VOLUME XI **NUMBER 5**

SEPTEMBER-OCTOBER

THE FIELD ARTILLERY JOURNAL

EDITED BY

ARTHUR F. CASSELS

LIEUTENANT-COLONEL (FIELD ARTILLERY), UNITED STATES ARMY, RETIRED

THE UNITED STATES FIELD ARTILLERY ASSOCIATION
1624 H STREET, N. W.
WASHINGTON, D. C.

Contents, September-October, 1921

THE UNITED STATES FIELD ARTILLERY ASSOCIATION

Organized June 7, 1910

THE FIELD ARTILLERY JOURNAL

Edited by

Arthur F. Cassels

Lieutenant-Colonel (Field Artillery), U. S. Army, Retired

PUBLISHED BI-MONTHLY FOR

THE UNITED STATES FIELD ARTILLERY ASSOCIATION

BY J. B. LIPPINCOTT COMPANY

227 SOUTH SIXTH STREET

PHILADELPHIA, PA.

LONDON OFFICE: J. B. LIPPINCOTT COMPANY, 16 John St., Adelphi.

EDITORIAL OFFICE: 1624 H Street, N. W., Washington, D. C.

Entered as second-class matter November 20, 1915, at the post office at Philadelphia, Pennsylvania, under the Act of March 3, 1879

Published without expense to the government.

Subscriptions to The Field Artillery Journal:
Domestic, $3 per annum.
Canada, $3.25 per annum.
Countries in the postal union, $3.50 per annum.
Checks from the Philippine Islands, Hawaii, the Canal Zone, and Canada, should include 15 cents for collection charges.
Subscribers should notify us promptly of changes in their addresses, and of failure to receive The Journal.
The Field Artillery Journal pays for original articles accepted.
Subscriptions and communications should be addressed to

THE UNITED STATES FIELD ARTILLERY ASSOCIATION
1624 H Street, N. W. Washington, D. C.

BRIGADIER-GENERAL ALBERT J. BOWLEY, U. S. ARMY

Colonel, Commanding 17th Field Artillery, A. E. F., December 1917 to June 1918, Promoted Brigadier-General June 1918. Commanding 2nd Field Artillery Brigade, 2nd Division, A. E. F., June to November 1918, Transferred to 6th Army Corps and assigned as Chief of Artillery, 6th Corps, November 1918.

THE FIELD ARTILLERY JOURNAL

VOL. XI SEPTEMBER-OCTOBER, 1921 NO. 5

LESSONS OF THE WAR AS AFFECTING AMERICAN ARTILLERY, PARTICULARLY DIVISIONAL ARTILLERY

BY MAJOR D. M. BEERE. FIELD ARTILLERY, U. S. ARMY

AWARDED FIRST HONORABLE MENTION, FIELD ARTILLERY JOURNAL PRIZE ESSAY COMPETITION, 1921

[EDITOR'S NOTE.—*It is our opinion that this is an excellent article showing much careful, painstaking study and containing a number of constructive and valuable criticisms of existing and former organization of the Field Artillery arm. In publishing them, however, the* FIELD ARTILLERY JOURNAL *wishes to record the fact that it does not concur in all conclusions arrived at by the author. Some items of faulty organization complained of have been corrected since this article was written. In the case of other criticisms, the author, by reason of the duties on which he has been engaged, has been unable to familiarize himself with the various factors considered by the Chief of Field Artillery in formulating our present organization and equipment. So far as the criticisms of war-time training are concerned, it must be remembered that the author went overseas soon after the office of the Chief of Field Artillery was established and did not return until long after the Armistice. He could not, therefore, be familiar with the scheme of training employed in the Field Artillery during the latter part of the World War. This scheme was complete and successful in every respect*.]

The lessons of the war as affecting our artillery may be classified as affecting: I. Organization, II. Matériel and Ammunition, III. Training, IV. Mobilization, V. Technical Methods and Tactics. The following discussions are arranged, as to subjects covered, in the order given with the exception of Technical Methods and Tactics. Various considerations affecting Technical Methods and Tactics are taken up as they happen to occur in connection with the other subjects.

I. ORGANIZATION

The new organization gives us a very practicable working machine. Naturally there are minor deficiencies which will have to be straightened out. We have largely increased Headquarters

Staffs and Personnel, the Battalion Combat train, and the Brigade Ammunition train functioning solely as an artillery supply unit no longer concerned with infantry ammunition, and the G.H.Q. Artillery Reserve with no organic Army Artillery.

There are, however, some questions concerning Organization which may be of interest.

A. ARE THE HEADQUARTERS STAFFS AND DETAILS, INCREASED AS THEY HAVE BEEN, LARGE ENOUGH?

B. IS OUR FOUR-GUN BATTERY AS ADVANTAGEOUS AS A SIX-GUN BATTERY?

C. ORGANIZATION OF COMMAND IN THE ASSIGNMENT OF FIRE MISSIONS.

D. SHOULD OUR DIVISIONAL 105 HOWITZERS BE ORGANIZED INTO A SEPARATE REGIMENT; SHOULD THEY NOT BE INCORPORATED WITH THE 75'S?

In all discussion as to Organization the following principles are assumed to be accepted as fundamental:

1. That our organization should be such as to function properly in a real war, *i.e.,* a war against a strong enemy.

2. That our organization must be such as to function in the offensive, since it is by the offensive alone that we are eventually to win.

A. ARE THE HEADQUARTERS STAFFS AND DETAILS, INCREASED AS THEY ARE, LARGE ENOUGH?

ARTILLERY BRIGADE HEADQUARTERS

Diagram I represents the Divisional Artillery Brigade Headquarters.

This diagram is merely a graphical representation of the headquarters as given in the new Tables of Organizations.

