatory that these deviations be measured with at least tolerable accuracy in order that the number of rounds fired during adjustment be kept within a reasonable limit. Another reason why the adjustment of major-caliber armament at night is not more widely discussed is that the use of such pieces at night is necessarily restricted to the limits of effective searchlight operation, and at such short ranges the necessity for their fire to be adjusted is not nearly as great as it is for pieces of less power. For these reasons, the discussions of adjustment methods for our large batteries assume conditions of visibility which are obtainable only by day.

For rapid fire batteries, and particularly for those of the smaller calibers, the situation is exactly the reverse. Primarily we must require that the method of observation for light guns be satisfactory for use at night (under searchlight illumination), and at dawn and dusk, for in bright daylight their targets are least likely to expose themselves. Also, for these guns the necessity for adjustment exists even at inner ranges, due to their less accurate range-finding system, the more approximate system of computing range corrections, the use of flat cor-

rections irrespective of changes in the range, the more rapid "falling off" of their projectiles, and the small size of the targets which are most likely to be assigned to them. To some extent observation for these guns can be made by eye, due to their less ranges, avoiding the necesssity for a special plotting system, with all its attendant complications and drawbacks, as is required for the heavier batteries. Putting the matter in another way, we can say that for the small calibers it is practicable to "use the gun as a range-finder" to a degree which would be prohibitive in the larger pieces of less accuracy life and more costly ammunition.

It is partly for these reasons that our present (1914) drill regulations when first issued contained no reference to observing and adjusting fire for any but the minor armament. It will be remembered that orders in force at that time expressly forbade making such corrections for the heavy guns. Since 1914 our professional horizon has widened, and observation and adjustment of fire are now invariably required. In the light of the large fund of information on such subjects which has come into our possession during the intervening years, it appears timely to consider whether the methods originally laid down for rapid fire batteries cannot now be improved.*

OBSERVATION

The inquiry may be properly divided into two phases: the problem of observation and the problem of adjustment. Of the principal method of of observation employed in land firing during the war, those not already recognized in this connection (such as aerial observation, bilateral terrestrial observation, sound-ranging and burst-ranging) are inapplicable for our purpose, due to their complexity, their cost, the fleeting character of the targets to be attacked, the number of batteries to be concentrated on a single target, and for many other reasons equally apparent. The excepted methods of observation, though under slightly different names, are found to be identical with those mentioned in our drill regulations: viz., axial observation by the battery commander and flank observation by a spotter.

Both of these systems have been extensively used at target practice. Formerly, axial observation was the more common, but during the last few years immediately preceeding the war the latter method became more and more frequently used. Its principal advantage lay in the ability of a flank observer to make better estimates of the deviations than could be done from the vicinity of the battery. Not only was his position more favorable for making a mere estimate by eye, but also it was possible to approximate a relation between the angular deviation as viewed from a flank and the linear deviation along the line of fire.

*Of the methods laid down in the C. A. D. R., it is interesting to note that those outlined in pars. 99-101 are almost identical with the system which Major Armstrong found had been in use at Heligoland. (J. U. S. A., Mar. 1921, p. 249.)

For service conditions, flank observation has the draw-backs: (1) that the operation of the system is dependent upon a distant observer and a telephone line—a combination sufficiently troublesome under any conditions, and one which can reasonably be expected to be productive of delays at a time when every second counts, as in the case of a raid or sudden attempt at run by at night, or in any case where a target is visible for a brief period only; (2) that due to the confusing similarity among torpedo craft and other small types, and the probability that any small boats will operate in considerable numbers, misunderstandings between the battery commander and the spotter are likely to occur, leading to a waste of precious time in explanations and in indicating the identity of the target; (3) that at night, due to the location of searchlights, a target clearly seen from the battery may be invisible to the spotter; (4) that in firing at any opaque target, small splashes are frequently lost by a flank observer, due to the interposition of some part of the hull*; (5) that due to the use of smoke screens or the merely fortuitous presence of smoke (from the enemy funnels and guns and our own shell-bursts), the observation of overs becomes nearly or quite impossible, thus largely reducing the advantages which are claimed to justify the occupation of a flank position; (6) due to the greater longitudinal dispersion of a gun, as compared with its lateral errors, the angular sector which must be watched for the splash is greatly extended, so that the fall of the shot is more likely to be lost and the identity of shots from one's own battery is rendered uncertain. As the range of torpedo-defense guns increases, the observer is forced further and further out to the flank, which accentuates the difficulties noted. Taken all in all, while the system of a flank observer is in some respects advantageous for target practice, or for deliberate firing at a stationary target on land, it promises little efficiency in its application to fire against light, fast naval craft, and especially for the quick night work for which these batteries are primarily intended.

In the past, the well known difficulties of adjustment from axial observation have led many officers to avoid this method for target practice. It has been generally felt that for long ranges, and especially for low-sited batteries, this method was of little value, and that even under the most favorable conditions it must be employed in connection with some scheme for estimating deviations in terms of the height of the target. Many ingenious methods for accomplishing this have been successfully demonstrated in target practice, especially by officers who had practiced for several seasons in estimating deviations in this manner,

*This difficulty was experienced several times during the firings on the *Massachusetts*, and it is far more likely to be encountered if several other hostile targets, equally solid, are in the field of fire. The need for accuracy will be greatest on the occasions when the greatest number of naval vessels are present, and some congestion at critical points seems inevitable. From the battery the view of the target must be clear, else it could hardly be fired on, but all view of it may be hidden from the spotter's station by some intervening ship.

subsequently checking their results from camera or range-rake records. That such methods are as artificial as are the conditions under which target practice is necessarily held is self-evident. In time of war our minor-caliber batteries will be commanded not by the older and more experienced of our officers, but by officers recently commissioned, or by officers of the reserve or of the militia, or by non-commissioned officers with temporary commissions. What an enthusiast who has made spotting his hobby can do in broad daylight in practice at a slowly towed target of known dimensions and on a smooth sea is one thing; what an inexperienced officer can do in battle, under fire, at a high-speed target of unknown height, perhaps in rough water, stormy weather and at night, is likely to be something quite different. Even had he the experience of many target practices to guide him, the lack of the vertical ten-foot edges against which to estimate the position of the "slick" would defeat the application of so artificial a method.

The prejudice against using an axial observer appears to have been based largely on the belief that in order to effect adjustment the approximate magnitude of the deviations must be known. Given a method where only their sense is required, axial observation is infinitely preferable to observation from a flank because it is free from the six faults of that method which have been set forth above. In addition, the required data can be determined at night fully as easily as by day, even though there is only enough light on the target to enable the gun-pointers to see it through their sights. There is but one method of adjustment where knowledge of the magnitude of the deviations is unnceessary, and that is the bracketing method. There is but one type of seacoast gun that can ordinarily afford to use this method, and that is the small rapid fire gun. A means of applying this method at seacoast batteries, embodying some slight modifications of its more familiar application to the stationary target, will follow. In describing it, the basis of the observation is the noting of the "shorts," and to avoid interrupting the explanation in order to account for this criterion, the reason for its selection will first be introduced.

Insofar as we can visualize them, the conditions confronting a battery commander of seacoast armament in service will differ markedly from those encountered in target practice. His increased difficulties have already been touched upon, but there is one compensating advantage in that his target will not be the ethereal, transparent network of peacetime. This deceitful screen forms no background against which a short splash can be silhouetted, but an enemy ship, even though camouflaged, cannot fail to do this. The white splash against the dark background of a ship's hull is so clear-cut that the peace-time mistaking of overs for shorts, which so enlivens the pages of analysis reports, is unlikely to occur. It will be by the splash that the observer must judge, especially if the light be poor or the water rough. Many overs will be

lost, either by intervention of the ship or by smoke, as suggested before; hits and overs frequently cannot be told apart; and the one thing of which a battery commander can be fairly sure at the end of a series is the number of shots which fell *short.* Unless the deflections or gun-pointers are exceedingly bad, an axial observer (who can be under no misapprehension as to the identity of the target) working under unfavorable conditions for observation, may as a last resort classify his observations by counting as "short" all splashes seen in line with and short of the target at the end of the time of flight, and as "over" all shots which are lost. For batteries of very low site, the use of this standard may be more frequently required than at batteries whose natural height gives them better observation in rear of the target. (For later reference, it should be noted at this point that the above method outlines an adjustment at the waterline of the ship on the side or end nearer to the battery.)

ADJUSTMENT

Since speed will be vital in most instances, and since there must be but one invariable practice to avoid confusion, the ranging should be by battery salvos. By giving the command "Battery Right" or "* * Left," interference by smoke is avoided and an interval between splashes obtained just sufficient to make each individually visible. In battle it is preferable that the first salvo be short to insure its being seen, but if lost it is counted as having fallen over. If no contradiction occur on the first salvo, a range correction is applied equal to the fork at that range and another salvo fired. This process is repeated, if necessary, until the target is enclosed between the splashes of two salvos of which the range corrections differed by one fork. In fire against land targets, the bracketing salvos would have to be repeated for verification before entering upon the relatively extended improvement series used in such cases, but for reasons explained above the procedure must be abbreviated, and each pair of splashes must be considered to have established and verified the bracket limits. While for precision adjustment at a stationary target, the failure to further confirm them would naturally be criticised, in fire at a fugitive target much must necessarily be taken for granted. The commander who insists on being sure and "playing it safe" will probably end with but one point positively established to his satisfaction, and that is that the target has gone. If he has any data at all on his ammunition, bracket should be obtained within three salvos, and with luck it should be established by two in the majority of instances, except at the outer ranges. Should contradiction occur with a battery known to be calibrated (a condition which is fundamental for any practicable system of adjustment, as otherwise the slow adjustment by piece must be undertaken) the salvo should be repeated twice over, as will be shown hereafter.

Having bracketed the target, improvement fire with the mean of the two corrections thus determined can be opened. Two rounds per piece must suffice for improvement. Obviously, limitations to this number of rounds opens the way to grave error in the event of a single wild shot in the improvement series, but it must be constantly borne in mind that the problem here is fundamentally different from firing at a fixed point, where deliberate adjustment can be made upon which an extended series of firings will be based even though observations be interrupted. The time and ammunition justifiably expended in the latter case cannot be expediently applied here, where the range itself changes from second to second, and the total period of exposure to fire is presumably brief. During improvement fire, it is only necessary for the battery commander to count the number of splashes which appear short of the target, and his improvement correction is tabulated with the number of shorts as an argument.

Improvement fire having been completed, it is desired to pass into fire for effect. Attention was drawn to the fact that an adjustment made according to the foregoing was really made with reference to the waterline on the exposed side or end of the ship. To avoid having to make a separate correction to lift the center of impact up the side of the target, the danger-space correction should be incorporated in the table of improvement corrections. The advisability of using any such correction has been contested hotly. Its opponents argue that in battle a hit at the waterline should be particularly effective, and that attempt should be made to hold the center of impact there, especially as a short may be capable of inflicting damage by an underwater hit, or on ricochet, or by its fragments if it burst on water impact, while an over is a total loss as regards damage to the enemy. Others have suggested that an over may lead the enemy to believe that our shooting is wild and may thus encourage him, but the sight and shock of the burst and the fragments and water thrown aboard* by a shell striking short should have the opposite effect on his morale. Certainly, as far as observation is concerned a short is the preferable, as it can be seen, while an over is likely to be lost or mistaken for a hit; certainly as regards the relative effect of shorts and overs the former is more desirable, as it may result in some damage to the target; but in fire for effect hitting the target itself is the principal consideration, and it is no less certain that the probability of a direct hit is improved by raising the center of impact above the waterline. This is particularly true if the ship is end-on to the battery, for especially at the longer ranges the chances of a deck hit must not be overlooked. The sketch illustrates the several options which are open to the battery commander. *A* represents the reference with respect

*The difficulty caused by bursts short of the ship, which splashed water on the gun-telescopes and also hid the enemy from view just as a salvo was to be fired, is reported in at least one naval action of the late war.

to which adjustment was made. *C* is the highest line of impact for effect. *B* is drawn halfway between, and theoretically gives the best chance for direct impact. (For a target of appreciable thickness, it will be seen that *B* cuts the side considerably more than halfway up.) At target practice, a common compromise between these differing views is to attempt placing the center of impact at *D*, ¼, or 1/3 of the way up the target, thus tending to favor the chance of a ricochet hit which may effect some damage, in preference to an over which cannot. In this connection, paragraph 34, page 12, C. A. Memo. No 2, May 14, 1921, which states that for target practice when the pyramidal target is used no danger-space correction should be made, should not be misinterpreted. For firing against screen targets or a hostile ship, such a correction may be important and consideration as to the need for its application should not be overlooked. The less the range, the lower the site of the battery, and the flatter the trajectory of the piece

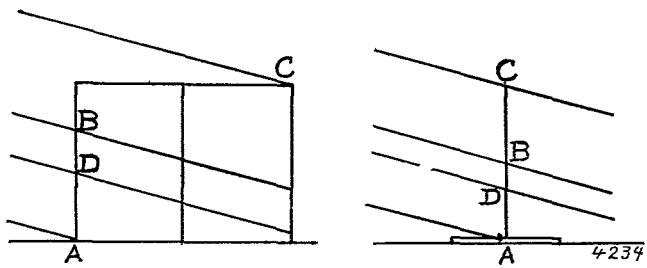

FIGURE 1.

concerned, the greater does this correction become for a vertical screen. Thus for a low-sited 3-inch battery, firing at the center of a target ten feet high, the correction is negligible beyond 5,000 yards, but at one fifth of this range the correction exceeds 175 yards.

Once applied, it is unnecessary to consider again the danger-space correction no matter how much the range may change, for its effect will be merged with so many other disturbing causes and corrected for without specific reference to its origin. As a matter of fact, when firing a rapid-fire battery without means of range prediction there is not only the change in danger-space correction but also the question of the ballistic correction and that of range-change during the time of flight to be considered. The last two are not ordinarily the subject of much thought. The former is generally negligible at target practice because the total change in range during the firing of any particular series is so small. The latter is never evident at practice because of the slow speed of our targets. Both are of much greater importance in fire at a high speed ship, as a few moments of thought over a range table will show. The relation of the three factors may be stated thus: having attained

adjustment on an incoming target, the decrease in time of flight as the range lessens will tend to lower the center of impact, because there is now less "dead time" between the reading of the range-finder and the instant of splash. In other words, the initial adjustment was based on the fall of the shots with respect to the position of the ship at the end of a longer time of flight, or on a point more short of the ship than is the (unplotted) set-forward point at a less range where the time of flight is reduced. This tendency will cumulate with that of the danger-space correction factor, for at the shorter range the danger-space correction should be increased and failure to change it will cause the center of impact to fall. Practically, the sum of these tendencies may be partially or wholly neutralized by the use of a flat range correction, if, as is generally the case, the range correction is additive (due to powder velocity being below the range-table value), for the amount of the ballistic correction applied at the longer range will be disproportionally great at the shorter. If adjustment be effected at a shorter range, and fire is to be maintained on a retreating target, the condition as regards the first two factors is reversed: the progressive lengthening of the "dead time" will tend to lower the center of impact, but because of the decreasing necessity for a danger-space correction at the longer ranges the center of impact will tend to rise, and these tendencies, being differential in character, will tend to neutralize. If the flat range-correction be additive in sign and considerable in amount, the center of impact will probably fall as the range increases. These comparisons are submitted here: first, because the whole question of danger-space correction has been the subject of so much misunderstanding that any advocate of its employment must be prepared to justify his action from all angles; second, because its relation to the other two factors involved is commonly neglected; and third, because for naval targets not only must fire be adjusted, but the adjustment must be *maintained*. For fire adjustment we have many rules, but for maintaining the center of impact on the target we have none. To hold to an advantage gained we must consider the disturbing factors, and for small, fast targets the above considerations, though not as familiar as some, are not the most unimportant in their effects.

Harking back to the conditions which have been cited as more or less descriptive of the difficulties surrounding a battery commander under service conditions, it is evident that no one should expect from him that same logical thought and painstaking analysis during adjustment upon a hostile ship which might be required of him in a section room or even at drill*. Particularly is this true if his experience has

In 1915 the Coast Artillery Board conducted some experimental mortar firings where more than usual difficulty in fire control was encountered. Their report states: " * * The fire control section was overworked, and on account of the shock and stress the individuals did not perform their separate functions as well as in their drills and subcaliber practice. * * *. A great many

been brief. Certainly he will have many duties and responsibilities in the former case which do not arise in the latter, and insofar as is possible his scheme for adjustment must be predigested. This aim is especially desirable for the smaller caliber batteries, to which the least trained officers and men are likely to be assigned**. Another reason for reducing the problem of adjustment to its simplest form lies in the fact that the presence of the battery commander at the battery may not be invariable, by reason of casualty or other cause, and the adjustment may have to be made by an inexperienced junior of little education and less training in gunnery. Furthermore, it is far from certain, even if the battery commander be present, that his personal services are needed in this matter. It was formerly considered incumbent upon the commander of a mortar battery to personally use the B. C. instrument, and it is only within the last six or eight years that our current practice and our drill regulations have admitted the practicability of the delegation of this duty to a subordinate. Granting that the range adjustment of one's center of impact is in reality a far more difficult problem, it is yet to be shown that for a particular set of conditions the procedure cannot be reduced to a set of rules sufficiently simple to enable this function to be delegated similarly†. In his recommendation of this practice, (J. U. S. A., May, 1921, page 429) Maj. Gray refers to this as "a radical opinion," but whether radical or not it is but a recognition of a contingency which is by no means unlikely to arise. In any event—whether the battery commander is to effect the adjustment in person or is to detail an assistant on this duty—the steps to be followed must be reduced to a simple form admitting of no exceptions and requiring no conscious thought. Only through such preparation can the unexpected emergency be met with an instinctive reflex action of the mind. The principal object of infantry drill is to make the soldier's

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errors were made in the range section. A strain was placed on the whole battery such as it had never borne before and one which only an unusually difficult practice or an action could bring out. The range section * * * could not shake off the feeling of the great responsibility which rested upon it. These are human failings and they are bound to be met in action * * *. The effect of such firing acts in entirely different ways on men engaged in mental work and men engaged in physical work. The former are strained and depressed, while the latter are decidedly stimulated." Last spring the writer entered a magazine plotting room of a 12-in. battery during its practice, and found a recruit who had done excellent work on the Pratt Range Board at drill; he was standing with his hands over his ears and mumbling, "Only three more! Only two more!" While such exaggerated instances are fortunately exceptional, a due regard for human frailty must be had in preparing methods. The confusing effect of mere noise is certainly the least of factors with which the nervous system must contend in battle.

**Our practice in this regard seems the reverse of that of the British. Their smaller armament is said to be manned by regular troops only, though a proportion of the heavier guns are assigned to second-line troops. This they explain on the ground that the service of rapid-fire guns requires the longer training and greater skill, especially in combining accuracy with speed.

† For several of the duties performed by soldiers at batteries today, the services of an officer formerly were thought necessary.

reaction to a command or a situation so instinctive that under the most trying conditions his response will be unconscious, certain, and immediate. The psychological value of this training has been proved through thousands of years of warfare. Not only the minds of the men but also that of the battery commander must be trained along similar lines to insure the desired end under the most forbidding conditions. Unlike the conditions of training, the nice weighing and balancing of different courses and the judicious selection of the best step to be taken have no place in this problem.

The following table is designed to present in the simplest possible form all data required in adjusting the fire of a rapid-fire battery along the lines which have been indicated. It was computed for a 3-inch battery 20 feet above sea level, firing short-pointed projectiles at a target ten feet in height, the point of aim being one third the way up its side. Similar tables can be readily constructed for any gun, ammunition, height of battery or type of target. Given the probable errors at the various ranges, and a range table, the time required to work up such a table as that given is about an hour. The fork column was constructed on the basis of such data on probable error as was available. The vertical columns to its right tabulate the range correction to be made as a function of the number of splashes seen short during the improvement series, and includes the danger-space correction. Each horizontal line of these columns is derived from the algebraic sum of two other columns, of which the first is the improvement correction according to the number of shots which fall short, and the second is the danger-space correction for that range. Each range in the left column of the completed table is the lower limit for that line: e. g., the line headed "3000" is computed for 3,500 yards, at which range the fork is 140 yards. It will be noted that entries are made in the table to the nearest ten yards, and that no correction for less than 20 yards is tabulated, for the reason that it would not pay to delay the fire for effect to apply a correction of so small an amount.

		SHORT:				
RANGE	FORK	0	1	2	3	4
2000	130	−40	0	+30	+60	+90
3000	140	−60	−20	0	+50	+90
4000	150	−70	−30	0	+50	+90
5000	170	−80	−40	0	+50	+90
6000	200	−100	−50	0	+50	+100

COMPUTATION FOR THE LINE HEADED 3,000 YARDS:

Number of shots striking short:	Correction for Improvement	Correction for Danger-space	Total Correction	Entry in in Table
0	−70	15	−55	−60
1	−35	15	−20	−20
2	0	15	15	0
3	35	15	50	50
4	70	15	85	90

The importance of maintaining an adjustment once effected has been referred to before, and some of the difficulties to be anticipated have been touched on. Due to the low speed of practice targets and the limited number of rounds available for target use, actual personal experience in this regard is and must remain lacking. Concrete evidence of the necessity for repeated changes in the range correction may be seen in practices where there is a prolonged interruption or delay during the firing of a series, so that a considerable change in range occurs between the first and last shots. Even where a Pratt range board is in use, the first and last group are likely to show considerable difference, and where but a flat correction system is used, this discrepancy will naturally be more pronounced. No better evidence being available as to how to hold a center of impact on the target, we must be guided by theoretical considerations. In a book on gunnery written at least fifteen years before its time, Col. Whistler stated that assurance that one's center of impact remained adjusted could be had only by noting an occasional short. If I recall his rule correctly, it was to the effect that about one short in five shots at short range, and one short in four at more distant ranges, was to be desired. So far as I know, this is the only specific guide on record in this matter. The French method of improvement fire seems to provide a more exact procedure. Consider a destroyer coming straight toward the battery with its range changing 800 yards each minute. An adjustment once effected is unlikely to continue satisfactory for over two minutes at the most, and very possibly even more frequent range-corrections will be needed. The rate of fire of a small rapid-fire battery will not fall below twelve rounds per minute. Observance of any twelve successive rounds by the method heretofore shown, and reference to a chart similar to the above, but constructed with twelve instead of four shots as a basis, will enable an improvement correction based on twelve rounds to be applied for about each 800 yards of range-change. In constructing such a chart, which may be called an "adjustment maintenance chart" methods identical with those outlined are applicable. No interruption of fire in applying these corrections need occur.

The difficulties involved in the application of several successive range-corrections can be avoided by the use of a proper slide-rule figure 2. Unlike that shown in the C. A. D. R., (Fig. 9) it is unnecessary with this rule for the operator to mentally add or subtract each correction after the first, with certain loss of time and no less certain error. To minimize the failure of divisions to line up, due to the vagaries of amateur graduation and the tendency of paper scales to crinkle, a scale of 2½ inches for each hundred yards is recommended. Since this requires about a six-foot rule for each three thousand yards of range, it is necessary to use several rules for each battery or else to leave the thous-

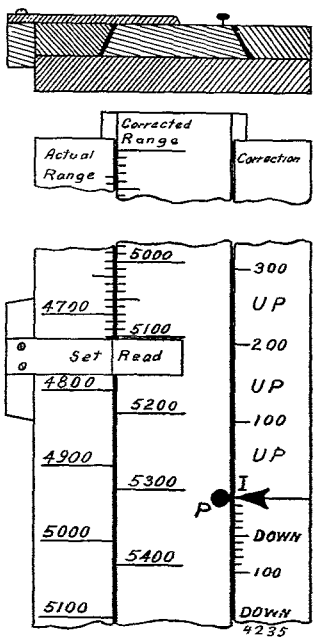


FIGURE 2.

ands figure blank to be filled in by temporary notation during use. The total width should not be less than five inches. These generous dimensions may be reduced, but only at the sacrifice of the clearness of the scales. It is my experience that a soldier works more rapidly, more accurately, and with greater satisfaction when he is given a man-size instrument. A short T-square facilitates reading. The unique feature of this rule lies in its movable index *P*, which is conveniently made from a pushpin. To use, the two left scales are first brought into coincidence. When the first correction is announced, the pin *P* is pushed into the right edge of the slide opposite the correction indicated, and the slide is then moved until the pin is opposite the index *I*. In the sketch, the first correction given was "Up 370," which we will assume the ballistic cor-

rection to be. After the first salvo, suppose the next correction to be applied is "Down 180". Instead of having mentally to subtract the latter number from the former, as is usually necessary, the operator proceeds thus: without changing the slide, he removes *P* to a position opposite "Down 80" on the correction scale, and by moving the slide he then again brings *P* back opposite to the index *I*. Succeeding corrections are applied in the same manner. The especial value of this arrangement is that it is never necessary to add or subtract mentally. This device was shown to the writer by an officer since retired, and in view of the present necessity for rapid methods for applying adjustment corrections in all seacoast firing (regardless of the type of armament) it is believed it may be of general interest. It has certainly worked very satisfactorily in practice. It is best operated by two men, of whom the first receives the ranges from the range-finder, keeps his T-square set to these ranges on the left-hand scale, and transmits the corrected range to the battery whenever (1) a new range is received from the range-finder, or (2) a new correction is directed by the battery commander. The second operator receives the corrections from the battery commander, adjusts the pin and slide, and when a new range which embodies the latest correction has been sent to the emplacement he reports back to the battery commander "Correction on," in order that the latter may be advised that (1) in obtaining adjustment, he may now order the resumption of fire with assurance that his last correction is included in the data now at the guns; or (2) in maintaining adjustment, he may again commence counting the short splashes in a series.

It is scarcely necessary to point out that in any sort of seacoast battery where correction of fire is to be used with any degree of success, especial training of the range-setters is demanded. The word "Ready" must never be given until the last range posted has been set, for in correcting fire any inattention or indifference in this matter will result not only in the loss of that shot, but in the confusion or deception of the battery commander as to the results attained, probably ending in the waste of a considerable number of rounds in consequence of a single faulty indication. When corrections are being applied, range setting ceases to be the monotonous job that it is generally considered when ranges progressively increase or decrease along a more or less smooth curve of time-range relation; for satisfactory results only the quickest, most alert, most accurate and most conscientious men will answer. In most batteries the interchange of gun-pointers and range-setters might profitably be considered; under present conditions the latter work is by far the more difficult and important, and it should be a rated position to which only the best men might aspire.

To summarize and illustrate the application of the method of adjustment herein described, the following sample commands are given. Tracking is assumed to have commenced at 7,000 yards on an incoming

target. Using the table on page 523, the battery commander orders "Battery Right" (and gets a short); "Up 200;" ("correction on,") "Battery Right" (and either sees an over or loses his splashes entirely); "Down 100;" ("correction on,") "Two rounds, commence firing," (and sees three of his splashes short;) "Up 50;" ("correction on,") "Battery commence firing". With personnel thoroughly drilled in this operation at subcaliber practice, very smooth team-work was developed and the only delay was in waiting for the shots to fall.

Visiting plotting rooms today is a good deal like inspecting a band: there are all sorts of queer instruments, no two men seem to have the same sort of thing, and each curious and intricate piece of apparatus evokes more surprise than the last. Thank God for the familiar aspect of the plotting board and the bass drum! The writer dreads to add the straw to break the camel's back, for our fire-control system is already cluttered up with gadgets and theories innumerable. Still, as a writer in the "Journal of the Royal Artillery" pointed out some years ago, "A seacoast work exists only for its fire effect. Failing that effect, it is a mere futile excrescence marring a coast line." Out of the present era of Bolshevism in fire direction, observation, and adjustment we must evolve a workable system. No matter how scientific its form we cannot accept a system so slow that a target is allowed to pass us and get out of range before the theory of probabilities assures us that adjustment has been completed and fire for effect can now begin. To lapse into the vernacular, we must "jazz up" our methods. In pursuit of that laudable end the writer submits the adjustment chart, the adjustment maintenance chart, and a system for their use.

The especial advantages claimed for the above method for firing rapid-fire guns are (1) that the system gives speed without unnecessary disregard of accuracy; and (2) that no brains are required to run it. The most inexperienced and worst rattled battery commander or acting director of fire has but to take his two charts and follow these simple instructions:

(1) Range by battery salvos, changing by a fork at a time until bracket is obtained.

(2) Split the bracket, fire two rounds per piece for improvement, and count the splashes which are short.

(3) Pick your correction from the card, and open fire for effect.

(4) If you get contradiction while ranging (see 1 above), open fire as though for improvement without changing your correction. If three of the six splashes are short, your adjustment is satisafctory; otherwise enter the improvement columns of your adjustment table with the number of shorts in your last four shots as an argument.

(5) During fire for effect, note the number of shorts in any twelve consecutive rounds. Apply the correction given in your adjustment maintenance table without interrupting the firing.

The Archies and the Anti-Aircraft Service

By Captain Benjamin F. Harmon, C. A. C.

PART I. FRONT LINE DEFENSE

WITH the conception and development of any weapon and art of war proceed equally the invention and perfection of the necessary counter measures. Thus we have artillery and armor, gas and gas masks, submarines and depth charges, and aviation and counter-aviation progressing one with the other.

No lesson has been so thoroughly learned during the world war as that of the importance and value of aircraft in warfare. The sequel of that lesson is that the future attack in the future war will consist largely of or be preceded and supported by a concentration from the air. There will be many difficulties in the path of hostile attacking aerial units due to the geographical location of the United States and its possessions, but in considering that particular phase of the question it should be remembered that obstacles confronting a determined enemy, even though apparently insurmountable, do not by any means assure protection. That the Germans did not bomb New York during the World War still remains a surprise to students of this type of warfare.

To frustrate the enemy's aerial attacks we rely on our air service and our anti-aircraft service, the latter controlling all units of the defense which are operated from the ground. Both of these services are essential for this defense as are the Navy and the Coast Artillery Corps for the Coast Defense. The anti-aircraft service, located, as it is, near the probable targets, on the ground where the attack must come, is always prepared for combat and is planned with a view to night attack when the enemy is unseen. If our own air force is in a position to attack the enemy the ground units will operate only against such of the enemy units as are clear of the path of the friendly planes, whose attack is the most effective defense by day.

It is not intended to deal with air service questions here, but with anti-aircraft alone. The subject is one which should interest all Coast Artillerymen in that they will be required to operate the units of the defense. The importance of this element of coast artillery duty should vary directly as the importance of aircraft in the military scheme. The number of regular army officers who served in France with the anti-aircraft service, is, relatively speaking, minute. Too many of the remainder who have not studied this service, basing their decisions on hearsay and rumor, have refused to read the handwriting on the wall

and recognize the growing importance and effectiveness of the ground defense against aircraft.

The technical side of anti-aircraft artillery holds more interesting possibilities than can be covered in one article. Remarkable progress has been made in instrument design and calibration and in the design and construction of guns and mounts. Much more remains to be accomplished. The action of fuses in high angle fire and the effects of wind on the projectile are not sufficiently well known. Some system must be devised whereby extremely high muzzle velocities, 4000 f.s. or greater, can be utilized without wearing out the gun in a day's fire. Perhaps the smooth bore gun will return. These and innumerable other questions will some day find their correct solution. The tactical employment of anti-aircraft means has not been presented as often or as completely as have various technical matters relating thereto, so it is upon that phase this paper intends to dwell.

There are two distinct tactical problems confronting us: Front line defense, and defense of back areas, as different from each other as day from night.

The distribution of anti-aircraft artillery units at the front is relatively simple; a continuous band of protection must be parallel the front lines throughout their entire extent. Arrangement "A" (Fig. 1) would furnish such a protected zone, but the resultant dead spaces are soon discovered by the enemy, and advantage taken of them in penetrating our lines. Arrangement "B" is an improvement, but "C" is much superior as it extends the active zone in depth and thus insures that the enemy planes will be under fire for a greater duration of time in penetrating the line, which is most important. Incidentally, this arrangement, with 2 gun 75-mm batteries requires approximately one gun per kilometer of front.

To locate the batteries in accordance with this scheme, which is one of the more important of the sector commander's duties, a sector commander's platen of concentric circles representing the horizontal radius of action of the gun at varying altitudes should be constructed. If this platen be constructed on celluloid, to the scale of the map in use by the sector commander, he can superimpose the center of the circles over the assumed gun positions, observe the extent of the fields of fire and by experiment with the map and actual reconnaissance finally secure an arrangement as near to the theoretically correct one as possible. The horizontal radius of action used in locating these batteries should be that for a target at 5,000 meters altitude. True, in a majority of cases, the enemy will be considerably lower than that, in which case the defense will be just that much more efficient, principally because he will be under fire continuously by more than one battery, for a greater duration of time.

Not only these immediate positions must be selected by the sector

commander, but also secondary positions for each battery, should they be forced to move by enemy fire, close enough to the original positions so the general scheme will not be affected. A complete new sector positioning for the eventualities of either advance or retreat must be always available for instant application. These various plans are

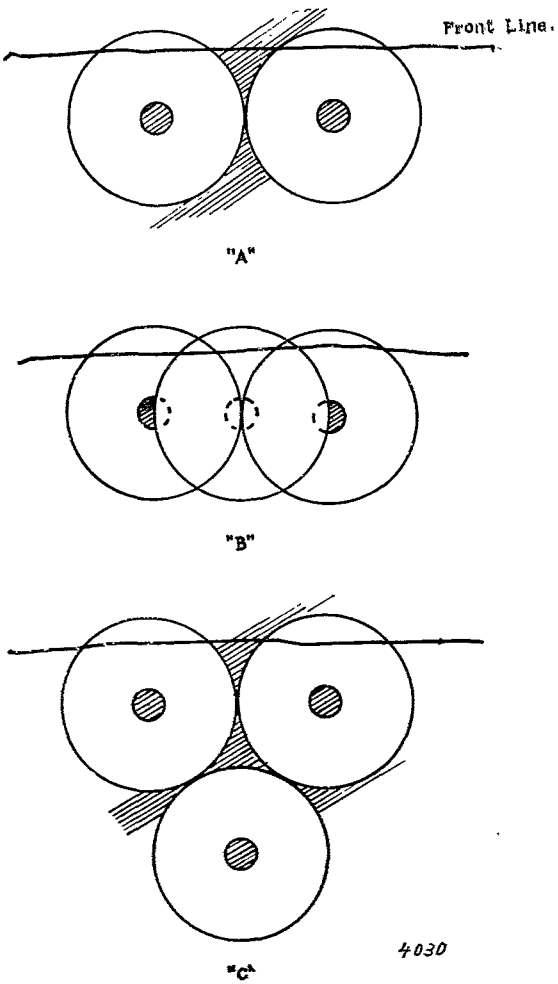


FIG. 1.
LARGE CIRCLES REPRESENT HORIZONTAL RADIUS OF ACTION AT 5000 METERS ALTITUDE. SHADED AREA REPRESENTS DEAD SPACE

brought into the general army artillery scheme through the Army Anti-aircraft Commander to the Commanding General of the Army Artillery for approval.