The Brigade Headquarters Staff and personnel is very apparently sufficient, except as to communication personnel.

Let us investigate the functioning of this personnel in order to see if it is large enough to accomplish its work.

Our Brigade communication personnel may be conveniently subdivided, as is shown in Diagram I, into groups functioning in a message centre section, a courier service section, a telephone section and a radio section.

THE MESSAGE CENTRE AND COURIER SECTIONS

The message centre needs an additional clerk. It should also be under the charge of a sergeant instead of a corporal. The personnel of the courier service section is otherwise ample.

Telephone and Radio Sections

In order to determine the composition of these sections we must investigate what work they will have to do, in an offensive against an enemy occupying a defensive position, for example.

We will suppose our Division to be deployed for the attack, Brigades abreast, Regiments within Brigades abreast, Battalions within Regiments in column, and that a regiment of 75's is in support of each Infantry Brigade, and in turn, that one battalion of 75's is assigned to the initial support of each regiment of infantry.

(The regiment of 105 Howitzers which, when the 105 is developed, is to be added to the Artillery Brigade will not be considered. If we find that our Brigade communications personnel is inadequate considering the requirements of communications to the two 75 regiments, we will admit that it will be inadequate with the additional communications necessitated by a howitzer regiment.)

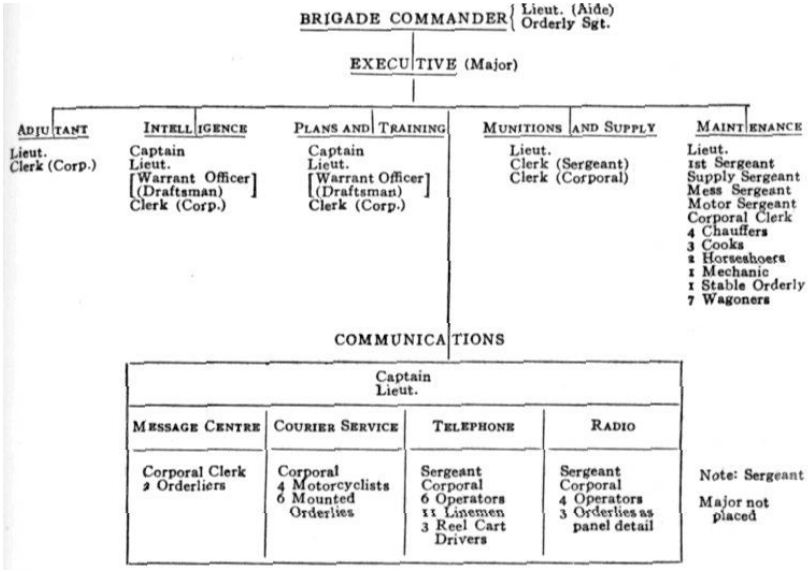


DIAGRAM No. 1

BRIGADE HEADQUARTERS

The Divisional Signal Company will establish an "axis of communication," as shown in diagram 4,[1] the 1st Forward Communication Central being chosen with reference to the initial positions of the Infantry Brigade Command Posts and the 2nd Forward Communication Central with reference to the initial position of the Infantry

[1] See diagram at end of article.

Regimental Command Posts. As the attack progresses these two Forward Communication Centrals are pushed forward step by step, keeping in their relative position to the Command Posts of the Infantry Regiments and Brigades as these are advanced.

The Artillery Brigade "axis of communication" is similar to, and runs approximately parallel to, the Division Axis. It extends from the Artillery Brigade Command Post forward through two Forward Communication Centrals established on it. The 1st Forward Communication Central should be located centrally with reference to the Command Posts of the two light regiments and in the close vicinity of the 1st Forward Communication Central of the Divisional Axis. The 2nd Forward Communication Central on the axis should be located centrally with reference to the 75 Battalions, and in the close vicinity of the 2nd Forward Communication Central on the Divisional Axis.

The Artillery Brigade Command Post is connected to the Division Command Post, and the Artillery Forward Communication Centrals are connected to the Forward Communication Centrals on the Divisional Axis.

The Artillery Brigade telephone personnel establishes the axis of communications above described. Connection to the Forward Communication Centrals from the Artillery Regiments and Battalions are established by the Regimental and Battalion personnel (diagram 5).[2]

An estimate of the telephone personnel required to establish and maintain the system described above is given below. It is believed that this estimate is very conservative. In this connection it should be remembered that one operator cannot continuously handle the work of a switchboard through which any large amount of traffic passes. He must have relief so that he can rest and eat. This requires two operators.

Telephone lines are constantly being cut by traffic or shell fire. When a line goes out (is cut) linemen start out from both ends, each attempting to "bracket" the break. The length of line one lineman can care for generally depends upon the location of the line; *i.e.*, upon its proximity to the front. The closer to the front the greater the probability of breaks due to both traffic and shell fire.

At the Brigade Command Post are needed:

One non-commissioned officer in charge of station,

Two switchboard operators,

Two linemen (maintaining lines towards the 1st Forward Communication Central and Division Headquarters).

At the 1st Forward Communication Central are needed:

[2] See diagram at end of article.

One non-commissioned officer in charge of station,
Two switchboard operators,
Five linemen (maintaining lines towards: the Artillery Brigade Headquarters Station; the Artillery Regiments; the 2nd Forward Communication Central on the Artillery Axis; and toward the 1st Forward Communication Central on the Divisional Axis.

At the 2nd Forward Communication Central are needed:

One non-commissioned officer in charge of station,
Two switchboard operators,
Four linemen (maintaining the lines toward: the 1st Forward Communication Central on the Artillery Axis, the Artillery Battalions; and the 2nd Forward Communication Central on the Divisional Axis (and eventually toward the 3rd Forward Communication Central on the Artillery Axis).