Protection against observation and fire, avoidance of registered spots or prominent landmarks, and other factors which influence the location

of a field battery apply equally to anti-aircraft batteries, except that all round fire and unobstructed view are two essentials. In allowing for these two vital considerations and at the same time affording a measure of protection to the personnel and of permanency of the battery, em-

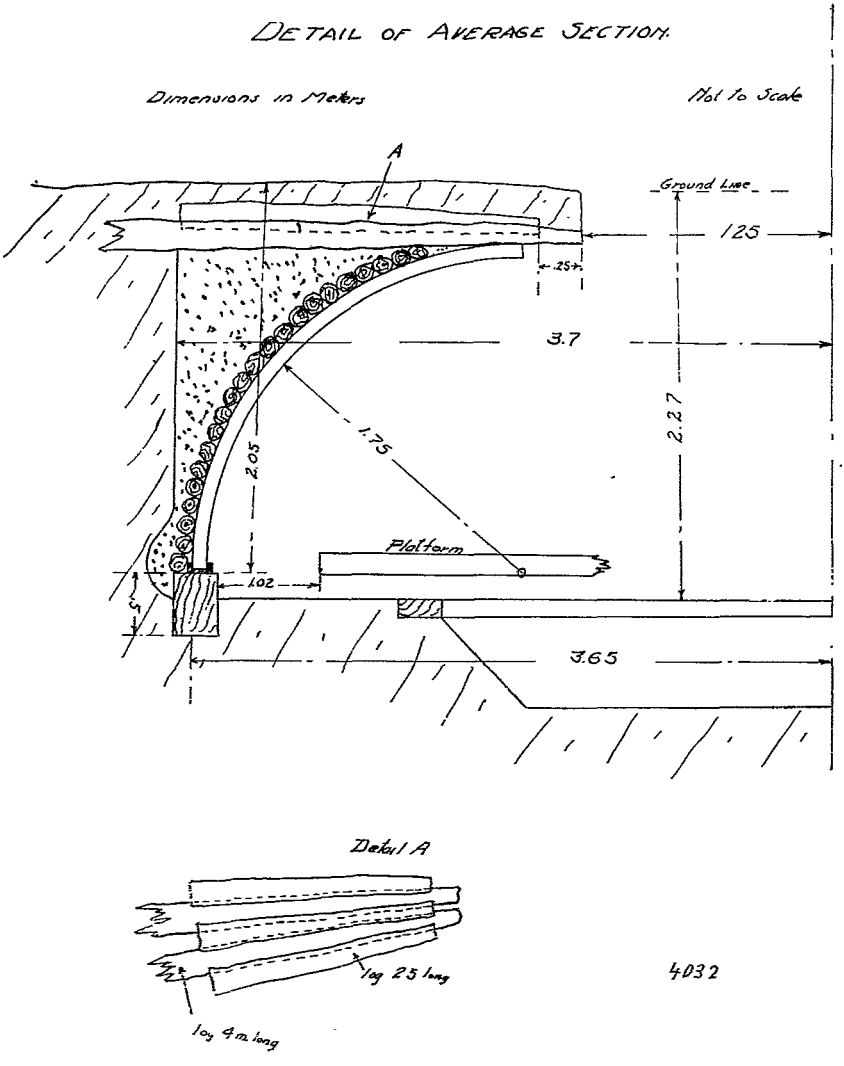


FIG. 2

placements are at times constructed in very exposed positions but built in the so-called "cupola" (Fig. 2). One such emplacement was dug into solid rock in a very exposed position in the Argonne Forest and another was constructed on Le Mort Homme (near Verdun). Both batteries were fired by the French without interruption from the time

of their completion until the allied advance left them too far in the rear of the line to be occupied, although under fire constantly. Note that nothing but a direct hit on the gun opening will disturb a battery so emplaced.

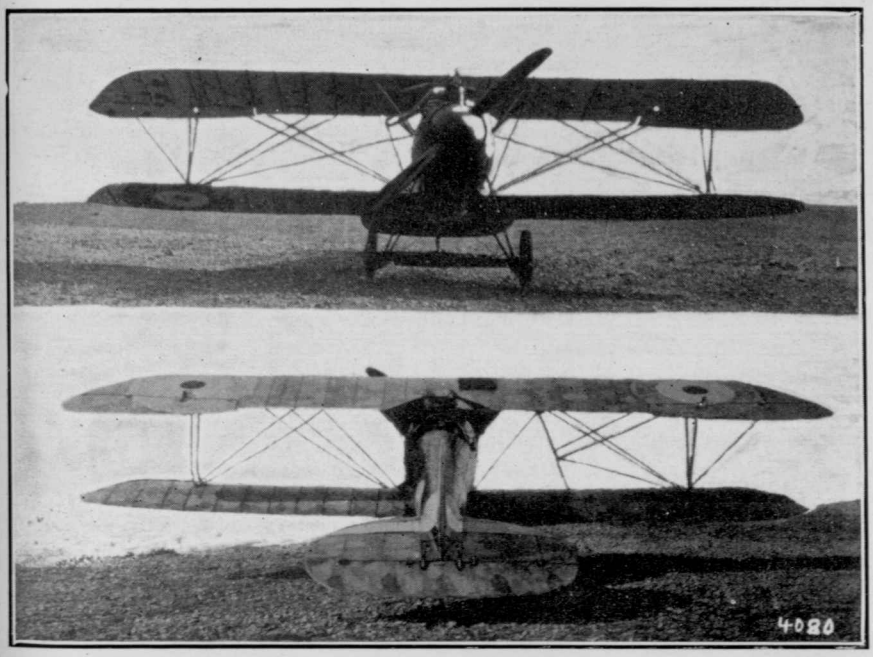
A mobile gun, should, naturally, be emplaced near a road, otherwise it would cease to be mobile. As nearly as it can be described, the idea of some casual observers is that an auto-mount anti-aircraft gun goes dashing madly across the country pursuing a hostile plane, firing as it goes. Presumably to be completely equipped, there should be a large fire gong in front to warn all and sundry out of the way as the gun goes careening through the streets. The exact contrary is true. The longer a gun is emplaced, the more efficient it becomes and an emplacement should never be changed except in cases of strict necessity. An anti-aircraft battery might be said to function in direct ratio to the excellence of its communications. Each time a battery is relocated the maze of communications necessary for it must be torn down and relocated. Particular mention is made of the lines connecting the distant post of the altimeter base line with the battery commander's post, for above all other factors correct altitude is the prime requisite for good shooting.

When the battery position is selected the battery moves in under cover of darkness, emplaces the gun, constructs a sandbag parapet for bomb or shell fragments and covers the entire work with a camouflage net. Since the gun must fire vertically, most batteries leave a circular opening about the gun which is covered by a circular piece of netting attached to and moving with the gun carriage as it traverses. A slit in this circular covering permits the gun to elevate or depress. At one time I passed within ten feet of a gun so concealed and believed it to be a small hummock of ground until the gun was fired.

Meantime the B. C. Station has been dug and concealed and the telephone linesmen have been connecting up the altimeter stations, the adjoining A. A. batteries, balloons, army centrals, Sector Hqrs., command posts, etc., with the battery. One thousand rounds of ammunition per gun, if possible, are brought up, and the battery is ready for action.

First, the target must be identified and located. It should be identified by sound first, because a target is generally audible long before it is visible. At first it appears to require some sort of genius to identify a target by the sound of its motor. Such is not the case. Everyone connected with anti-aircraft work should on hearing a plane overhead, first decide what type it is and then look for it. At first his identifications will be all wrong, but in a surprising short time he will have learned to tell the difference between motors; will know at once the undulating sound wave of a twin engine plane and can name instantly any plane he may hear. There are, locally, 5 types in service; DH4, JN4, (land planes.) N9 (sea-plane), HS2L and H5L (flying boats.)

These have been identified repeatedly and correctly by their sound with case except that a squadron of DH4s in formation might be mistaken for one or two F5L twin engine boats.



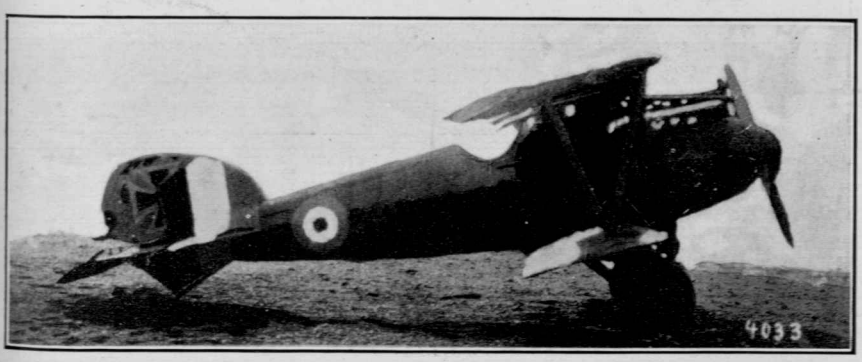
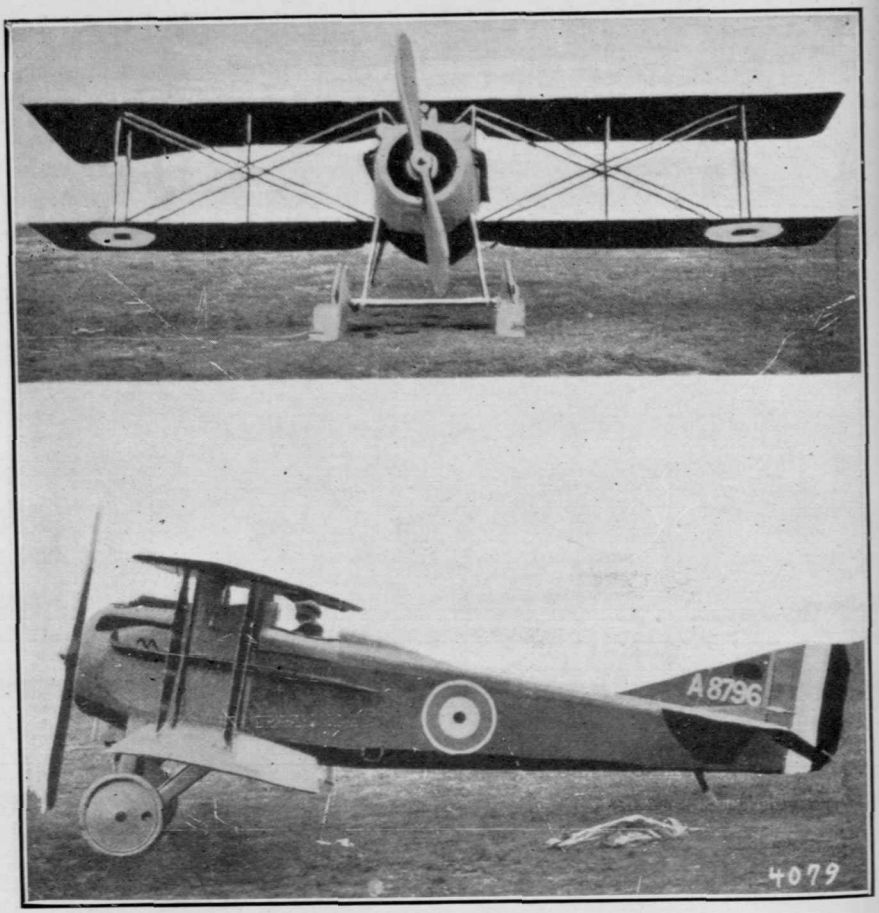


FIG. 3.

There are few American citizens who cannot glance at an automobile casually and call it a Packard, Cadillac, Ford or whatever it may be. Also they can tell an Airedale from a Daschhund. Identifying aeroplanes by sight is simply a matter of observation. Having heard the target the watch detail gives the alarm and the entire battery personnel spring to their posts and search the sky. Finally an infinitesimal speck or



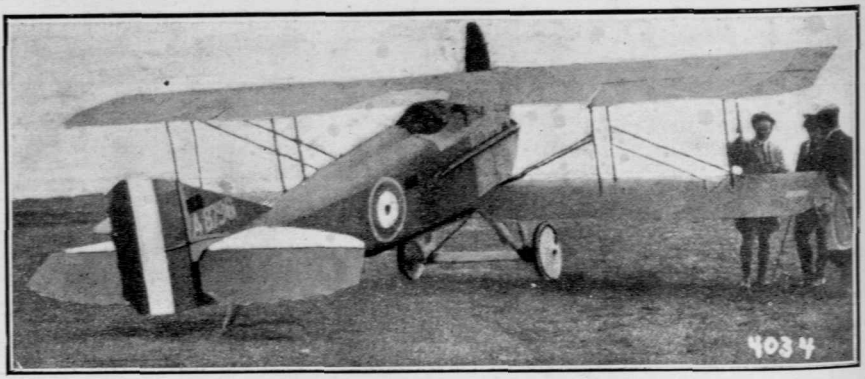


FIG. 4.

specks against the blue are discovered and the B. C. instrument turned in that direction, then "TARGET; HILL 304; THREE ALBATROSS FIGHTERS; FUSE 24/31; COMMENCE FIRING." The best way to show the characteristics of an airplane and how the battery commander knew it was an Albatross is to compare two types, for example the two which met so frequently in aerial combat, Albatross (Fig. 3) and S. P. A. D. (Fig. 4). The following table shows wherein the difference lies:

S. P. A. D.	ALBATROSS
Size	
Small, single seater.	Small, single seater.
Wings	
Biplane.	Biplane.
Engine	
One, tractor.	One, tractor.
Struts	
Two pair either side of fuselage, parallel and perpendicular to the planes.	One pair V struts either side of the fuselage.
Fuselage	
Square with rounded edges.	Rounded.
Fins	
One triangular on top of the fuselage	Two; One rounded on top of the fuselage and one triangular beneath.
Tail Plane	
Approximately triangular, small.	Semi-circular, large.
Nose	
Flat and not projecting ahead.	Pointing, rounded and projecting.
Shape of wings	
Rectangular; absolutely geometrical; no stagger, dihedral or overhang.	Slightly swept back along the leading edge; staggered; cut-back at the wing tips; dihedral on the lower wing.

If an observer makes a careful study of all friendly planes he can make no mistake, for every plane which is not friendly is naturally hostile. Here the importance of close associations with our own air force is suggested in order that advance information of new types of planes may be obtained. If a new plane appears over the front, and cannot be identified as friendly, it will naturally be fired on. Of course the circles and crosses or other identifying insignia are very seldom seen unless the plane is within machine gun range. The proposition of the enemy flying captured planes will be considered under "Back Areas." There is little front line sections can do to guard against this.

When there are several squadrons or single planes in the same general area, the difficulty of assigning a definite target to a distant post may well be imagined. The angle of site from the two stations is not the same. The only solution so far is the cotangent chart which entails some delay but, apparently, necessarily so. In general it will suffice to designate the nearest landmark over which the target is flying. To the guns and instruments in the B. C. Station the azimuth and site of the target can be given. The leading plane of a formation is generally assigned as the target.

Immediately the target is assigned the range section functions to furnish the altitude, range and deflection. At COMMENCE FIRING, the fuse is cut, the gun loaded and the cadence of fire of 4 seconds is taken up. There is a thrill about waiting, say 20 seconds, for that first burst while the target sails serenely on, and that thrill is intensified when the first burst covers the plane or appears directly on his course and he turns for home with H. E. following him on his way across the sky.

A well trained battery should fire each gun every 4 seconds while the plane is in range; no faster, no slower. One instance when the 4 second cadence should be exceeded is that of the defense of balloons. A direct telephone line runs from the battery position to the balloon and an enlisted man from the balloon company personnel is detailed to the battery B. C. Station to transmit all "alerts" to the balloon. The balloon crew will thus have the benefit of the trained anti-aircraft observers and false and unnecessary warnings can be avoided; the balloon should be lowered only on the approach of an enemy plane of a type suitable for making balloon attacks. When the aviator makes his attack he is flying at too great a speed for an anti-aircraft gun to follow him. Fortunately his line of attack is known—he will strike upwind to the end of the balloon—therefore a barrage can be thrown across his path. For this purpose the firing data must be measured continually throughout the day. The designation of the balloon and command to commence firing by the battery commander should insure accurate fire as rapidly as possible from both guns at a point sufficiently clear of the balloon to assure its safety from the fragments, and across the path of the attacking plane. The guns are trained on the basket of the balloon and a deflection of about 10 mils toward the plane and 5 mils up applied (the exact deflection, of course, depending on the range to the balloon.)

As mentioned previously, correct altitude is the essence of good shooting. Here again other forms of artillery have the advantage over anti-aircraft, for it is impossible to correct anti-aircraft fire during action. It is impossible to say whether a miss in deflection is due to personnel errors, change in course of the plane, incorrect deflections, incorrect range, incorrect altitude, change in wind or a number of other factors. By means of trial shots, fired once a day, the battery comman-

der determines what corrections to apply, particularly in order to produce bursts at the proper altitude. A plane changes altitude very little in comparison to changes in direction unless under fire. If the anti-aircraft fire is at the correct altitude he immediately takes notice and his mission is, temporarily at least, suspended. On the contrary he will pay very little attention to poor shooting, which is to say, at the wrong altitude.

Office hours for a battery at the front are from dawn to dark. Their orders are to engage every enemy target that presents itself and to assist friendly aircraft in any way possible. If, for example, a squadron of fighting planes and a squadron of bombing or reconnaissance planes are present in the area, the bombing or reconnaissance planes should always be engaged first because they offer the greatest danger to the ground areas which the battery is to protect.

The anti-aircraft commander should bear in mind that the Archies must co-operate with and assist friendly aircraft and in no way interfere with their operations. Thus, if a battery is engaging a hostile air force and friendly planes appear in a position to attack "suspend firing" must be given in time to permit the attack to be made without danger to the friendly units from our own fire. The guns are still trained on the enemy, however, to await developments and to assist, if possible. I have in mind one incident in which an archie section rendered timely assistance in the case of aerial combat. A Salmson and two Spads were cruising about in company a short distance in front of the battery immediately under low lying clouds when five Albatross dropped out of the clouds above them. The three put up a game fight and the machine guns were popping lustily. While the friendly planes were circling and standing off the enemy the battery had been put "on target" and were ready for action at any instant. The fight was quite uneven and the French planes were forced to take advantage of the first opportunity to dive for the ground. Action was immediately ordered and a burst of excellent shooting from the battery forced the German planes to turn and give up all ideas of pursuit. The pilot of the Salmson called up the battery commander to exchange notes on the fight and reported that he had 41 holes in his plane, one in his leather helmet and an explosive bullet, fortunately unexploded, in his shoe. It will frequently happen that enemy and friendly planes will be in the sky together without apparently being aware of each other's presence. Even though the enemy be out of range a burst of three rounds should be fired in his direction to call the attention of our own pilots to his existence.

In addition to engaging hostile aircraft, anti-aircraft batteries are frequently called upon to shoot down enemy observation balloons, although a six inch gun is really required for this purpose. To do this it is usually necessary to run the gun up to within a short distance of

the line under cover of darkness and conceal it. When the enemy balloon is raised in the morning the firing data to it is carefully measured and a burst of tracer or other ammunition put up as rapidly as possible. In a few minutes the vicinity of the gun becomes exceedingly unhealthy and the gun is put on the road again in record time. Incidentally, the British Archies section in Flanders operated this way at all times. There was no defilade or protection whatever and the guns would be forced to take position on an exposed road under the watchful eye of a row of observation balloons. Picking off archie guns became great sport for the German gunners, as a result of which a good section could take a gun out of battery and get on the road in something like 20 seconds.

Auto mounts are capable of being dispatched to various temporary positions on short notice for certain special missions. I have in mind one very interesting mission which unfortunately failed. In the Verdun region a German aviator, flying an Albatross Scout, was beginning to fancy himself somewhat, with reason, as a destroyer of balloons. In order to cool his ardor a bit, all the mobile guns in one sector were withdrawn from the front and placed on the roads about Clermont en Argonne, nearly 12 kilometers from the front. At daylight a balloon, with a dummy passenger, was temptingly raised in its usual position near Clermont. Since the guns brought no instruments with them, altitude was continually phoned from the balloon section, all guns trained on the basket and there followed hours of waiting without the expected attack. Late in the afternoon a Rumpler observation plane passed overhead at about 4000 meters, became suspicious and proceded to investigate. Seeing that the game was up the sector commander gave the order to fire and a rain of shells started up, but since no instruments were available the firing was very poor. We gathered all the guns and caissons into Clermont and considered the incident closed, but the Germans, it seems, couldn't take a joke, and proceeded to turn a 120 mm. high velocity battery loose on Clermont by way of having the last word.

That the joke might still have been on them if the instruments had been available was thoroughly demonstrated by this same section shortly thereafter. Action was ordered on an artillery plane which appeared overhead to register for a German battery. In a few minutes the unpleasant truth was brought home that he was registering on this particular section. The duel commenced and the plane was shot down in flames before they succeeded in putting the battery on target.

Any ground target could be engaged by the Archies in an emergency. Particular preparation was made for engaging tanks at the time they first made their appearance, because anti-aircraft guns are preeminently suited for fire at moving targets. It will be a surprise to some to realize that an anti-aircraft gun ever fires below 75° elevation. Many people

conceive an anti-aircraft gun as firing straight up in the air, all gunners being thoroughtly equipped with steel helmets to protect them from the rain of fragments falling back on them. As a matter of fact by far the greater percentage of firing is at angles less than 30°. The elevation from 0° to 10° is infinitely more important than that from 80° to 90°.

All aerial activity is carefully recorded, and therein lies one of the important functions of an anti-aircraft battery. The graphical representation of the day's activity in the air (Fig. 5) is compiled at Sector Headquarters and forwarded at once to G-2 of the Army, to the Army Air Service and to the Anti-aircraft Commander of the Army. G-2, by a study of this authentic record of the enemy's aerial movements, can make important deductions with reference to threatened ground movements or intentions on the part of the enemy by noting the activity of certain type planes from day to day in particular areas.

Fig. 5 is an exact reproduction of the report form used by a French battery near Verdun. A glance at the descriptive table which accompanies the chart will show considerable aerial activity over the area Malancourt, hill 304, Esnes. A further study develops that a greater part of this enemy activity consisted of Rumpler, L. V. G. and Halberstadt planes, all 2 seater reconnaissance or photographing types. Assuming that past reports have shown no such activity in this region, G-2 immediately sets about finding out why the enemy is so desirous of photographing and observing this area and as a result dispatches reinforcements or takes such other steps as seem necessary for its protection. The army Air Service is warned to be on the watch for aerial activity over this region and confirms the report of a pilot that he shot down a Fokker D-7 over La Claire.

Each sector is equipped with a radio set for instant communication with all air service units in rear of the sector. Immediately upon passage of any enemy airplanes a message is sent of which the following is typical:

1P	2045	2500	A	C	B

which indicates that station 1P reports enemy aeroplanes (2 for aeroplanes, 1 for dirigibles), four in number (04) are traveling north (5), (the azimuth scale in use for that purpose had but 5 graduations), at an altitude of 2500 meters. They are under fire (A), are fighting planes (C), and are evidently intending to penetrate into friendly territory (B). The message should be duplicated by phone.

The greatest possible stress is placed on complete liaison with the Air Service for a thorough study of allied and enemy aerial tactics and the best method of cooperation between land and air forces; for a discussion of observed incidents in the air; for a thorough knowledge of the speed and performance of airplanes; for a study of the effect of land fire under varying conditions upon aircraft and for the discussion

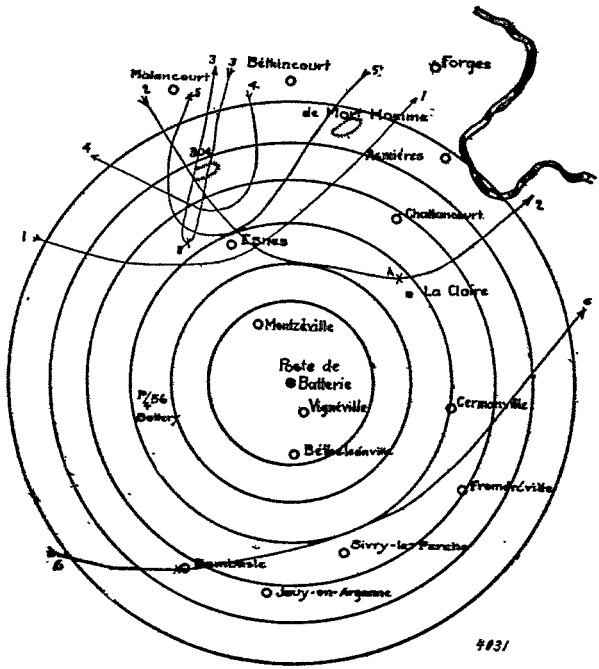


FIG. 5. DAILY REPORT OF AERIAL ACTIVITY

– – Section Auto Cannon Report Rendered on April, 5, 1918.

No.	Time	Type and Number	Altitude	Rounds Fired	Remarks
1	7:50	2 L.V.G.	3800 m.	23	None.
2	9:12	3 Rumpler 3 Fokker D-7	3000 m. 3800	31	Attacked by 3 Spads, Escuadrelle C-11 at A. One Fokker D-7 shot down in flames near La Claire.
3	12:15	1 Halberstadt	4350 m.	13	Hit at B. Glided apparently out of control within German lines.
4	14:05	2 Rumpler 1 Albatross	3500 m. 4200 m.	20	None.
5	14:20	2 Rumpler 1 Albatross	3600 m. 4100 m.	30	Apparently same as 4.
6	18:30	1 A.E.G.	2100	10	Appeared intermittently below clouds. Dropped 6 bombs over Dombasle. No damage.

of any of innumerable other factors important to both services. There is only one way in which the necessary contact between the air and ground forces can be maintained, and, to do that, it is necessary for the anti-aircraft officer to cultivate personal friendships among the pilots who operate over his area.

Mention has been made herein of a sector. The sector corresponds roughly to a battalion except that it is not fixed as to number of component batteries. If sector B due to impending operations or for any cause, becomes of great importance, additional batteries can be moved into that area and immediately become a part of that sector and function under the sector commander. These sectors are part of the Army Artillery and are directed by the Chief of Anti-Aircraft Service of the Army who is on the staff of the general commanding the Army Artillery. There are, within the army areas, and serving as army troops batteries and sectors for the defense of railheads, munitions dumps, etc. These units, however, are located tactically as the G. H. Q. artillery units are and will be considered later under "Back Areas."

Much has been said and will continue to be said about the number of rounds fired per hit obtained. Considering that a shot perfectly aimed may result in a perfect miss of one mile if the aviator happens to change his course, and that the danger volume for a H. E. shell is one millionth the size of the volume containing all points at which the plane could be at the end of an average time of flight, the Archies point with justifiable pride to their record in France. Considering all the American batteries in France that fired, one plane was brought down for each 1050 rounds fired. Of the batteries that actually shot down planes, however, the record is one for every 604 rounds, a remarkable record. This does not nearly measure the efficiency of such batteries. A plane may be thrown completely over by the force of the explosion and still not come down. Innumerable planes get home literally ripped to pieces, but still, they do *get home!* There was a twin engine Caudron plane on exhibition at the Hotel des Invalides with one engine completely shot away, but still, it *got home!* Time after time planes have been completely wrecked in landing due to injuries received in the air, but still * * *. The Archies in France amply justified themselves and while gratifying, the number of planes they brought down is by no means a measure of that justification.

Before passing to the subject of Back Areas a few words must be said for the anti-aircraft machine gun battalions, part of the anti-aircraft service. The first machine gun unit arrived at the front August 1, 1918, and at the signing of the armistice there were two battalions on the front, operating 96 machine guns and they had in so short a time accumulated 41 planes to their credit, again a remarkable record. It has been estimated that there were 1500 other machine guns for anti-aircraft purposes assigned to other units of our army. So far as has

been officially reported but two planes were shot down by these other guns. The contrast tells its own story.

PART II. DEFENSE OF BACK AREAS

In defending sensitive areas located away from the immediate front night fire is considered as the determining factor in the tactical distribution of the units of the defense. It is an unseen enemy that must be combatted. The difficulties confronting the Archies in ordinary fire are enormous. Add to these difficulties an invisible target and they become superlative. The more difficult the answer to the problem, the more interesting the solution. Electricity, psychology, deceit, ballistics, fireworks, mechanics, aerial obstacles, combustion of carbonaceous material, extinguishing illumination, increasing illumination and a thousand other factors play their own part.

Before discussing the tactics, or logic used in building up a defense, it would be well to discuss the means which have been used in the past to combat the unseen targets.

The active means of defense are the air service, artillery and machine guns. By day there is no possible excuse for a surprise attack by bombing planes on any area located at a distance from the front. The Anti-Aircraft surveillance system must be such that the course of the bombers is carefully watched from the front immediately and communicated to the air service. Our planes, thus forewarned, can take the air and meet the attack. By night the burden of the defense falls on the artillery (for high planes) and machine guns (for low planes). Co-ordination of the two services by day or night (Air and Anti-Aircraft) has found different solutions with different armies.

It will be recalled that at the beginning of the war there were no Anti-Aircraft service and no bombing planes. Zeppelins alone were to be feared and by day or night the air service could be counted on for protection. Beginning with early 1917 the Germans built their Gothas and bombing by airplanes became a serious and definite menace. Paris watched the raids on London and took steps to create an artillery service to reinforce the work of the defending planes by night. The division of responsibility was immediately over the periphery of the city; outside, the artillery, and inside the air service. During 1917 the German aviators confined their attention to London, but early in 1918, however, the expected raid by Gothas on Paris occurred, and a more beautiful aerial carnival cannot be imagined. Innumerable French planes circled around the city dropping colored flares in answer to the searchlight beams sweeping around them and burning small riding lights as a token of their friendly status. The flash of the guns and wink of the bursting shells added their share and the air was completely filled with a mixture of noises impossible of description. This

volume of sound prevented "fire by sound" (of which more later) and the necessity for challenge and reply between ground and air to insure that no friendly plane was engaged delayed the opening and conduct of fire. In March, 1918, then, the entire field of fire was left provisionally free to the Artillery after dark with the understanding that if their defense was insufficient the air-service would be called back. This recall never became necessary.

A different solution was found in England. Successive bands were assigned alternately from the sea to London as fields of activity for guns and air service. The interior defense of London itself is assigned to the Artillery and a band of air service defense surrounds this.

With the development of the high powered bombing planes in 1916-17-18 ingenuity and inventive powers were used to their fullest to develop counter measures for opposing or hindering the march of the enemy planes to reinforce the defense by the three active means referred to.

The searchlight, most important of these passive means of defense, was early developed for high angle fire. They relate the incident at the British "Archie" school of the Belgian ace who volunteered to fly for a crack British searchlight section. The lights picked him up and forced him to land in five minutes, and he knew the lights were friendly! When a searchlight group picks up a target the aviator can see nothing but the light. He does not know where his target or landmarks are and his bombing mission is, for the time, forgotten because before he can accomplish anything he must escape from the beam. Probably he will attempt to bomb the lights. Even so, every bomb he drops on the light is a bomb which cannot be directed on his original target and the light, by diverting him from his primary mission is certainly furnishing its share of protection by being the recipient of the enemy bombs intended for a vulnerable dump. Searchlights during the war operated in groups of three, located on the vertices of an equilateral triangle 3000 meters (for 60-inch light) on a side. One of the three lights acted as pilot light and was equipped with sound locating apparatus for directing the beam while the other two lights searched along the beam of the pilot light. A good searchlight section, though classed with the passive elements, can certainly exercise a very positive effect on any plane caught in its beam.

Camouflage (much abused word) is another passive means. Each unit of an army, of course, has its own duties in this respect and the entire subject properly comes under the Engineer troops, but there are certain things peculiar to Anti-Aircraft work which will be considered later in planning a defense.

Anything which may in any way deceive the enemy air service or protect his bombs may be classed as a passive means of defense. Dug outs and overhead cover, for example, utilization of marks on the terrain already registered in enemy photographs, or locating matériel and per-

sonnel under trees. These expedients are already well known and will not be discussed. Such things as defensive balloons, however, are peculiar to and operated by the "Archie" troops. These are small hydrogen balloons, of similar pattern to the familiar "sausages" which are raised across the probable path of the attacking planes. Theoretically, a wire the size of a small pencil connecting the balloon to the ground is the only obstruction in the way of the attacker. Actually, however, the entire zone in the neighborhood of the balloon is guarded, because the location of the balloon is, to the aviator, no indication of the position of the cable because the latter, due to the wind effect, is inclining to the ground at some unknown angle. Should the reader doubt the efficacy of such an obstacle it is suggested that he request an aviator acquaintance to fly with him under an observation balloon in broad daylight. For such small objects as bridges, individual buildings, etc., this form of defense is particularly well suited. A row of balloons down wind from a bridge could absolutely preclude the possibility of a successful attack.

There are two forms of smoke which have been used to interfere with enemy aviators, "hot smoke" formed by the combustion of carbonaceous materiels, and "cold smoke" formed by chemical reaction. There are several tactical uses of smoke. Suppose the area to be bombed is found by the enemy planes by means of its relative position to a small land mark such as a pond, bridge over a river, etc. In that case several smoke patches, one of which covered the landmark in question would cause the attacker to lose his objective. Should the sensitive area itself be small and easily discernible from the air it may be covered by a large smoke screen. True, the enemy can see the smoke screen, but his bombing within the area covered by it must be by guess work, whereas the objective, without the covering screen, could be easily located. Were the objective not readily found from the air the use of smoke would be inadvisable as it would attract attention to the target which would not otherwise be located.

Better than smoke for this purpose is the so called "luminous camouflage." This, however, requires a very extensive plant. 22,000 candle power light units are located about a kilometer apart over a large area within which lies the target area. These lights have 45 degree vertical reflectors the effect of which is to show a sea of light to the aviator and blind him to every object on the ground within the lighted area. Again his bombing would have to be by guesswork. A further refinement would be to subdivide the large area into three smaller ones, each of which would cover the target area but extend beyond it in a different direction. On different nights different areas could be illuminated to guard against espionage revealing the relative position of the target within the illumination.

Another use of lights is the "luminous barrage" which is a vertical

stationary wall of light through which the attackers must pass to reach a certain target. In passing through they become prominent targets for our guns and machine guns below and our planes waiting outside the light.

The listening service, which is controlled by the "archies," is a very important adjunct to the defense scheme as a whole. This service must not be confused with the sound apparatus which is used for searchlight control and gun fire control at night. It consists of a line of stations at which men are placed who have had training in differentiating between the nationality of planes by the sound of their motors. Their purpose is to give the defense units warning to prepare for an attack; to enable "alerts" to be transmitted to the civilian population for their protection and to prevent useless disturbance and decrease in the morale of the civilian population by unnecessary alerts.

In France, for example, a listening line extended along the coast, across France paralled to the front and down parallel to the Swiss border. A second line extended across France roughly parallel to the front and at some distance south of the first line. Transversal lines, running north and south, divided the entire area susceptible to attack into rectangles corresponding approximately to the areas of the various armies. The listening service in each area was usually centered at army headquarters. Here the informtion was received and warnings issued. Should a plane cross the line into the Ist army area, that area is immediately "alerted." Should he then turn westward and cross into the IInd army area, he is detected by the transversal line and the IInd army area alerted.

The most important area and center of all the listening service was, of course, the C. R. P. (Entrenched Camp of Paris). This was surrounded completely by an immense listening circle and the defense headquarters was in constant communication with the listening centers previously referred to. To the northeast from which the attacks usually came, thousands of kilometers of wire were used in installing a checkerboard listening scheme by means of which the attackers could be followed kilometer by kilometer. Thus, the planes would be engaged and their course followed by the men on the intersections of the checkerboard lines until they reached a certain point and then the sirens and buglers in Paris would warn the population to take cover. Should the attack be frustrated before reaching this point, and this was frequently the case, Paris would sleep peacefully on unaware of the imminent danger. The efficacy of this system depends, of course, on absolute telephone control (in the absence of private lines). The phrase "Anti-Aircraft Priority" must insure an immediate connection with any point desired.

And now to the planning of a defense. No two cases are alike. Each project must be studied separately and the best solution under the circumstances found. There are, it is true, certain general considera-

tions which always apply and which should insure a similarity between defense projects planned by two individuls of equal experience.