When the Infantry shall have made an advance from the initial position of about two thousand yards, some of the artillery battalions will have begun their displacement to the front. The Artillery Brigade telephone personnel must install a 3rd Forward Communication Central with which these battalions will connect their advanced positions. This personnel should include:

One officer in charge,
One non-commissioned officer in charge of reel cart (who later will be in charge of the Forward Communication Central),
Three-reel cart drivers,
One wireman on reel cart,
Two switchboard operators,
Four linemen to maintain lines toward: the 2nd Forward Communication Central on the Artillery Axis; the advanced artillery Battalions; and the 3rd Forward Communication Central on the Divisional Axis.

None of this personnel can be taken from the part of the system already installed because all the parts of that system must still function. At a later phase when the Brigade Command Post will have moved forward to one of the Forward Communication Centrals, the personnel previously engaged with the original Command Post will become available. However, about this time a new or 4th Forward Communication Central will have to be installed with the result that in so far as the number of personnel is required we are no better off than we were before.

The total personnel required are:

Four non-commissioned officers,
Eight switchboard operators,
Fifteen linemen,
Three reel cart drivers,
One wireman (reel cart).

The tables of organization fall short to the following extent:

Two non-commissioned officers,
Two operators,
Four linemen,
One wireman (reel cart).

Incidentally it will be seen that whereas our tables of Equipment provide for three 8-line switchboards, in reality we need four 12-line switchboards. It is apparent that some type of light reel, either hand, or light wheeled, should be furnished. They are not included in the present equipment.

RADIO SECTION

Equipment

There are two sets operating at Brigade Headquarters. One to talk with the Division Headquarters and the Infantry Brigade Headquarters; the other to talk with the Artillery Regiments and airplanes.

When the progression of the attack necessitates the movement forward of the Brigade Command Post, radio communication at the forward Command Post should be installed before that at the old Command Post is dismantled.

This necessitates duplicate equipment which is not at present issued.

Personnel

There must be continuous listening in on radio sets. This is trying work and necessitates a very minimum of two operators per set. Three would be better, and were usually provided in France.

The Tables of Organization provide four operators, barely enough to operate the two sets which are issued. If duplicate sets are issued in accordance with the reasons, therefore, as stated above under "Equipment," at least one operator per set, or a total of two extra operators should be provided.

In communicating with airplanes with the type of set at present issued to Brigade Headquarters a panel detail of three men is required. These are not provided for in the Tables of Organization, unless we take three of the orderlies.

Since it is seen fit to specify in the Tables of Organization, the duties of the various personnel, it seems that the panel detail should not be slighted.

REGIMENTAL HEADQUARTERS (DIAGRAM NO. 2)

Liaison Personnel

We note that, except two officers, no liaison personnel is provided.

Since the artillery regimental liaison detail usually works with the Infantry Brigade Commander, a large detail of scouts, observers

and communication personnel is not required. However there should be *some* personnel (one or two telephone operators, two or three couriers).

Communications Section

No personnel is available for the formation of a message centre.

An investigation of the telephone communications to be installed and maintained by the telephone section (similar to the investigation of the

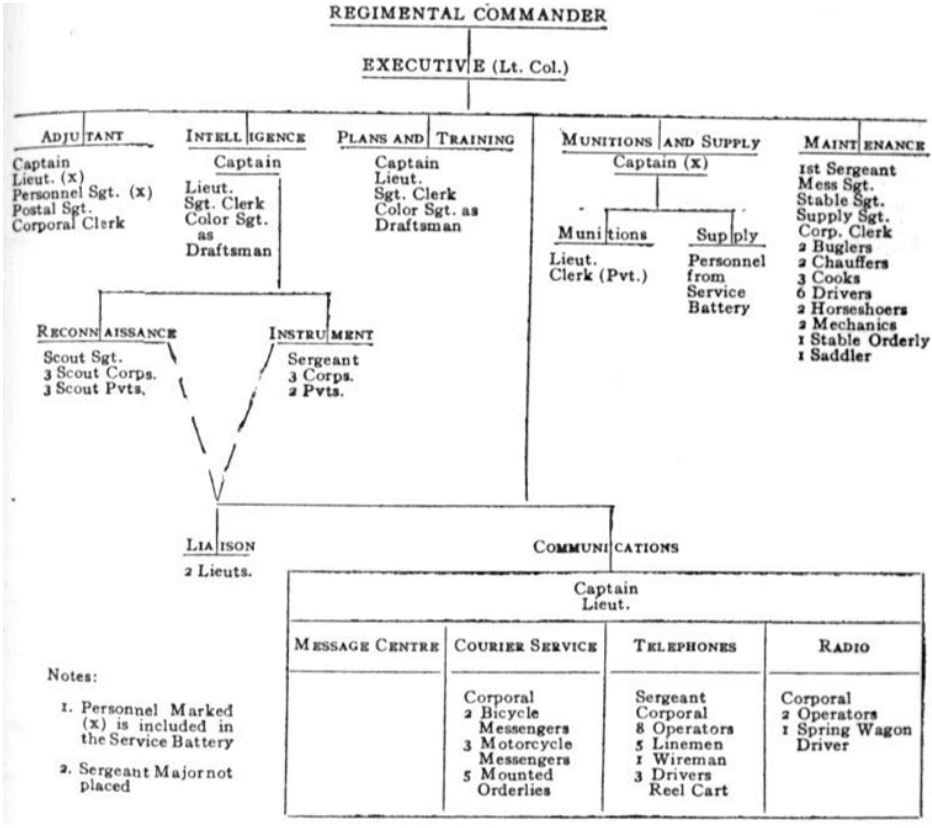


DIAGRAM No. 2
REGIMENTAL HEADQUARTERS

Brigade communications) will show that sufficient personnel is not available.