There are, in general, two kinds of defense, false and direct. False defense consists in leading the enemy to believe that a certain area, at some distance from the real area, is his target. The Germans erected a false analyne factory at Franken (near Mannheim) for example. The best example of a false defense, however, was one developed by the British to protect a large munitions dump. At the time this defense was visited (November 1917) it comprised of 26 guns, 16 searchlights (in the use of which the British excelled) and numerous machine gun sections. Certain of the guns were sited around the munitions dump, unconcealed, but forbidden to fire at night, while the remainder were arranged about a false area to the north and forbidden to fire except at night. By day, then, the enemy sent a reconnaissance plane at a great altitude to observe the location and defenses of the dump. The direct defense batteries engaged him from all around the dump (easily found by day) which fact the aviator noted and reported on, but the false defense batteries were concealed and silent. At night when the area is not easily found, the bombing squadron found itself engaged by a circle of batteries (the false defense batteries) within the circumference of which could be seen switchlights, tracks, buildings etc., and this area was bombed. The judicious explosion of a lot of condemned explosives by wire from the defense commander's station caused glowing accounts of the raid to be reported back to German headquarters.

The efficacy of this defense is illustrated by the fact that an open field adjoining the defense commander's station, considerably to the north of the munitions dump, had been the recipient of over 200 bombs up to November 1917. A project of this nature suggests at once the advisability of locating any sensitive area in open fields where there is no definite guide for airmen to follow at night. Avoid intersections of railroads and rivers, towns, ponds etc.

In planning a direct defense, consider first, the probable path the enemy will follow. Railroads, rivers and main highways are the principal guiding posts. In flying to Paris the enemy aviators utilized the railroads principally because the roadbed itself running from village to village, the glow from the engine fireboxes and the light of the necessary signals definitely pointed the way to them. The river valleys were susceptible to fog and therefore unreliable. The enemy must use a definite guide or he will be unable to locate his objective.

Next, determine the number of battery positions from which the area must be defended, regardless of the number of guns per battery. Assume each battery to be the center of a circle the radius of which is the horizontal range of the gun at the maximum altitude at which attacks may be expected. Each battery must be located so that it is as far from the defended area as possible, consistent with covering the area

with this circle, in order that attacking planes may be engaged as far as possible from their target. Let us assume that there are three probable lines of approach to a certain munitions dump, northeast, northwest and south. Three batteries (depending somewhat on the size of the area of course) could be sited, one advanced along each of these lines of approach. Thus, no matter from which direction the enemy approaches he can be engaged as far as possible from the dump and kept continuously under fire by at least one battery until he approaches close to the target, when he will be brought under the concentrated fire of all the batteries of the defense. Of course it may be that more than three batteries will be required. Each case has its own peculiar solution.

Having located the three battery positions, and having (we will assume) 12 guns for the defense, each battery would be made a four gun battery because in night fire a two gun battery is practically valueless. Now one of the axioms of general application is this: once an area is properly covered by fire, to increase the strength of the defense add guns to the batteries already installed rather than increase the number of batteries. The reason for this will be made clear when the choice of method is discussed. So, if two more guns became available they would be added to the battery located along the most probable avenue of approach, making a six gun battery.

In certain cases where the most probable avenue of approach is clearly defined it is advisable to place an "advance battery" of two or four guns out along that line of attack for the purpose of opening fire on the attackers at considerable distance from their target, letting them know they have been detected, breaking up their flying formation if possible and worrying them by subjecting them to fire so far from their objective.

The defense of Paris, London, Berlin, New York or any city of that size naturally falls into a class by itself. It is impossible, in the first place, to conceal the target. By extinguishing all lights we can prevent the enemy from picking up his objective at great distances and flying a straight course toward it regardless of landmarks, and by this means and the use of smoke we can render it extremely difficult for him to find individual targets within the city area, but we cannot prevent him from finding the city itself. Therefore he must be repulsed by the volume of fire from the defense batteries. Battery after battery must be located completely around the city and extending far out from the city particularly in the direction from which attacks usually come.

The French defense of Paris was one of the marvelous developments of the war and the results obtained were far beyond what the laws of mathematics teach us to expect. The unbeliever, who knows as much about Anti-Aircraft as most of us do about the Russian language, says "Do they ever bring any down?" This unbeliever should study the defense of Paris; should become aware of the fact (if previously unknown

to him) that during 1918 every aerial attack was broken up by the Archies outside the walls of Paris; that practically all planes returning to their lines did so in a damaged condition, that of 483 planes attacking, 13 were shot down and only 37 actually penetrated the defense. Let him further realize that the Anti-Aircraft guns are for the purpose of protecting an area first and destroying planes second and that such was the efficacy of the Paris defense that during the *year* 1918 the total weight of bombs *dropped* on Paris was approximately one half the total of bombs *actually carried* and destined for Paris in *one night* (September 15-16.)

To return to the smaller defenses. In France, as previously mentioned, searchlights operated in groups of three, 3000 meters apart. These groups should be arranged about the area roughly the same distance away as the guns and close enough to each other so enemy targets can be passed from the radius of activity of one to the other. A light should not be placed too close to a gun battery nor within the defended area. Quiet sites of maximum elevation should be selected whenever possible. An "Advanced Group" corresponding to an "Advanced Battery" is of very great value. Searchlights must be well protected against bomb fragments but neither searchlights nor guns in back positions, except in the case of false defense, need be concealed. The defenses will usually average one searchlight per gun.

When a plane comes down to machine gun range he is usually aiming for a small target and must have a definite guide to follow as a road, railroad or river, which runs through or at least alongside the target. Machine guns are placed close to the target and to one side of the probable route of the attackers so as to fire across his path at an angle of about 15 degrees. If the guns are mounted in tandem but firing at slightly different elevations a much greater danger zone will be established.

The units of the defense being located the entire scheme must be centralized in the Defense Commander's Station. He will be in touch with all adjoining defenses and with the listening service and must have each of his units at all times directly under his eye. In the Paris Defense each unit was represented on an immense wall map by an appropriate symbol with a small electric light mounted over its position. Upon the entry into action of a battery or searchlight that fact was indicated by the illumination of its corresponding light on the map. Thus the status of the defense was always visible at a glance. The important British defenses employed this same scheme.

A plane cannot always be identified by the sound of its motor and there is always the possibility of captured planes being used, of which there are several instances on record. Therefore a system of challenge and reply was adopted. By night a suspicious plane is heard and a pre-arranged letter is flashed to it by searchlight. If friendly, the plane drops a Very light of a certain color or colors (changed each day)

and if such response is not made, it is engaged. Naturally any plane showing hostile actions is engaged immediately regardless of its identification.

If the area to be protected is extremely sensitive, that is, of such nature that a single bomb would do infinite damage (e.g. a compact munitions dump,) it should be made a "closed area," which means that all planes are forbidden to fly over it. Any plane violating this prohibition is either unfriendly or unfortunate and will be fired upon at once.

While it was not intended to delve into the technical side of Anti-aircraft fire in this paper, yet in considering the choice of method of fire to be used by the batteries, and showing the necessity for multiple gun batteries it is believed advisable to show, briefly, the mathematics of predicting the future azimuth and site and the altitude of a target at night. In the Cotangent method, for example, the data from two or three listening posts (azimuth and site) is compiled at a central post which must be separated from the battery by a mask to prevent sound interference. The route that the airplane takes is a function of the altitude, azimuth and site of the various positions. If, then, we plot the course to the scale of 1/h, the traced route becomes a function of the site and azimuth only (where h represents the altitude of the target). A graph may be prepared beforehand consisting of radial lines of equal azimuth and concentric circles drawn with radii of Cot S′ (the cotangent of angle of site to the position of the airplane from which the readings are taken) and the course of the target tracked on that without reference to the altitude.

If a course of length mn is covered in a time t, to this scale of 1/h,

$$\text{then} \quad mn = Vt/h \text{ or } h = Vt/mn$$

in which V the speed of the aeroplane can be estimated and the altitude calculated. We know in advance what the speed of the airplane will be, and can simplify our calculations accordingly. For example, if we take the distance mn always as V/100, by means of dividers or a marked length on a rule, then the above relation reduces itself to

$$h = 100\ t.$$

It remains, then, to determine the future position of the target on the graph and read the future azimuth and site directly. If a′ is the position on the graph of the "targetpast," and the future position is a, then the length of the line joining the two is VT/h, where T is the sum of t, the time of flight, θ, the dead time and t_s, the time lost due to the lag of the sound. We know that

$$t = \frac{5D}{1000} - x \text{ (Empirical formula for 24/31shell)}$$

$$\theta = 20, \qquad \text{(assumed from observation)}$$

$$t_s = \frac{3D'}{1000} \text{ (sound travels 1 Km in 3 sec.)}$$

and that $D = h/\text{Sin } S$, and $D' = h/\text{Sin } S'$

By substituting these values

$$a'a = \left(\frac{5h}{1000 \text{ Sin } S} + 20 + \frac{3h}{1000 \text{ Sin } S'}\right)\frac{V}{h}$$

$$= \frac{5V}{1000 \text{ Sin } S} + \frac{3V}{1000 \text{ Sin } S'} + \frac{20V}{h}$$

and if we assume that the mean value of V is 36,

$$aa' = .18/\text{Sin } S + .11/\text{Sin } S' + 720/h$$

which may be easily calculated from a slide rule.

If, then, the length from a′ to a can be computed as indicated above, a can be plotted immediately on the cotangent chart and will give the future azimuth and site of the target, from which the future fuse range may be determined and the guns fired, since the altitude is also known.

There are inaccuracies in this method even after all possible corrections (wind, parallax etc.) have been made. But we are predicting a point in the heavens at which we expect the plane to be when the projectile bursts which will be thousands of yards closer to the truth than the most sensible guess we can make. If we fire a rifle (figuratively speaking) at this point we shall certainly not hit the target, but if we fire a shot gun our chances are good. Hence multiple gun batteries. A four, six, or eight gun battery firing as rapidly as possible with the center of its shots at the predicted point will cover a considerable volume and the target is very liable to lie within that volume. For the proof of the method attention is again directed to the marvelous results accomplished in defending Paris. And here is one of the opportunities for the Anti-Aircraft officer—improve the method of "fire by sound" and a great service will be done the Artillery which is charged with the difficult task of firing at unseen planes.

It is obviously impossible to lay down a certain set of rules which shall govern the planning of defenses for back areas, for each locality requiring protection will be different in one way or another from the rest. Different factors must be taken into consideration which would invalidate any set of rules attempting to regulate such defenses. Each problem must be studied carefully by itself and a solution determined for it according to its requirements. The purpose of this paper is to present the theory of the various forms of defense, if we may call it so, and the factors which influence the various defense plans as observed with the various armies.

Remember, first of all, that it is impossible to prevent the enemy from dropping his bombs if he so wishes. Our duty is to cause him to drop them in the wrong place. If he bombs us, our searchlights, or a vacant field near by, we have accomplished the purpose for which we

are working, for while he is bombing us he cannot be dropping bombs within the protected area.

We attempt to do this by direct fire, barrage, trickery, or any means within our power to prevent him from coming within striking distance of the protected area or knowing where that area is.

Throughout the whole discussion of Anti-Aircraft defense the psychological effect of the various forms of defense on the aviator play a large part. Imagine, for example, an aviator travelling with orders to bomb a certain spot. He is worried by searchlights, advance batteries and perhaps machine guns from the time he crosses the line until he arrives at his destination. Here he is confronted by a heavy barrage. The scattered shots and searchlights keep suggesting to him the advisability of cutting loose his bombs and returning. His natural impulse is to do so. Finally upon his arrival at his target, the concentrated fire of our batteries carries to him in no uncertain terms the message made famous by an American publication—"Obey that impulse." We may be the recipient of his cargo of bombs but the area has been protected.

THE JOURNAL WANTS SOME MORE GOOD ARTICLES ON ANTI-AIRCRAFT ARTILLERY

Adapting Old Lots of Mortar Powder to the Aliquot Part Charge

By Captain E. H. Taliaferro, Jr., C. A. C.

IN the mortar practice, held at the Coast Defenses of Key West, December 13, 1921, there was one rather interesting and unusual feature, the adapting of any lot of mortar powder to the aliquot part charge system and at the same time using Form 942, Provisional Range Table for 12-in. Mortars, Models 1890 and 1908, firing D. P. Shell, weights 1046 and 700 pounds, with aliquot part charges. The idea is believed to have originated with Major Willard K. Richards, Ord. Dept.

The procedure is as follows: Take the ballistic tag of any lot of mortar powder and on ordinary cross section paper, using the Y-ordinate for weights of powder charge in pounds and the X-abscissa for muzzle velocities in f/s., lay off the points corresponding to weight of powder charge and muzzle velocity for each zone and connecting these, the resultant will be found to be a very regular curve, in fact almost a straight line. Having very carefully plotted a curve from the ballistic data tag of a given lot of mortar powder, take the ballistic data from W. D. Form 942 and enter the curve with the maximum muzzle velocity to be attained during any given practice, which will be that of the outer zone, and on the Y-ordinate the new weight of powder charge for the outer zone will be found. Dividing this weight by the zone number will give the weight of aliquot part charge for the lot of mortar powder to be used. Now on the Y-ordinate, lay off the new weights of powder charges forthe various zones (obtained by multiplying the weight of aliquot part charge by the zone number) and enter the curve with these weights; on the X-abscissa the new muzzle velocity for each zone will be found.

A concrete example will be given to show clearly the salient features of this procedure. In the mortar practice held at the Coast Defenses of Key West, the lot of mortar powder used was D. P. 122, 1913 and the outer zone the 7th. The curve, as shown in the accompanying diagram, was plotted from the ballistic data tag of Lot 122, D. P. 1913. In the aliquot part charge (W. D. Form 942) the muzzle velocity for the 7th zone is 1000 f s. Entering the curve, obtained by plotting Lot 122, D.P. 1913, with a muzzle velocity of 1000 f/s. and then finding the corresponding point on the Y-ordinate, the resulting weight will be found to be 40.2 pounds, which will be called the aliquot part charge weight

for the 7th zone of this particular lot of powder. Dividing 40.2 pounds by 7 gives 5.74 pounds, which is the weight of the aliquot part zone charge.

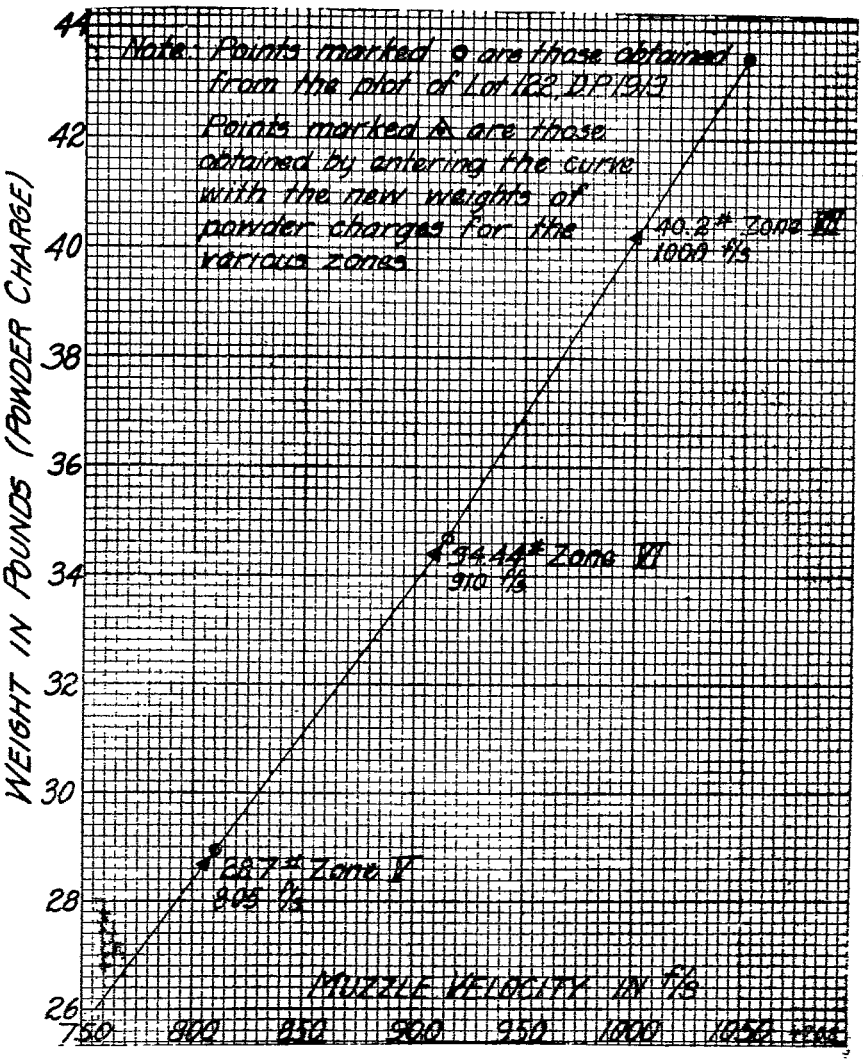


FIG. 1.

Then: 5 × 5.74 pounds = 28.70 No. — Charge for Zone V.
6 × 5.74 pounds = 34.44 No. — Charge for Zone VI.
7 × 5.74 pounds = 40.20 No. — Charge for Zone VII.

Entering the curve with these weights will give for the 7th zone a muzzle velocity of 1000 f/s., for the 6th zone a muzzle velocity of 910

f/s., and for the 5th zone a muzzle velocity of 805 f/s. Form 942 gives as a muzzle velocity for the 5th zone 790 f/s, for the 6th zone 900 f/s., and for the 7th zone 1000 f/s. Thus it will be readily seen that the muzzle velocity for the 7th zone is normal, while for the 6th there will be plus 10 f/s. and for the 5th plus 15 f/s.

The errors in range which would naturally result from these differences in muzzle velocity were computed as follows:

Looking into the range table, Form 942, the inner limit of Zone V is found to be 4237 yards and the outer limit 5693 yards.

Then: 15/805 × 5693 = 106 yards.
15/805 × 4237 = 79 yards.
2) 185 yards.
90 yards which is the mean.

Also for Zone VI, the outer limit will be found to be 7282 yards and the inner limit 5411 yards.

Then: 10/910 × 7282 = 80 yards.
10/910 × 5411 = 60 yards.
2) 140 yards.
70 yards which is the mean.

In the 5th zone, plus 15 f/s. at mid-range would make an error of plus 90 yards and in the 6th zone plus 10 f/s would make an error of plus 70 yards at mid-range.

To account for the different muzzle velocities and the errors resulting therefrom, the following rules were made up and given to the Range Officer; for applying corrections for the various zones on the Mortar Range Board during the practice, who in turn gave them to the operator of the Mortar Range Board for application, as soon as the set forward point appeared in any particular zone:

RULES

For any course beginning in the 5th zone, correct minus 90 yards for all fire in 5th zone. Upon entering 6th zone, enter zone to zone correction, then correct [illegible] 20 yards. Upon entering 7th zone, after zone to zone correction, correct plus 70 yards.

For any course beginning in 7th zone, no correction. Upon entering 6th zone, enter zone to zone correction, then correct minus 70 yards, and upon entering 5th zone, after zone to zone correction, correct minus 20 yards.

It was demonstrated during the practice that these zone to zone corrections are very accurate as can be seen by the fall of the first six shots of the practice. Shot No. 1—short 70 yards; shot No. 2—over 5 yards; shot No. 3—short 77 yards; shot No. 4—over 57 yards; shot No. 5—over 106 yards; shot No. 6—zero range deviation. Shot No. 1

was in zone V, shot No. 2 was in zone V, shot No. 3 was in zone VII, shot No. 4 was in zone VII, shot No. 5 was in zone VII and shot No. 6 was in zone VI.

As the powder charges, Lot 122, D. P. 1913, were already made up with a base charge for zone 5 and increments for the 6th and 7th zones, and as there were no bags in the Coast Defenses for aliquot part charges, it was decided to make the charge for zone 5 into one bag, using the two increment bags for the aliquot parts for the 6th and 7th zones.

It is believed, since the results obtained in this practice seem satisfactory, that in the future all old lots of mortar powder can be adapted to the range table for mortars with aliquot part charges, simply by plotting a curve from the ballistic data for any given lot of powder, and entering the curve with some zone muzzle velocity as shown on Form 942, determine the weight of powder charge for this zone, then entering the curve with the new zone weights, find the resulting muzzle velocity, compare it with the muzzle velocity for any particular zone as shown on Form 942, and for the difference in muzzle velocities determine the resulting errors to be expected in yards and corrections to be applied to counteract this error.

SEND YOUR IDEAS

TO THE

COAST ARTILLERY BOARD

Radio

By Captain J. V. Matejka, Signal Corps

THE article "Radio in the Coast Artillery" appearing in the JOURNAL for April was of particular interest because the experiences of the author of the article with the SCR-67-A set so closely parallelled those of the writer in making tests with the same type sets in the Coast Defenses of Cristobal. Soon after the tests at Cristobal were made the writer was detailed to the Signal Corps and since that time has heard very little about the further employment of the radio telephone by the Coast Artillery Corps.

It will be noted that Circular 16, War Department, 1921, authorizes the issue of an SCR-132 set to each coast defense headquarters and an SCR-136 set to each fort not entitled to the SCR-132 set. Both of these sets are telephone and telegraph sets of relatively long range and their operation should be excellent, altho the writer has no information as to whether they have been issued to any of the coast defenses. However, the results which will be obtained from the use of these sets will depend to a great extent upon the interest that the operators take in their work, and enlisted men usually show more interest in a subject if their immediate commanding officer is well informed and enthusiastic about it. It is evident that the sets furnished will have to be used as directed in instructions, and very little, if any, experimenting can be attempted with them. For this reason, an officer will not have the opportunity to obtain first hand information as to radio which will come to him if he can play with a set of his own, more as a diversion than a performance of duty. The moment one can connect his battery to a set in his den, library, or barracks, and pick up the broadcasting stations which send out daily concerts, weather reports and music, his interest in radio will increase perceptibly, and in the attempt to make his set better, he will learn at least the fundamentals of the science of radio in a short time.

The following experiment conducted under the supervision of the Signal Officer, Eight Corps Area, may be of some interest to the Coast Artillery Corps in general. Its purpose was the making of a simple transmitting radio telephone set out of an obsolete spark receiving set. At the same time it was hoped that the usual dynamotor and storage batteries necessary could be eliminated by the use of some sort of dry

cell. If this latter object could be attained, the effects of poor commutation of the dynamotor on the modulating circuit could be overcome.

Figure 1 is a diagram of the set, type SCR-54, a spark airplane receiving set, which is also a good telephone receiving set when used either with a crystal detector or a vacuum tube.

The set shown in Figure 1 was modified as shown in Figure 2 in a comparatively short time:

The electromotive force of 220 volts was obtained from eleven batteries, type BA-2 in series, and that of 4 volts either from a small storage

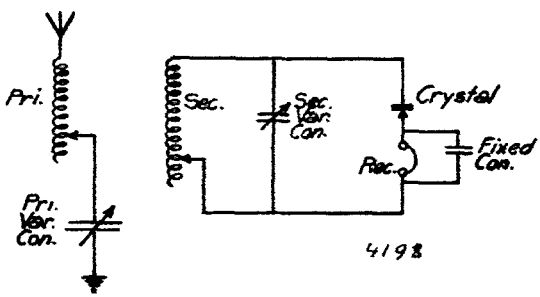


FIG. 1. RECEIVING SET, TYPE SCR-54

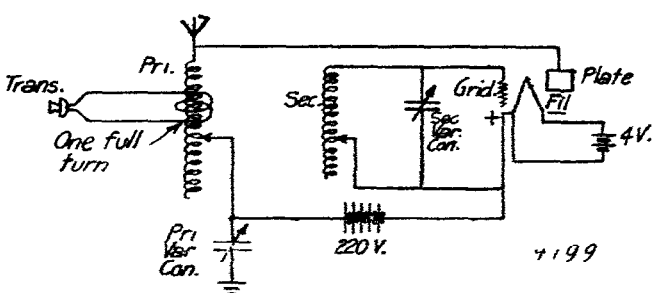


FIG. 2. SET TYPE SCR-54 MODIFIED FOR USE AS TRANSMITTING SET

battery or any suitable dry cells. The transmitter was an ordinary telephone transmitter, and the vacuum tube was either a receiving (VT-1) or a transmitting (VT-2) tube. With an ordinary field inverted L antenna, 150 feet long, this set proved to be an excellent radio telephone transmitter for all ranges up to a distance of 15 miles.

The SCR-54 set is now obsolete and has been superceded by the SCR-54-A set, but it is believed that there are a great many of the old sets still on hand at various depots. It appears to the writer that these sets can be of more value to the service if used for instruction and experimental purposes than if they are sold as surplus property to the public.

But even if these sets cannot be obtained for this purpose, it is not a difficult task to make a receiving set, and the pleasure and instruction received from its use will amply repay one for the time expended in its construction. One of the finest books of instruction on the subject of radio is Radio Communication Pamphlet No. 40, "The Principles Underlying Radio Communication," second edition, revised to May 24, 1921, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, for the price of $1.00 per copy. Whether an officer expects to be charged with the handling of a radio set or not, he should nevertheless have this book for reference, so as to be fairly well informed on this subject.

WHAT ARE YOU DOING TO INCREASE YOUR KNOWLEDGE OF RADIO?

WHAT ARE YOU DOING TO DEVELOP THE USE OF RADIO IN YOUR COAST DEFENSES?

SEND YOUR SCHEME TO THE JOURNAL.

EDITORIAL

A Significant Step in C. A. Policy

The following letter is presented for the careful consideration of every reader of the JOURNAL:

THE COAST ARTILLERY BOARD
Fort Monroe, Va.

May 23, 1922

Editor JOURNAL U. S. ARTILLERY:

IT is proposed to institute a change of policy in the conduct of the affairs of the Coast Artillery Board with the approval of the Commanding Officer, Coast Artillery Training Center and The Chief of Coast Artillery, which may be outlined briefly as follows:

Communications relating to the development or improvement in methods or matériel for the Coast Artillery will be welcomed from any member of the Corps, or of the service at large.

These communications, with models or drawings of devices proposed may be *sent direct* to the Coast Artillery Board, Fort Monroe, Va. and will receive careful consideration. In certain cases proposals will be filed, to be considered later on in connection with other suggestions of a similar nature.

In every case the receipt of such a communication will be acknowledged and further correspondence invited. In all cases in which suggestions give promise of immediate or future value to the service and indicate an earnest effort on the part of the correspondent to contribute to the efficiency of the Coast Artillery service, and are of such a nature as to appear to warrant special commendation, a memorandum to that effect will be forwarded through the Commanding Officer, Coast Artillery Training Center, with recommendation that appropriate notation be made on the efficiency report of the officer concerned.

It is believed that the Coast Artillery Board should be brought into closer and more direct touch with the Coast Artillery service and that

the maximum of progress in the development of methods and matériel will be realized, only if every member of the Corps becomes interested in such progress to the extent that he will devote a reasonable portion of his energies and thoughts to that end. Present regulations and orders are such as to permit the exercise of initiative on the part of officers of all grades and to encourage the sincere effort of every member of the Corps, commissioned and enlisted, toward the improvement of the service of Coast Artillery in all its branches.

There is no lack of ideas or enthusiasm for progress in the Coast Artillery Corps, and if every member of it can be impressed with the fact that his ideas and suggestions are solicited, and may be submitted informally, a first step will have been taken toward the highly desirable esprit de corps, in which all realize that they are partners in the effort to build up an efficient service.

The Coast Artillery Journal is the logical medium for promulgating, not only the policy to be pursued by the board, but also for keeping the service informed concerning the important projects under consideration and the general lines along which development is anticipated.

I request that in the next issue of the Journal, you inform its readers that they are invited to communicate directly with the Coast Artillery Board on all matters of professional interest, and that you reserve space in subsequent issues for matters under some such caption as "Coast Artillery Board Notes" which may be utilized for acquainting the service with the general work of the board.

Very respectfully,

(Sgd) Henry J. Hatch,
Colonel, C. A. C.,
President, C. A. Board.

In the opinion of the Editor, this letter constitutes a tremendously significant pronouncement of Coast Artillery policy. It means several things. First, it definitely destroys the illusion that Fort Monroe considers itself the one fountain of all Coast Artillery wisdom. Whether with or without justification, this opinion has here and there been expressed in the past, to the discouragement of him who, serving elsewhere, hesitated to advance his ideas, lest they be frowned on as the uninspired interference of an *outlander*. The utter dispelling of such an attitude, both within and without the gates of the alleged Holy of Holies, is one of the most necessary conditions to the unimpeded progress of the Corps.

Second, it guarantees that no one's ideas, after formulation and presentation to the board, will simply be put on ice after arrival, but will be fully tested and compared with other suggestions in parallel directions, and that the author will be advised of what happens to the

child of his brain, so that he may know it has not become an orphan in an inhospitable world.

Third, the assurance is given that he who develops something worth while will be given personal credit for it, a most important prerequisite to the mutual confidence between the members of the Coast Artillery Board and their fellows throughout the service, who should be striving to work hand in hand for the fullest exploitation of Coast Artillery efficiency.

Fourth, all red tape is slashed, and the direct path is opened for consultation and experiment, without the necessity for the earnest artilleryman to worry whether his typewriter slips and makes him forward an *en*closure instead of an *in*closure.

Needless to add, the JOURNAL may be depended on to make available each month any amount of space desired by the Coast Artillery Board to acquaint the Corps with the Board's work, needs and progress.

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The Coast Artillery and Democracy

We *must* be good artillerymen. Few of us but can be better artillerymen than we now are. The best that we can become as artillerymen may be, in the time of trial, less than good enough to meet the need of the land we serve. Despite discouragement, in the face of misunderstanding, we who claim the spirit of soldiers may not deviate, must not abate. The mastery of the artillery art and a never flagging zeal in its practice are obligations whose preformance we measure against our self-respect and do not dole out to the scale of a monthly wage.

But while we pursue perfection as artillerymen, we are not thereby aiming high enough. We acknowledge a deeper obligation. We realize that in the last one hundred and fifty of the million years during which human civilization has been emerging, there has been born the idea of Democracy, an idea which has grown so that it now seems almost ready to be adopted by every race and people.

We have also seen that at the very moment Democracy seems to be full-grown and ready to serve all mankind, the methods and institutions of Democracy, are challenged harshly—within and without its own gates.

Democracy has indeed held forth promises of human betterment and alleviation which have not been fulfilled. We have been prone to assert, as by ritual repeated from childhood, that Democracy is the ultimate step and the final form in the evolution of government. But now this belief is hoarsely challenged by myriad voices of discontent and disillusion. We cannot, unfortunately, answer this challenge by

an immediate and conclusive demonstration of the practical ability of Democracy to attain its theoretical perfection.

However we may stand firm in a conviction that Democracy holds more promise for the eventual attainment of a large measure of human justice and happiness than are offered by discontent in such forms as Communism, Syndicalism, Anarchism or the New Guild.

Most of the recommended substitutions for Democracy are bred of the smarting recognition that Democracy has failed to remove every element of tyranny, and are therefore urged as remedies, but each seeks, either wittingly or blindly, to purge old wrongs merely by transferring the tyrannies. Were there no hope for the further growth and perfection of Democracy, we would hold no position which ought to be defended, and individually need not yield to a higher ethical claim than that we strive for artillery perfection.

Democracy does hold a great hope. While the mental level of large numbers of adult Americans is shown by statistics to be too low to warrant their attempting personal direction in governmental matters, yet has this condition always existed, and nevertheless do we know that in every community, from hamlet to metropolis, enough of the mentally gifted have always been recognized by their fellows as leaders so that our democratic experiment has proceeded from its simple inception, through its awkward and admittedly fumbling adolescence to its present status of definite accomplishment and formulated practice in civil administration. From our observation of this phenomenon of the emergence from the mass, by the consent of the mass, of the relatively fittest as leaders, we derive a two-fold hope. First, we hope that the great bulk of the American people may continue to realize that while they should prescribe the *ends* to be attained by government, the *means* must be determined and activated by those who are fitted by mental heritage and subsequent educational opportunity to act as leaders in thought and specialists in performance. Democracy must trust its representatives to be initiators, and not merely the rubber stamps to record the evanescent opinions of a majority.

Second, we hope that there may develop a universal recognition of the principle that in any individual, the fact of a superior mental endowment improved by the opportunities of education is, as far as he is concerned, largely a fortuitous incident over which he had no control, and for which he deserves almost no credit, but that on the other hand the vesting in him of a superior degree of mental power marks him as a prospective leader, while the funding of knowledge through the accumulated efforts and sacrifices of men in all ages, in which he has shared through his education, has made him an especial beneficiary of mankind to an extent which he could not repay were he worth billions. Therefore he is ethically under bonds to his race to exercise the leadership for which he is fitted, and to direct that leadership toward the service

of the men and women of his generation, instead of toward his own enrichment and gratification.

Our Democracy can justify itself only if efficient. It can be efficient only with skilled leadership. Skilled leadership can be recruited only from the intelligent and the educated. Neither the markedly intelligent nor the educated will ever appear in ratios in excess of the demands for leaders. He who can get and use an education is immediately placed at an advantage in life over his fellow who lacks such an opportunity. This advantage is ethically justified only when the man who holds it recognizes the obligation thereby imposed upon him of unselfish leadership.

And so we have a hope for Democracy. But herein lies Democracy's only hope. As successful bankers, engineers, professors, preachers, doctors must—so must we artillerymen, and all other educated Ameri cans, achieve a dual success as the *unselfish* leaders of Democracy.

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Harmony in Anti-Aircraft Doctrine

He who reads Captain Harmon's article in this issue, entitled "Archies and the Anti-Aircraft Service," and who has also read in the April JOURNAL the discussion by Captain K. M. Loch, Royal Field Artillery, will be impressed with the remarkable agreement on many important matters indicated by the parallel statements of an English and an American A. A. Gunner.

Concerning the extreme importance of air concentrations and consequently of anti-aircraft defense in the early days of future wars, Captain Loch says, "It cannot be too much emphasized, how in the first days of a war, air defense may be the decisive factor in the successful mobilization of the land and sea forces and hence in the campaign itself." Captain Harmon parallels this with—"The future attack in the future war will consist largely of or be preceded and supported by a concentration from the air."

Captain Harmon and Captain Loch again parallel each other in their dicta concerning the tactical relations between the Air Service and the Anti-Aircraft Service. Witness two instances:

Captain Harmon—"The Anti-Aircraft service, located, as it is, near the probable targets, on the ground where the attack must come, is always prepared for combat and is planned with a view to night attack when the enemy is unseen. If our own air force is in a position to attack the enemy the ground units will operate only against such of the enemy units as are clear of the path of the friendly planes, whose attack is the most effective defense by day." Captain Loch—"The A-A gunner will be the first to admit that the most efficacious weapon of air defense is.

the aeroplane with the proviso that sufficient numbers can be concentrated at the right time and place."

Again Captain Harmon—"Both of these services (Aircraft and Anti-Aircraft) are essential for this defense." Captain Loch—"A-A Artillery has never arrogated to itself the capacity for forming a complete air defense. It is merely a link in the chain of aeroplanes, guns etc."

Both writers agree as to the impossibility of correcting Anti-Aircraft fire by observation, and both remark on the desirability from a tactical standpoint of engaging hostile planes even at extreme range. Captain Harmon states—"Even though the enemy be out of range a burst of three rounds should be fired to call the attention of our own pilots to his existence." Captain Loch has this on the same point, "They should be engaged, as even failing tangible results the firing may serve to warn our machines of the presence of an enemy."

Numerous other examples might be cited from these two papers to show the harmony in tactical doctrine which subsists between the English and the American Anti-Aircraft services. The point worth noting in this connection is that while these two services have been developing quite independently since the war, yet the fact that each arrives at similar deductions of principle serves as a demonstration of the extent to which the Anti-Aircraft Service has passed the experimental stage and has found its place in the tactical scheme. Accordingly it is high time that all Coast Artillery officers who may have hitherto fought shy of Anti-Aircraft work, feeling that it was still too inchoate and undeveloped to warrant their attention, now revise their estimate of the situation.

There is as yet a wide field for development of fire control methods and improvement of matériel, but the tactical foundation has been established.