Radio Section

The Artillery Regiment has three radio sets at its disposal. One for communication with Artillery Brigade Headquarters, one for communication with the Infantry and one for communication with airplanes (radio telephone, no panel detail necessary).

The equipment should be duplicated in order that during the advance of an attack a forward Command Post may be completely functioning before the rear Command Post is dismantled.

A total of eight operators are required. Only two are provided by the Table of Organization.

The Executive

The new Table of Organization designates a lieutenant colonel as the executive.

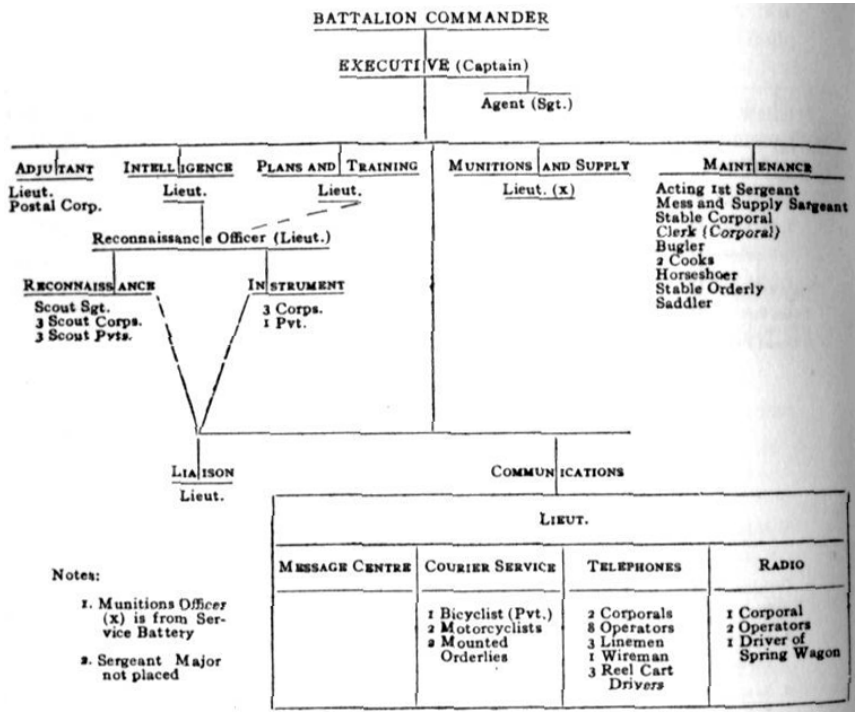


DIAGRAM No. 3

BATTALION HEADQUARTERS

Would it not be an error to use an officer of the training and experience of a lieutenant colonel as an executive?

A captain, or possibly a major, would perhaps be more suitable.

THE BATTALION (DIAGRAM NO. 3)

An adjutant is provided for Battalion Headquarters. It is doubtful if the amount of paper work, etc., conducted at Battalion Headquarters necessitates an officer for its supervision.

Liaison

We find no personnel designated as liaison personnel. This personnel, consisting of scouts, observers and communication personnel, might be taken from the Intelligence and Communication Sections, but these are none too large for their own needs.

The liaison detachment is one which requires teamwork as much as if not more than any section of the detail. If any specifications are to be given by the Tables of Organization, as to the assignment and employment of personnel, it seems that the liaison personnel should be so assigned.

Radio

The Battalion uses two sets: for communication with its regimental headquarters, with the infantry and with airplanes.

Since the Battalion ordinarily moves in a body and not in echelon as do the Regiment and Brigade, a duplication of equipment is not necessary.

Again we find the Tables of Organization provide few operators, only two, whereas at least four are needed. Panel men are needed but not provided for.

General Resumé

Although the war emphasized the importance of liaison and communication, it is believed that we still hesitate to face the actual facts.

These functions require an *enormous* personnel.

An insufficient personnel is all but useless. We must actually *maintain* liaison and communication. Half measures are usually a waste of the personnel engaged in them. During the war the higher commands, Brigade, Regiment and Battalion were forced into the pernicious habit of taking the necessary additional men from the Batteries. It is believed that this was one of the causes of the lack of care for horses. The batteries were drained until there were insufficient men to do the work.

The Infantry has fully grasped the importance of communication.

The tables give a comparison of the communication personnel allotted by the new Tables of Organization for like echelons of command in the Infantry and Artillery.

	Officers	Non-commissioned officers	Privates	Total
Infantry Brigade Headq.	1	12	43	56
Artillery Brigade Headq.	2	6	39	47
Infantry Regt. Headq.	1	14	38	53
Artillery Regt. Headq.	2	5	31	38
Infantry Battalion Headq.	1	19	18	38
Artillery Battalion Headq.	1	4	25	30

The Artillery Battery has a communications personnel whereas the Infantry Company has none. However, the communications personnel in the Battery is needed for the technical conduct of fire, whereas the Infantry Company has no such necessity.

Now the communications within the Artillery are as hard to install (just as heavy and as long lines) as those within the Infantry. In addition the Artillery must establish and maintain communications with the Infantry. It also must establish an axis of communication similar to that established by the Divisional Signal Corps Company.

The Artillery has more communications to install and maintain than the Infantry and has less personnel. Now it is not argued that the Infantry has too much personnel; it is argued that the Artillery has too little.

B. THE SIX-GUN AS OPPOSED TO THE FOUR-GUN BATTERY.

Before the war the French, and ourselves closely modelling on the French, had the idea that artillery action in war was to be characterized by brief, violent fire. In our pre-war practice, after a sector was assigned to us, we waited and watched until a target appeared, then adjusted rapidly, fire for effect being short and violent. Then, the target destroyed, we waited for another one to pop up, when the process was repeated.

Based on this idea of artillery action, the French conducted a careful series of experiments and came to the conclusion, which we adopted, that the battery of four guns was better than that of six guns. The 75 is capable of firing for *short* time 20 rounds per gun per minute. By firing 4 guns at 12 rounds per gun per minute, we put down as much fire as by firing 6 guns at 8 rounds per minute. Under such a conception, six guns with the extra personnel, matériel and animals involved, are unnecessary.

The war has shown that the main characteristic of artillery fire is its long duration. Since the 75 can fire only 100 rounds per gun per hour over a long period, four guns are not as good as six. As a matter of fact our four-gun 75 batteries provided a firing battery of three guns, one gun usually being out for cooling purposes. It is only in the action of "accompanying" batteries that we find our prewar conceptions of artillery action fulfilled. These are a small part of our artillery and our organization should not be based on them.

The Headquarters detail in the batteries, battalions, regiments and brigades have been enormously increased in order that command, supply, liaison and communication may properly function. We have a tremendous overhead in the new brigade organization. We find that there are 71 men of all ranks per gun served (3400 ÷ 48).

If we make the necessary additions in personnel to serve and supply six gun batteries, we find that it takes only 48 men per gun.

We get an increase of 50 per cent. in fire power with an increase of only 23 per cent. in personnel. And mark that this increase in personnel is in grades, comparatively easy to train; in lieutenants, sergeants, corporals and privates. No increase is required in Brigade, Regimental, Battalion or Battery Commanders, which of all the personnel, are the most difficult to train.

With our pre-war conception of Artillery fire, rapid adjustment, rapid fire for effect, involving the quick sensing of bursts, and shifting and manipulating the sheaf of fire, it may be that one man cannot properly conduct the fire of six guns. Note that the British, with artillery technical methods inferior in the above respect to ours, successfully handled six gun batteries in all phases of the war.

Because of the large population of our nation, it may be said that we are not interested in saving man power. This is true unless we qualify the word "man power." If we say "trained man power," there is, due to our national policy of unpreparedness, no nation which must be more careful to conserve its trained man power.

The pre-war conception that the six-gun battery was not sufficiently mobile, must be denied. How often during the war was occupation of position, or movement forward, affected by the factor of four guns rather than six?

While the American Artillery was in defensive sectors, it manned old French 90's and 95's. In our offensive we took captured German guns and fired them. We wanted more guns.

The Germans started the war with six-gun batteries and changed to four. Why? Because they increased the number of their Divisions and had to have artillery with each Division. They were short in matériel and man power (and note that this shortage in man power was essentially a question of numbers, not of *training*). Their Divisional Artillery consisted of three battalions of three batteries each (two battalions of 77's and one battalion of light Howitzers). The only logical way to make a forced reduction was in the number of guns per battery.

To sum up: The question of six-gun batteries is obviously of importance. So far it has been dismissed on pre-war arguments. Whether it will eventually prove worthy of acceptance or not, it should be carefully considered.

C. ORGANIZATION OF COMMAND IN THE ASSIGNMENT OF FIRE MISSIONS.

Let us suppose a Division is deployed for the attack with its Infantry Brigades abreast, the Regiments within Brigades abreast, and the Battalons within Regiments in column.

The missions of the Divisional Artillery are: (1) To prepare the

way for the Infantry; (2) to accompany it with fire; (3) and when the Infantry advance ceases, to protect it with fire.

The Preparation

Within the enemy's lines in our Division sector of attack are certain areas and targets upon which the artillery should fire during the preparation.

Artillery fires on some of these areas and targets are of importance to the Division Commander, depending on the scheme of manœuvre for the two Brigades. Artillery fires on other of these areas and targets while not essential to the scheme of manœuvre of the Division are, however, of importance to an Infantry Brigade Commander, depending upon his plan of manœuvre for the two Regiments. Still other areas and targets, though not of importance to the plan of manœuvre of the Infantry Brigade, are of importance to the advance of the Infantry Regiments.

During the World War the usual mechanism by which the artillery put down the preparatory fires above described was as follows:

Artillery Brigade Headquarters selected such areas and targets as were thought important and assigned them to the Regiments, with directions that so much fire be put down on them at such and such times. In other words, the entire system of preparatory fires was ordered from Brigade Headquarters. The Artillery Regiments and Battalions were usually so burdened with the execution of these fires that they had no guns available to execute any other fires.

If it chanced that the Artillery Brigade had itself ordered fires to be delivered on areas and targets which were of importance to the scheme of manœuvre of the Infantry Brigades and Regiments, the system of fire command described above was well and good.

When the time available for the preparation of plans of fire action is short, such a system of fire command has its weaknesses; Artillery Brigade Headquarters is in close contact with Division Headquarters, and therefore can find out the scheme of manœuvre of the Division and "dope out" the proper fire support essential to this scheme. But Artillery Brigade Headquarters is not in close contact with the Infantry Brigade and Regimental Headquarters, and, if considerable time is not available, cannot find out the scheme of manœuvre of the Infantry Brigades and Regiments, and therefore cannot properly "dope out" preparatory fires which will assist these schemes.

Artillery Regimental and Battalion Headquarters *are* in close contact with the Infantry Brigade and Regimental Headquarters, respectively, and can find out their schemes of manœuvre and

therefore properly "dope out" preparatory fires which will assist these schemes.

Would it not be better then:

1. For Artillery Brigade Headquarters to assign only a few targets to the Regiments (*i.e.,* those on which preparatory fires will assist the scheme of manœuvre of the Division), and for the rest content itself with an assignment of zones of action to the Artillery Regiments together with an indication of the amount of ammunition to be expended?

2. For the Artillery Regimental Headquarters in turn to assign only a few targets to the Battalions (*i.e.,* those ordered by Artillery Brigade Headquarters and those on which preparatory fires will assist the scheme of manœuvre of the Infantry Brigade), assigning zones to the Battalions?