There are certain services whose efforts, offensive or defensive, are of paramount importance in the early stages of a war. For such services the possibility of quick mobilization and concentration is tremendously necessary. One of these services is the Air Service—both hostile and friendly. For the very reason that the hostile Air Service will try to obtain an initial command of our military situation, it follows that the duty of the Coast Artillery to mobilize quickly an adequate Anti-Aircraft Service—guns, machine guns and searchlights—is a duty involving a tremendous responsibility, which must be shared by *all the Coast Artillery Corps.*

Solution of Problem No. 8—Orientation

THREE POINT PROBLEM—COMMON CHORD SOLUTION. FORM FOR COMPUTATION.

I. Length and Y-azimuth of BA.

X of B =	99141.60
X of A =	96580.35
△ X =	2561.25
Y of B =	105731.15
Y of A =	104047.17
△ Y =	1683.98
Log △ X =	3.4084519
−Log △ Y =	3.2263369
Log Tan Bearing =	0.1821150
Bearing =	56°40′33″
Y-azimuth =	236°40′33″
Log △ X =	3.4084519
−Log Sin Bearing =	9.9219858
Log Line =	3.4864661
−Log Sin α =	9.7143524
Log BQ =	3.7721137
BQ =	5917.17
BW =	11843.80
BW+BQ =	17760.97

II. Length and Y-azimuth of BC.

X of B =	99141.60
X of C =	102136.30
△ X =	−2994.70
Y of B =	105731.15
Y of C =	109978.11
△ Y =	−4246.96
Log △ X =	3.4763533
−Log △ Y =	3.6280782
Log Tan Bearing =	9.8482751
Bearing =	35°11′21″
Y-azimuth =	35°11′21″
Log △ X =	3.4763533
−Log Sin Bearing =	9.7606319
Log Line =	3.7157214
−Log Sin β =	9.6422303
Log BW =	4.0734911
BW =	11843.80
BQ =	5917.17
BW−BQ =	5926.63

III. Solution of Triangle BQW

Y-azimuth BA =	236°40′33″	90°00′00″	90°00′00″
Y-azimuth BC =	35 11 21	$-\alpha$ = 31 12 00	$-\beta$ = 26 01 30
Angle ABC =	201 29 12	ABQ = 58 48 00	CBW = 63 58 30
−(ABQ+CBW) =	122 46 30		+ABQ = 58 48 00
Angle QBW =	78 42 42		Sum = 122°46′30″

180°00′00″

q+w = 101 17 18
½ (q+w) = 50°38′39″

Log Tan ½ (q+w) =	0.0861231		90°00′00″
+Log (BW−BQ) =	3.7728078	−q =	72 47 04
	3.8589309	QBP =	17 12 56
−Log (BW+BQ) =	4.2494667		90 00′00″
		−w =	28 30 14
Log Tan ½ (q−w) =	9.6094642	WBP =	61°29′46″
½ (q−w) =	22°08′25″		
½ (q+w) =	50 38 39		
q =	72 47 04		
w =	28 30 14		
q+w =	101°17′18″	Check.	

Solution for length and Y-azimuth of BP and coordinates of P

Triangle QBP		Triangle WBP	
Log BQ =	3.7721137	Log BW =	4.0734911
+Log Sin q =	9.9800934	+Log Sin w =	9.6787172
Log BP =	3.7522071	Log BP =	3.7522083

Average Log BP 3.7522077

Angle ABQ =	58°48′00″	Y-azimuth BC =	35°11′21″
+Angle QBP =	17 12 56	+Angle CBW =	63 58 30
		+Angle WBP =	61 29 46
+Angle ABP =	76 00 56		
+ Y-azimuth BA =	236 40 33	Y-azimuth BP =	160°39′37″
Y-azimuth BP =	160°39′37″		

Bearing BP S 19°20′23″ E

Log BP =	3.7522077	Log BP =	3.7522077
+Log Sin Bearing =	9.5200492	+Log Cos Bearing =	9.9747749
Log X =	3.2722569	Log Y =	3.7269826
X =	+1871.79	Y =	−5333.14
X_b =	99141.60	Y_b =	105731.15
X_p =	101013.39	Y_p =	100398.01

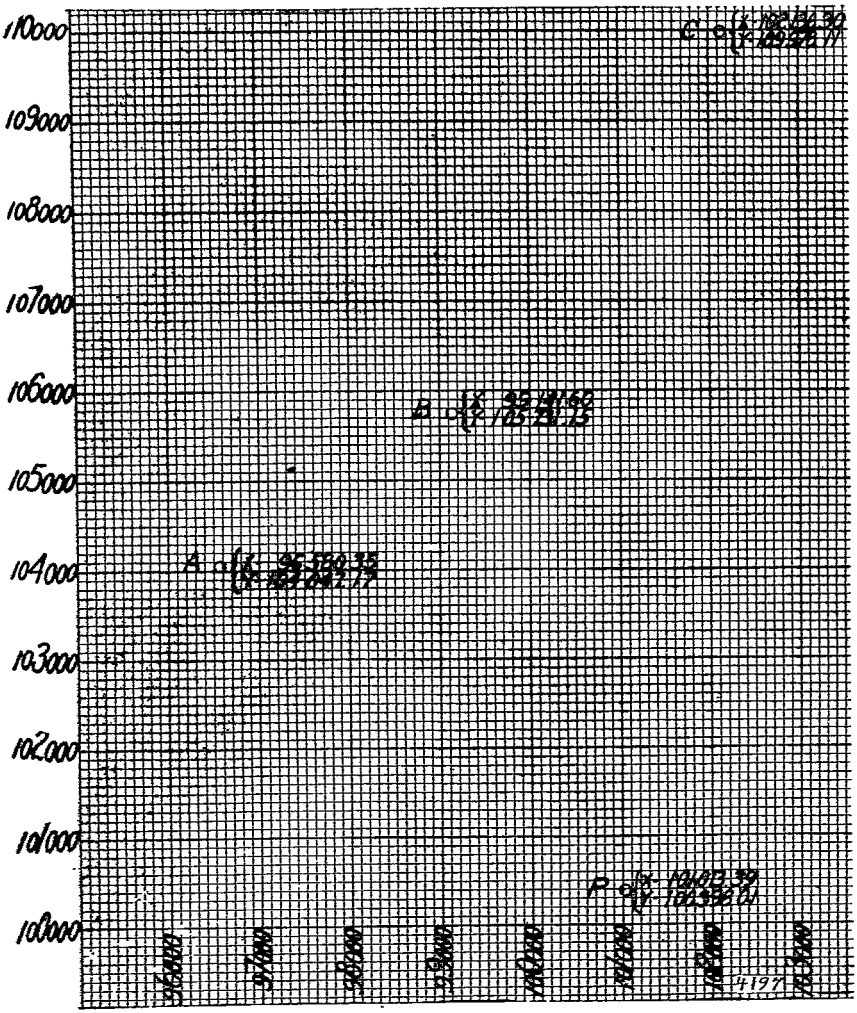

FIG. 1. SOLUTION OF PROBLEM NO. 8—ORIENTATION

Orientation

Questionnaire on Chapter XII

Reference: Orientation for Heavy (Coast) Artillery.

What general principles apply in the choice of a battery position? p. 215.

What study must be made by the Battery Commander before the occupation of a position? p 216.

Upon what does the amount of defilade necessary for a battery depend? p 219.

How is defilade determined? p 220.

What is balloon defilade and how is the amount determined? p 221.

What topographic features determine the minimum range at which a battery may fire? p 223.

No problem on minimum range and the determination of dead areas will be given as this matter consists of extended application of Problems 41 and 42, Gunnery which appeared in the BEATEN ZONE in September, 1921. The subject is important and should be thoroughly understood

Briefly describe the construction of a chart showing the possibilities of fire on an area. p 229.

How is the area in which a battery position should be selected determined? p 222.

Questionnaire on Chapter XIII

What is the purpose of a firing board? p 237.

Describe the construction of a firing board and its preparation for use. p 238.

Explain the use of a non-transparent protractor to draw rays on a large scale map. p 249.

Questionnaire on Chapter XIV

What is the purpose of a panoramic sketch? p 251.

How is a panoramic sketch made? p 255.

How should one be graduated? p 258.

What principles of perspective apply to panoramic sketching? p 259.

Questionnaire on Chapter XV

Of what does the location survey of a railroad consist? p 261.

What type of curve will be most generally used with railway artillery? p 262.

Draw a sketch showing the principal parts of a simple curve and name them. p 263.

What is the relation between the deflection angle for a 100-ft. chord and the degree of curvature of a curve? p 263.

Why is a vertical curve necessary? p 265.

What are the different types of epis? p 267.

After determining the angle between two adjoining tangents, what steps are necessary in the laying out of a railway curve? p 273.

How are the coordinates of a gun position on a curve determined from the survey of that curve? p 274.

Problem No. 9—Orientation

DETERMINATION OF VISIBLE ERRORS

Reference: Chapter XII-Orientation for Heavy (Coast) Artillery

GIVEN:

Your observation post is at *7088* in the northeast corner of the sector shown on the map page 569. The enemy line extends along the streams marked ABC.

REQUIRED:

Determine the portions of enemy territory that can be seen from this observation station and cross hatch the invisible portion.

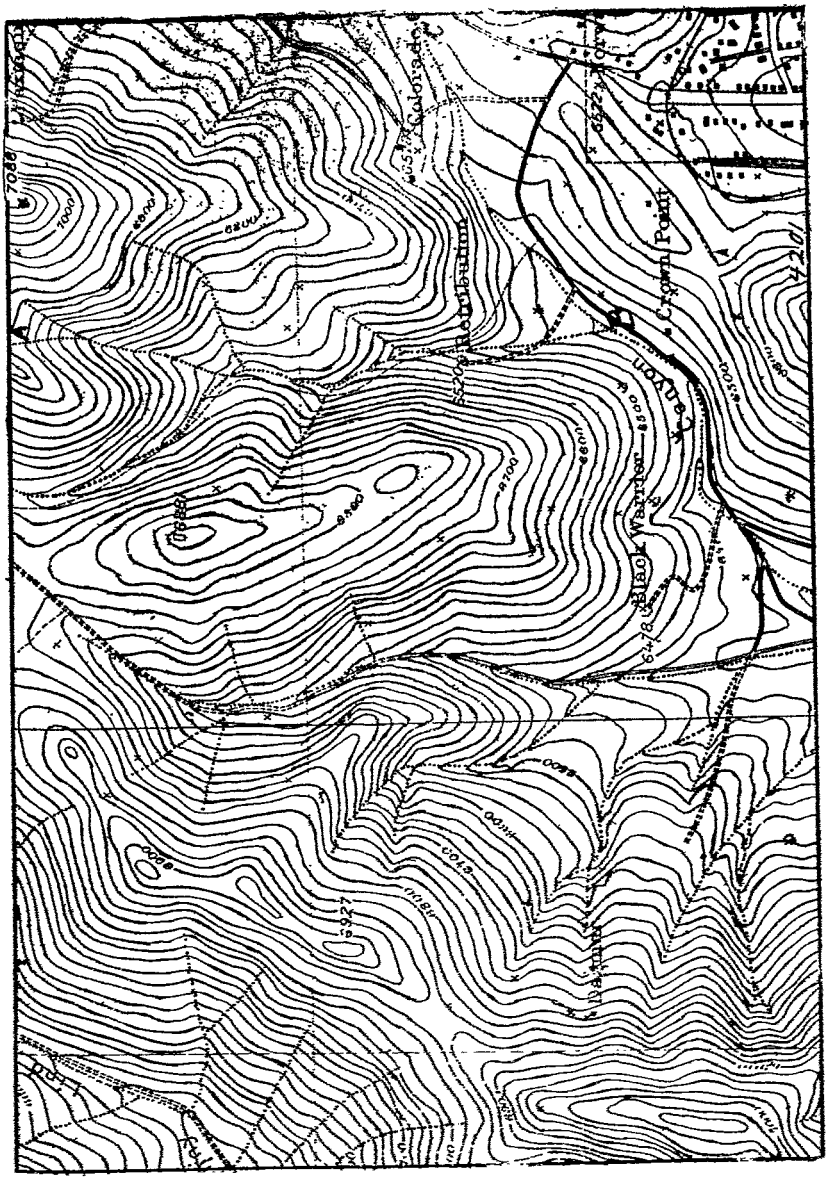

FIG. 1. PROBLEM NO. 9—ORIENTATION

Problem No. 10—Orientation

DETERMINATION OF FIELD OF FIRE

Reference: page 227,—Orientation for Heavy (Coast) Artillery

GIVEN:

A battery having a total of 30° traverse is installed 4200 yards in rear of the front line. The accompanying table indicates the drift for the different ranges and zones of the 8-inch Howitzer Mark VI.

Range	Drift—yards			
	Zone			
yds.	1	2	3	4
4,200	103	73	49	28
4,500	130	87	58	35
5,000	210	118	74	46
5,140	279			
5,500		162	96	60
6,000		233	123	75
6,240		334		
6,500			158	91
7,000			199	111
7,500			255	135
7,960			405	
8,000				163
8,500				194
9,000				231
9,500				276
10,000				333
10,500				420
10,760				537

REQUIRED:

Sketch the area in enemy territory that can be covered by one gun of this battery to a scale of 1,000 yards to the inch assuming that the median line of fire is normal to the front lines.

THE BULLETIN BOARD

Additions to Rifle Team Fund

Between May 3rd and June 3rd, the 1922 Rifle Team Fund was augmented by the following subscriptions. These contributions are gratefully acknowledged on behalf of the Rifle Team.

SOURCE OF DONATIONS	AMOUNTS
Coast Defenses of Key West	$9.00
2nd Lieut. G. H. Kristek, C. A. R. C.	1.00
Major T. A. Terry, C. A. C.	1.00
Capt. Delbert Ausmus, C. A. C. (531st A. A. Arty.)	1.00
Total this month	12.00
Previously acknowledged	568.78
	$580.78

General Maitre Assigned to Important Post

The many American friends of Brigadier General A. Maitre of the French Army will be pleased to learn that he has been appointed to the important post of Commandant du Centre d'Etude Tactiques d'Artillerie. Unquestionably, all who had the pleasure of knowing him in France will join in congratulations for his well deserved recognition, and for his success in this new duty.

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Index to Current Artillery Literature

Key

Ar-1	Boletin de Centro Naval
Au-5	Technische Mitteilungen
Be-4	Bulletin Belge des Sciences Militaires
C-1	Memorial del Ejercito de Chile
Cu-1	Boletin del Ejercito
D-0.5	Dansk Artilleri-Tidsskrift
F-3	Le Genie Civil
F-10	Revue d'Artillerie
F-12	Revue Militaire Generale
H-1	Organ der vereeniging ter Beoefening ven deKriegswetenschap
I-3	Rivista di Artilgieria e Genio
I-4	Rivista Marittima
M-2	Revista del Ejercito y Marina
N-2	Norsk Militaert Tidsskrift
Po-2	Revista del Artilharia
Po-4	Rivista Militar
Sp-2	Memorial de Artilleria
Sn-1	Artilleri-Tidsskrift
Sn-2	Svensk Kustartilleri-tidskrift
UK-2	Army Quarterly
UK-8	Engineer
UK-9	Engineering
UK-11	Journal of the Royal Artillery
UK-18	The Photographic Journal
UK-21	Royal Engineers' Journal
US-6	Army and Navy Register
US-7.5	Army Ordnance
US-27	Field Artillery Journal
US-29	General Electric Review
US-29.5	Hispanic-American Historical Review
US-30	Infantry Journal
US-36	Journal of the Franklin Institute
US-41	Military Engineer
US-43	Military Surgeon
US-52	Popular Mechanics
US-53.5	Power Plant Engineering
US-55	Proceedings of the American Philosophical Society
US-59	Proceedings of the U.S.Naval Institute
US-65	Scientific American

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L'Artillerie Allemande dans les Batailles de Rupture. Attaque du Chemin des Dames, 1918.—*F-10*, March, 1922.
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Le Service de Renseignements de L'Artillerie.—*F-10*, March, 1922.

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BOOK REVIEWS

Balistique Interieure. By Le General Gossot et M. Liouville. Paris. Librairie J. B. Bailliere et Fils. 9¼" x 6¼". 464 pp. Price 50 francs.

The extended application of ballistics during the war soon demonstrated that the existing formulas could not always be safely applied; hence arose the necessity for further research in this field, which the authors have utilized in the preparation of the present work. This work, which appears to be an important contribution to the science of interior ballistics, is divided into three parts, preceded by an extended introduction.

In Book I, the authors proceed to develop the experimental elements of Interior Ballistics derived from the laboartory and to construct the theory based on the data thus determined. In establishing the laws and checking the results, measuring instruments play an important role, and of these the most important are those which measure the pressures developed. The latter instruments, known as crusher gages, have been the subject of investigation for more than half a century and the authors devote considerable space to indicating the results of such researches.

For the study of the laws of the combustion of powders it is essential to know not only the maximum pressure developed, but also the variation of the pressure with the time. For this determination the crusher gage was assembled in a test bomb so as to give a continuous record of the pressures during the combustion of the explosive in the bomb. A brief description of this bomb and its operation is given in section 2 of Chapter I. The laws of the combustion of explosives as determined by means of the bomb, together with the principles of thermodynamics, form the basis of the theory and are summed up by the statement that for the powders now employed the combustion takes place in parallel layers with a velocity nearly proportional to a power of the pressures represented by the exponent 2/3; that it applies both to cellulose powders as to those containing nitroglycerin. The proof of the accuracy of these statements are discussed in section 3 of Chapter I.

The bomb also furnishes the means for procuring all the data relating to the force and quickness of the powder, the character of the combustion depending upon the form of the grains and the influence of mixtures of powders. Thus is determined all the data essential for building a theory based on experiment, capable of being checked on the proving ground and providing the gun constructor and powder manufacturer with precise rules for the proper execution of their common efforts.