The Artillery Battalions have available all information in possession of the Artillery Brigade and Regimental Headquarters and being in close contact with the Infantry Regimental Commander, have an intimate knowledge of how the Regiment is going to manœuvre, and can therefore "dope out" to better advantage the proper preparatory fires.

Accompanying Fires

During the war these were ordered practically in their entirety by Artillery Brigade Headquarters. Would it not be better to employ a mechanism of command similar to that used in selecting the preparatory fires, *i.e.,* 1. to assign sectors to the Artillery Regiments (coinciding with the zones of action of the Infantry Brigades), the Regiments in turn assigning sectors to the Battalions (coinciding with the zones of action of the Infantry Regiments)?

2. For the Artillery Brigade and Regimental Headquarters to order only those fires which are necessary to the scheme of advance of the Division and Brigade as a whole, leaving to the Artillery Battalions to work out their own accompanying fires?

This mechanism of ordering accompanying fires has the advantage that (as discussed under preparatory fires) the Artillery Battalion Commander has all the information available at his Brigade and Regimental Headquarters, and has additional information as to the plans of the Infantry.

When we consider that Infantry acts by *fire and movement*, it would seem that we in the Artillery must make our plans of fire to conform with the plans of the Infantry for fire and movement.

The objection may be raised that the scheme suggested might result in an Artillery Battalion delivering fire which would be dangerous to troops in attack zones adjoining that of the Infantry in which the Artillery Battalion is in close support. It is obvious that proper

care must be exercised in this respect regardless of the Artillery Headquarters which works out the plan of accompanping fires. There is no reason why the Artillery Battalion Headquarters should not be as capable as Artillery Brigade Headquarters of exercising this care—it has available the time table of Infantry advance and is in closer touch with the subordinate Infantry units.

If the Artillery Battalions are permitted to make their own plans for the employment of fire, it will result that the batteries will have their fire missions assigned to them sooner than would be the case with the other system where all would have to wait until Brigade Headquarters had completed its plan and until the Regiments had in turn reassigned missions to the Battalions. This is no small advantage, as any subordinate commander who during the war feverishly waited for his fire missions can testify. Incidentally a more thorough study of the terrain and enemy organization would result, for each the Battalion Staff would have to study only the terrain and enemy organization in its own sector, approximately one-fourth that of the Division.

The proposal should not be taken as suggesting that the artillery is to be parcelled out to the Infantry, thus losing unity of command. The Artillery Brigade (and Regiment in turn) issues such fire missions as it desires.

Now there is nothing new in the above proposal for decentralization in the mechanism of assignment of fire missions; it is the system outlined in our Drill Regulations. The subject is dwelt upon at such length because the "centralized" method was used by most brigades in France. We adopted the methods used by the French with whom the "centralized" method was in vogue, due probably to the influence of staged attacks where plenty of time was available.

D. MIXED BATTALIONS OF 75'S GUNS AND 105 HOWITZERS.

The new Tables of Organization state that when the 105 Howitzer shall have been developed, one regiment of them is to be added to the Divisional Artillery Brigade. The proposal is made that a better organization would be obtained by incorporating these Howitzer Batteries within the existing Battalions of 75's. Technical training would perhaps be easier with the Howitzers organized into a regiment. The arguments in favor of the mixed battalions are based on the tactical and technical employment of Divisional Artillery. To a brief review let us now turn:

Let us suppose an attacking Division to be deployed Brigades abreast, Regiments within Brigades abreast with Battalions in column. How will our Divisional Artillery Brigade supporting it (to include a 105 Howitzer Regiment of three Battalions of two batteries each) be organized to support the attack? The almost stereotyped procedure

would be for one regiment of 75's and one battalion of 105's to be assigned to the support of each Infantry Brigade, the 3rd battalion of 105's being held under the direct command of the division commander. The one regiment of 75's and one battalion of 105's assigned to support each Infantry Brigade might be grouped under the command of the colonel of the 75 regiment, so that the Infantry Brigade Commander would have but one artilleryman to deal with. During the preliminary stages of the attack one 75 battalion might be assigned to each infantry regiment. Now the mission of the Divisional Howitzer differs from that of the gun only in the type of targets attacked. The Howitzer is needed: (1) to reach deeply defiladed targets which cannot be reached by the 75; (2) to attack targets too strong for the 75; (3) for counter-battery when corps artillery is not available. As we have seen in the foregoing discussion on the mechanism of command in the assignment of fire missions the commander of the 75 battalion in support of each Infantry regiment should be permitted to select fire missions for the batteries of his battalion. He will find some missions requiring Howitzer fire. In order to get this Howitzer fire he must apply to his regimental commander, who may in turn order the commander of the Howitzer Battalion under his command to deliver these fires. When the attack shall have advanced a certain amount, it will be necessary to move forward some of the artillery—let us suppose one battalion in each group. During the time that this battalion is on wheels going to its new position the remaining artillery of the group must cover the front of the entire infantry brigade. When the displaced battalion occupies its position it will probably be time for the remainder of the group to move forward. The advanced artillery battalion must then cover the front of the entire Infantry Brigade. If a front line Infantry Battalion requests artillery fire and the particular mission necessitates Howitzer fire, the commander of the advanced 75 battalion must relay the request to his Regimental commander, who may order the Howitzer Battalion grouped under his command, to deliver the fire. At some time or other as the attack progresses the 105 Howitzer Battalions must be displaced to the front. This displacement will ordinarily be carried out by battalion (as with the 75's) in order that road traffic, etc., may be properly coördinated. Let us suppose that an Infantry front line battalion requests artillery fire which necessitates a Howitzer for its execution, and that the Howitzer Battalion of the artillery group in support of this front line Infantry is on wheels displacing itself to the front. The request for fire would have to be forwarded from the commander of the advanced 75 battalion to the group commander, who in turn would forward it to the Artillery Brigade

commander, who might order one of the other Howitzer Battalions to execute the fire.

Let us now consider our proposed mixed battalions, containing both 75's and 105's, with two of these battalions forming a regiment, and two regiments composing the brigade.

With such an organization the artillery preparation could be worked out by each artillery battalion commander so as to best fit the scheme of Infantry manœuvre. This battalion commander would have immediately under his command the Howitzers needed for fire missions requiring their fire.

Especially during the advance of the attack would such an organization be advantageous. Requests from front line Infantry for Artillery fire necessitating Howitzers for its execution could immediately be satisfied without application to higher authority.

In case Artillery Brigade Headquarters desires, for any reason, to control the details of Howitzer fire, it can be done with the proposed organization as easily as with the Howitzers organized in a separate regiment.

Perhaps technical training would be better with the Howitzers organized in a separate regiment. Just as the Infantry has now put the machine guns within the Infantry Battalion instead of in separate battalions, so with the light Howitzers technical considerations must give way to those of a tactical character.

To sum up: It is proposed that the light battalion consist of two batteries of 75 guns and one battery of 105 Howitzers, all batteries of six guns (or Howitzers) each. The regiments to consist of two of these Battalions with the necessary increase over the present light regiment in Headquarters and Supply Organizations and in the Battalion Combat Trains. The brigade to consist of two regiments.

The following advantages are claimed:

1. Better tactical coördination with the infantry.

2. The same fire power as with the Brigade, consisting of two regiments of 75's and one regiment of 105's, with a saving in personnel of approximately 25 per cent., the personnel saved being the personnel difficult to train, *i.e.*, Regimental and Battalion Commanders and their Staffs. In addition to the actual number and quality of the personnel saved there it should be considered that the training of the headquarters staffs of the Howitzer Regiment and its three Battalions would be done away with.

This saving in personnel is important from two considerations. We will always be short of trained personnel. The saving in personnel results in less transportation and difficulty of supply. This affects the supply trains of the Division and the Corps with a resulting effect extending even to the S.O.S.

3. Saving in communications. The vital importance of reducing these is obvious. The proposed organization would do away with the communications system of a whole regiment (the Howitzer Regiment), and necessitate no additional communications within the two regiments.

4. Saving in equipment.

(1) The entire signal equipment of one regiment would be saved (33 per cent. saving).

(2) The entire fire control equipment of one regiment would be saved (33 per cent. saving).

The disadvantages are obviously that the large batteries and battalions will be more difficult to command and to manœuvre and the minor difficulty of technical training.

II. MATÉRIEL AND AMMUNITION

Radio for Field Artillery

That great developments are being made in radio is a matter of common knowledge. Briefly, these developments, as affecting Field Artillery, are:

a. Increased reliability.

b. Increased compactness and portability.

c. Increased ability to avoid "interference" (permitting a larger number of sets to operate in a small area).

d. Increased simplicity of operation.

e. Increased ruggedness of sets.

Although these developments in radio will render it of enormous value to the Army as a whole, it is believed that it will be of especial and utmost importance to the Field Artillery in particular—especially to the Divisional Artillery. It is believed that the greatest problem of Divisional Artillery will be solved by the aid of Radio; *i.e.,* the accompanying of the infantry with fire.

Let us investigate how this may be.

We may picture an Army of any size we choose, deployed for the attack. Each front line Infantry Battalion can be accompanied by an Artillery Officer (or officers) with personnel for scouting, for the preparating and observation of fire, and the necessary personnel operating a radio set in communication with a radio set at the Battalion (Artillery) position.

This detail observes the Artillery fire in front of the Infantry Battalion. By radio communication it shifts this fire, backwards and forwards, to the right or left, to where it will be most effective. Assume, for example, that an accompanying barrage is being delivered, and is getting away from the Infantry. It can be called back to where it belongs. If the observer with the Infantry is in doubt

as to which part of the barrage his Battalion is firing, he can, by radio, call for Battery "A" to fire several rounds of smoke rapidly—then Battery "B"—then Battery "C." He can distinguish the fire of his Battalion and can adjust it.

By similar methods fire can be concentrated on points dangerous to the Infantry.

In a word, we will have all of the Artillery "accompanying," with none of the disadvantages of the present accompanying gun or battery.

A similar discussion can be made of the influence of radio in defensive operations.

It is believed that radio material capable of functioning, as described above, will be in production in, at the outside, five years.

The Field Artillery should prepare itself to use this highly developed radio. This preparation will consist in, not so much the technical training of operators, as in the training of all Field Artillery Officers in the methods involved (Tactical use).

In addition there should be a Radio School through which a large number of younger officers should be sent. This school should teach the theoretical and practical operation of the sets, and the tactical employment of the sets.

There should also be a course for enlisted radio operators—the instruction covering the practical operation of the sets and the tactical employment.

The tactical employment noted above will involve manœuvres on a larger scale (Army). These manœuvres, during the formative period of instruction (first few years), would involve only the radio and other personnel mentioned above. (Troops need not participate.)

That this training will be a matter of some time (several years) is obvious. (Consider how long it took for a simple matter like the "P-T" system of computing firing data to be promulgated through the entire Field Artillery.)

In addition to the above points there are other features. It is believed that in addition to being a powerful agency for the control of fire, that this developed radio will, in connection with the increased ranges expected for new guns, result in somewhat radical changes in the tactical employment of Field Artillery.

For example:

Let us consider the offensive employment of artillery in a meeting engagement. With the facilities for communication that we have today, it is impracticable to obtain a great deal of artillery fire during the early stages of the combat (to support the advance guard, for instance). The artillery in the main body must push rapidly to the front in order that the positions occupied may be suitable to support the continuations of the attack.