The theory proper is developed in Chapter II, Book I. The first step consists in constructing the differential equations of motion of the projectile; the

method followed is that indicated by Resal and developed by Sarrau and results from the application of the principle of Equivalence. The next step consists in reducing these equations to purely numerical terms so as to permit the investigation of the properties of the motion without reference to the particular conditions relating to each piece and its loading.

The motion of the projectile in the bore thus becomes defined by two differential equations of the first order; the most suitable method of employing these equations is discussed by the authors in section 3 of Chapter II.

After presenting an historical sketch of the methods successively followed in the integration of the above equations, the authors emphasize the objections which seem attached to all of them, present a method of discussion of the differential equations, inaugurated in 1905, which they follow throughout the rest of the work. The authors conclude from this discussion that a surface exists for the determination of the velocities and a curve for those of the maximum pressures and positions of maximum pressure, which may be calculated in purely numerical terms. The same is also true of the pressures at the muzzle, which are most often imperfectly known experimentally and even poorly defined.

With reference to the form of the function used to represent these curves and surface, the authors warn the reader that it is neither strictly determined nor even determined by integration. On the contrary, within the limits of error permissible by the deviations of the experiments, there exist a number of functions which may be used indifferently and which, furthermore, have no analytical resemblance. The forms chosen to represent the experiments are remarkably indifferent and the agreement observed between the results of the experiments and the representative functions chosen can only confirm what is common to all these practically equivalent forms, namely, the choice of the variables between which numerical relations exist. This choice is an immediate consequence of the differential equations, without any integration or development into series.

It has long been known and abundantly verified during the war, that the velocities and maximum pressures in pieces cease to obey the ordinary laws when the ratio of the weight of the powder charge to that of the projectile attains values in excess of the usual limits, that is, values equal to or greater than unity. In such case the velocities calculated by the formulas conforming with the facts for the usual value of this ratio are always too large and the calculated pressures too small. It is with the idea of finding an explanation for these differences that the author presents a detailed study of the Lagrange problem. This problem is an application of the well known theories of Riemann and Hugoniot to the behavior of the gases in guns and although important differences may exist between the theories and this special application, the authors are of the opinion that the analogies between them suffice to give a fair representation of the phenomena as they actually take place. Thus the Lagrange problem, by a proper assimilation to the real problem, furnishes results which at once lead to consequences of practical importance.

Sections 4-7 inclusive of Chapter II, are devoted to some researches bearing on the subdivision of the velocities and pressures in a gaseous mass acting upon a projectile, the velocity acquired by the latter at each instant and its displacement.

In Book II the authors show how the velocity surface was first constructed in 1905 from data derived from experimental firings conducted in the same year by the Gavre commission. Owing to uncertainties in the values of the coefficients relating to the quickness of the powders and to certain other defects inherent in these firings, but a small portion of the velocity surface could be regarded as completely known.

In 1913 a series of experimental checks, conducted under better conditions

than were available in 1905, gave more precise information and then the war yielded a large variety of new cases, all of which were useful for the present work. The employment of this new data involved no essential change in method but only required a slight retouching of the formulas to bring them into harmony with the facts determined.

This new study brought to light several kinds of corrections to be applied to the original formulas. In proportion as the velocity surface became known in a wider region certain variations which were originally confused with accidental variations now became apparent and were taken into account by appropriate modifications of the formulas. The authors then proceed to show that the velocity surface is represented by an equation expressing w by the product of two functions, one of x, the other of l, in which w is simply related to the square of the velocity and x and l are two characteristics depending on the elements of the gun and of the loading. Of these, the function depending on x, while agreeing with the results included in the field explored in 1905, was found to be lacking when the data of the subsequent experiments were taken into consideration. Hence arose the necessity of modifying this function so as to obtain a less complicated representation beyond the limits originally determined. The form adopted by the authors approximate very closely to that used by Sarrau, but with a slightly different expression for x and applicable in a much broader interval—an interval which comprises nearly all the usual values.

The values of the other characteristics, l, occurring in the expression for w, derived from the 1905 experiments, approximated to unity and were generally less than unity. When the results of the later experiments indicated values of l considerably greater than unity, it was at once recognized that w could no longer be assumed proportional to l as was done originally. This second cause of modification of the formulas is however less marked than that relating to the function of x; up to the present, too, fewer elements have been available from which to determine it, hence it must be given a subordinate place in the study of the necessary modifications.

The lack of very precise experiments relating to the influence of l upon the value of w obliged the authors to adopt a special method of deducing the law from the numbers actually known. Thus was the formula for w extended to a broad field of variation of x and l comprising all the values of these variables used up to present time and doubtless those that it will be useful to examine for a long time to come.

The authors then take up the study of the pressure formulas. Here difficulties of another nature are encountered. The experimental measurements give the pressures on the breech of the gun whilst the pressures entering the differential equations of motion are those on the base of the projectile. Thus the comparison of the experimental results with the theory can not be made without knowing the relation between these two pressures. This relation varies at each instant, but if it be assumed that these pressures are equal then would the experimental determinations permit of tracing a pressure curve in the same way as the velocity surface was traced. This hypothesis failed to conform with the experimental results obtained in 1905, and it then appeared that agreement could be obtained by introducing a factor representing a certain function of the elements of loading. Afterwards it was observed that an equally good result could be arrived at for the usual values of the elements of loading, and in some cases an even better one, by introducing the factor indicated by the first wave of the Lagrange problem. But as the subsequent waves indicated rather the equality of the two pressures, the factor finally adopted was the simple factor constituted by the function of the ratio of the powder charge to the weight of the projectile.

The study of the Lagrange problem has thus led to the rejection of the idea

that an important difference exists between the two pressures, even in the cases when the above ratio is equal to or greater than unity. On the other hand the results obtained by the Lagrange problem indicate the necessity, in these latter cases, for taking into account the energy absorbed by the gases of the charge and the means for doing this are brought out. The formulas finally obtained are found to be in satisfactory agreement with the experimental results and the authors believe they may now be safely applied to designs of guns of very high power.

Chapter IV is devoted to a short discussion of the position of maximum pressure, a knowledge of which is so important to the gun constructor. The formula applicable for this purpose was derived in 1905 and the author states that no new checks on it have since been obtained.

Book III is devoted to applications of the formulas. The first series relate to the effects of powders in a given gun (Chapter I). In all these applications it is assumed that the caliber, volume of powder chamber, total volume of the bore and weight of the projectile remain constant. There then remain five elements which may be varied; the weight of the powder charge, the time of combustion, the velocity, the pressure and the modulus x. As there are three formulas expressing the relations between these five quantities, any three can be determined when the other two are given.

Ten distinct problems result from this classification depending upon the choice of the two elements assumed as given. They are subdivided into three classes presenting varied difficulties in solution. The first class includes all those in which the weight of the charge is known; these are the simplest. In the second x is given but not the weight of the charge. In the third both x and the powder charge are unknown. The two last classes alone require a special method of solution. The method adopted is that which groups together terms so as to constitute a nearly constant quantity, whatever the values of the given quantities. The quantity is then replaced by a constant in a first approximation, there being thus obtained a supplementary relation which at once leads to the solution.

Similar methods are sometimes also useful in the study of the differential formulas. The object of these formulas is to give the relations between the variations in the elements of the gun and of the loading and those of the ballistic functions, when such variations are so small that they may be regarded as differentials. Such relations serve to give the corrections to be applied to the ballistic functions in order to convert them to what they would have been under normal conditions of loading. The differential formulas also serve to solve the converse of the above problem. This discussion is given in section 2 of Chapter I.

The design of guns is discussed by the authors in Chapter II. This is one of the most interesting questions of ballistics and one requiring the most complete and varied utilization of the formulas. The design of a gun is always based on an assumed ballistic effect which it is desired to obtain and always certain exigencies intervene which restrict the range of variation of the elements. Thus the caliber and weight of projectile are generally fixed by the effects desired. The length of the bore is restricted by the necessities of the service and the pressure by the exigencies of construction. In any design therefore the four quantities mentioned may be regarded as constant, thus leaving the remaining elements to be varied to suit any particular problem. In order that the problem may be completely defined there remains but to choose one undetermined quantity, which may be any one of the remaining elements.

To make the necessary choice, the authors have found it convenient to adopt a condition of maximum or minimum of these remaining elements and by considering each element separately they finally arrive at five extreme conditions which define five corresponding, so-called, families of solutions. The study of these families, coupled with the application of the numerous tables provided by

the authors to facilitate the computations, presents a clear idea of the methods of calculation adopted, which can not fail to be of extreme interest to the reader. The authors also indicate a number of approximate equations, some algebraic, some transcendental, which furnish a means for abridging the researches with but negligible errors.

In conclusion, the authors call attention to the fact that they have consistently avoided introducing in their formulas any variable whose character might in any way be regarded as doubtful; and in this way have not only kept down the number of the parameters entering the equations, but have also avoided introducing any variable of uncertain significance, intended only to supply the short-comings of the formulas.

Where the influences appeared very slight, as, for example, for the differences in the law of combustion of the powder due to the form of the grain, within the limits in which these differences are maintained in the French service powders, they have been assumed as zero under ordinary conditions. Such differences would only have been considered had they been brought out by the firings, which appears not to have been done. The same is true of the variation in the loss of energy due to the windage, within the limits in which the windage is generally maintained, or the heating of the gun, or the variation in the starting resistances of the projectile, etc.

Indeed, the formula should agree with experiment without necessitating the assumption of any hypotheses other than the smallest number essential to a conclusion upon points which experiment has failed to clear up. Besides being logical, this procedure is justified by the fact that the formulas are intended to give indications upon the average phenomena and to permit of making predictions and not to give a semblance of justification to anomalies without well established causes.

The last chapter is devoted to numerical applications of the formulas to a number of different guns, and thus provide the student with sufficient examples to enable him to thoroughly familiarize himself with the workings of the formulas.

Problems in American Democracy. By Thomas Ross Williamson. D. C. Heath and Co. New York. 1922. 5¼″ x 7¾″. 567 pp. Cloth. Price $1.60

The author is assistant professor of economics and sociology in Smith College, and from his combination of wide teaching experience and profound study of government and its human problems, he has conceived and created a college textbook which is unique in method and content.

The purpose and method of this surprisingly comprehensive work cannot be stated better than in Professor Williamson's own preface:

"There is an increasing demand for a textbook which will bring the student into direct contact with the great current issues of American life, and which will afford practical training to those who soon must grapple with the economics, social, and political problems of our own time. It is with the hope of meeting such a demand that this text has been prepared.

"The plan of the book calls for a word of explanation. It is poor pedagogy to expect the student to attack the defects of American life, and at the same time to place in his hands a book which deals preeminently with the mechanism of government. As well send a boy to a hardware store to buy tools before he is told whether he is to make a mouse-trap or a boat. Furthermore, to spend much more time on the mechanism of government than on the actual problems of democracy is a mistake in emphasis. Government is a means, not an end. It is a tool by means of which we attack and solve our problems.

"Therefore the student of this text begins, not with the mechanism of govern-

ment, but with the historical background of American democracy, its origin, development, and promise for the future. Following this is a brief survey of the economic life of the nation, because that economic life constitutes the fundamental basis of our problems. Considerable space has been devoted to a problem growing directly out of economic conditions, i. e. the question of social justice or industrial reform. This is the most pressing question before any modern people, but strangely enough one which heretofore has been neglected by our schools.

"Because they tend to arise primarily from a bad economic situation, such social problems as industrial relations, health in industry, and immigration are next considered. From social problems the text passes to the economic and social functions of government, and thence to the question of making government effective. The mechanism of government has been placed last, and for the reason already given, i. e. because a knowledge of the framework of goverment is valuable only after the citizen knows something of the needs which that mechanism must be made to fill."

The usefulness of the book as a text is supplemented by the inclusion after each chapter of six different sorts of especial instructional suggestions: first, questions on the text; second, a list of required supplementary readings; third, questions on the required readings; fourth, topic work requiring the student to link up his own experience and observation with the subject matter of the book; fifth, topic work requiring especial research and study; sixth, questions for classroom discussion and debate.

Provisional Instructions for the Tactical Employment of the Larger Units. By the French Minister of War. Paris. Berger-Levrault. 4¼" x 7½". 139 pp.

This work corresponds in scope to the Field Service Regulations, U. S. Army. It is the result of the studies of a commission of which Marshall Petain was president.

It presumably embodies the latest tactical doctrines of the French Army as changed by their four years of war. As such it is invaluable to the student at arms. No officer who is interested in his profession or on whom the responsibility rests for the organization or the leading of our forces in the field can afford to be unfamiliar with the contents of this work.

There will doubtless be an authorized General Staff translation available in the near future. In a work of this character it is impossible to give any summary of its contents in the space available for a review. The best that can be hoped is to indicate some of the divergencies from American practice.

The foreword is translated in full as follows:

"In respect to those international agreements to which France is a signatory, the French Government will be compelled on the outbreak of War, and in conjunction with its allies, to obtain from the enemy Governments an agreement to refrain from the use of gas as an Arm of War. If this agreement is not obtained it reserves to itself the right to act according to the circumstances."

In the matter of organization the following differences are noted: The Division has either 3 or 4 regiments of Infantry. The divisional artillery consists of two regiments of horse-drawn artillery but 1 regiment is composed of Heavy Howitzers.

The Army Corps consists as with us of Corps troops and an indefinite number of Divisions but the typical number is two. The Corps Artillery consists of a single regiment of horse-drawn long range, heavy guns. (Presumably G. P. F.'s).

Thus it will be seen that the typical French Corps is a far less powerful organization than the American. Its relative strength is only 50% of the Infantry,

33% of the field guns, 66 2/3% of the Howitzers of an American Corps. There are no motorized units of artillery except in the GHQ reserve.

The air service organization is complete and divided for purposes of command as follows:

Combatant Air Service
Heavier than air
Pursuit squadrons
Bombing squadrons
Lighter than air
Dirigibles.

These are organized into regiments, brigades and divisions and act practically as a separate large unit under the orders of the Army.

An auxiliary air service
Heavier than air
Observation squadrons
Lighter than air
Balloons
Dirigibles

which form integral parts of the divisions and Corps.

The anti-aircraft defense service.

1. Consisting of a service of Security and Information.
2. Anti-aircraft artillery
3. Anti-aircraft machine guns.
4. Searchlights
5. Captive balloons for obstacles.

The Cavalry is organized into squadrons, regiments, brigades divisions and may if circumstances require it be organized into Cavalry corps. This is in addition to the divisional and corps cavalries. The Cavalry's weapon is its fire. It fights habitually on foot. Its horses are used to give it strategic mobility.

In tactics the defensive is considered on equal basis with the offensive. Par. 123 reads in full "The strength of the defensive rests upon a good system of fires, a judicious organization of the ground and the rapid play of the reserves.

"All echelons of the command are organized in depth. When all these conditions are fulfilled an Army can *victoriously resist* with means inferior to those of its assailant if its chief has a clear cut plan and a tenacious will."

The Artillery of a large unit is divided in combat into three groups.

1. Accompanying guns (at times)
2. Direct support
3. The Artillery Mass.

The last of which remains at the disposal of the chief of the unit concerned. The infantry acts habitually in conjunction with Tanks and this latter arms seems to be one of the chief reliances of the French.

The doctrine of the Advanced Post is reiterated.

The difficulties and necessity for night work are fully set forth. In night combats maneuvers are considered impossible and hence first line units are not organized in depth under these circumstances. The chapter headings are as follows:

Part I Command
Part II Means of Action.
  Chap. I Characteristics and organizations of the arms and services.
  Chap. II Characteristics and general organization of the larger units.
Part III Tactical Employment of the larger units.
  Chap. I The General Plans and orders.
  Chap. II Service of Security and information.
  Chap. III Transportation, marches, and stations.

Chap. IV Battle
Chap. V The Army in Battle
Chap. VI The Corps in Battle
Chap. VII The Division in Combat
Chap. VIII Influence of the terrain on operations.
Chap. IX Operations in the mountains.
Chap. X Operations at night
Part IV The functions of the services
Chap. I General principles.
Chap. II Service of communication
Chap. III Service of supply and subsistence
Chap. IV Service of Transportation
Chap. V Services of Law and Order.
Part V Method of Instructions of the larger units.
This last portion is divided into
1. Map maneuvers.
2. Terrain exercises without the combatant troops.
3. Camps of instruction
4. Grand maneuvers.

The Soul and Body of an Army. By General Sir Ian Hamilton. New York. George H. Doran Company. 5½" x 9". 303 pp. Price $5.00.

After reading his "Staff Officer's Scrap Book" and "Gallipoli Diary," one expects much when he takes up a book written by Sir Ian Hamilton. In "The Soul and Body of an Army," he will not be disappointed. The very title arouses the imagination but as one continues to read, he finds it a very apt selection. It is not possible to sum up concisely the contents of this book, they must be dealt with almost chapter by chapter. The book opens with an exposition of how little the British public knows of the British Army. It knows of its existence but due largely to the policy of keeping most of its works confidential, it has learned little of the actual construction, use and operation of the Army. Then follows a discussion of the factors entering into the makeup of an Army: organization, discipline, training, numbers, patriotism and genius. Following this discussion in which are included many specific instances with quotations of chapter and verse come excellent chapters devoted to the application of the previously deduced principles to the needs of an Army. Sir Ian here brings forth prominently the fundamentals of organization as applied to National Defense. He strongly advocates a Ministry of National Defense which would be charged with the use of the Army, Navy and Air Service. He would develop a single General Staff to operate for this new unit. He would organize his Army into such units during a period of peace that they could be of immediate value in time of hostilities, the size and strength of these units to be governed largely by the experiences of the World War, their number to be governed by the next probable war of the future. He would so train them as to develop good discipline, a sense of individual responsibility, efficiency in the use of weapons, and above all patriotism which carries with it excellent morale.

So much has been compressed in this single volume and the space in these columns is so limited that it is not possible to render a satisfactory review of the book. Re-reading brings out new points which must be read in the original to be appreciated. The reviewer commends this book to the careful attention of every officer. Each who reads it will appreciate its value, enjoying the light touch and personal reminiscences of the author, and then will realize that Sir Ian has again made a valuable contribution to military literature.

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