With a highly developed radio some of the artillery with the main body could occupy positions almost immediately and open fire controlled by observation officers far to the front by means of radio. (This occupation of position by part of the artillery of the main body as described above would be a preliminary measure—naturally these positions would be too far to the rear for the support of the main attack—in the usual case such a preliminary occupation would not delay the eventual occupation of position, this because of road congestion.) Time consumed in selection and occupation of position would result in delays which we merely take advantage of to fire instead of halting or moving slowly.

Another example. During the attack our artillery must displace itself forward because it becomes out of range and because it loses connection with the infantry that it is supporting. This displacement to the front is exceedingly difficult. We can rarely get forward all the artillery we want, due to road congestion. The long range hoped for in new weapons will of itself give us little relief for communications between the infantry and artillery, in their present stage of development do not permit of effectively employing long-range fire. We will therefore find our artillery displacing itself to the front long before it has lost range merely in order to maintain contact with its infantry. A perfected radio will permit of effectively employing our artillery to the limit of its range, thus postponing the displacement to the front of some of the artillery. This question of displacement to the front is one of the most difficult tactical problems of the artillery. The solution of the problem using radio does not imply any lack of aggressiveness; some of the artillery will move forward as it does now. It merely means that the artillery which we now cannot get forward can effectively be used.

To sum up: It is believed that radio is of the utmost importance to the Field Artillery and that every effort should be made to develop its technical and tactical employment as soon as possible.

A HEAVIER SHRAPNEL BALL

There is a very strong feeling in the Field Artillery that shrapnel has lost the importance we formerly assigned to it. Now shrapnel fire, when properly adjusted, is so much more effective than shell, that the question is a most serious one. The 75 shell covers an area of 5 yards deep and 15 yards wide. The properly adjusted shrapnel covers an area of approximately 25 yards wide and 125 yards deep. (These figures are larger for short ranges and smaller for long ranges.)

In spite of the acknowledged greater effect of shrapnel the American Artillery used very little during the World War. During the last phase of the Argonne-Meuse operation, the First Army Artillery

Headquarters were compelled, due to a shortage of shell, to force organizations to draw 25 per cent. of their ammunition in shrapnel. A considerable part of this shrapnel, although drawn, was not used, in spite of the fact that special instructions were issued from Army Artillery Headquarters insisting on the use of more shrapnel. The French used comparatively little shrapnel and according to Marshal Ludendorf's book the Germans gave it up almost entirely.

The reasons which lead to the shrapnel being abandoned in favor of the shell are not difficult to find. Shell is more effective against personnel covered by trenches. During the long period of stabilization battery officers lost their facility for handling shrapnel. Furthermore, most of the German, French and also American officers who had pre-war training in shrapnel shooting were casualties or promoted beyond Battery Officer rank. The new officers had insufficient instruction in shrapnel shooting. The British, on the other hand, did use shrapnel a great deal. Until late in the war the British did not have very much shell (it will be recalled that Lord Kitchener refused to change the proportion of shell and shrapnel to be manufactured and it was not until after his death that a change was accomplished). The new officers were thus forced to learn how to shoot shrapnel. But in 1918 the British had all the shell they wanted. However, they still used enormous quantities of shrapnel with their light field gun of 3.8 inches calibre, employing it even in the first line of the accompanying barrage in preference to shell. The British fired these barrages with zero height of burst (having made all atmospheric, ballistic and topographical corrections), maintaining that although half of the rounds were thus lost in the ground that the remaining half gave more effect than would have been obtained by a shell barrage. The weight of the British shrapnel ball is not more than the weight of the French shrapnel ball. It is possible that the balls have a bigger initial velocity than shrapnel balls of a 75 shrapnel, due to the larger bursting charge which may be contained in the 3.8 case as compared to the charge which may be contained in a 75 case. Of course this greater initial velocity would result in comparatively high bursts still being effective.

The great difficulty in shooting shrapnel is in getting the proper height of burst. This difficulty may result from the poor training of the officer conductng the fire or from lack of observation (at night, during fog, etc.). If we can get a shrapnel that will still kill even with high bursts (the German 105 shrapnel did) the difficulty will be largely solved. It would seem that a heavier shrapnel ball which would retain its initial velocity longer would help. Also an increase in the bursting charge. The number of shrapnel balls would perforce be diminished and under perfect conditions such a shrapnel would not be as effective as the present shrapnel. Would it not, however,

be enormously more effective than shell? Such a shrapnel could be fired by comparatively inexperienced officers and would be effective at night and during fog, etc.

The question seems on the face of it interesting enough to warrant the expenditure necessary to manufacture enough shrapnel of the proposed type with which experiments as to its value could be made.

Reproducing Apparatus

In issuing plans and orders for artillery fire a great many duplicate tracings are required. These take time to make which can ill be spared, as it shortens the all too limited time available to the batteries for the preparation of the fires called for by the plan.

A quick and accurate method should be devised whereby, when one copy or tracing is available, duplicates can be turned out very rapidly. The gelatine and "cyclostyle" methods do not fill the bill. Some sort of chemically prepared sensitized paper would be more accurate and rapid.

Headquarters Equipment

All Headquarters should have suitable equipment in which to establish a Command Post. In France a ruined house, a cave or a dugout was usually available. In our country we cannot count on these conveniences. The essentials of such equipment are: A lighting system (candle lanterns are not sufficient—oil lamps would do); folding tables; and cover of some sort. It might be possible to use escort wagons for this purpose, the interior being arranged with the necessary brackets, so that when the equipment forming the ordinary load of the wagon has been removed, tables could be set up. Or, if this is not practicable, tentage must be supplied.

Officer's Equipment

At the Front in France an officer could draw clothing, shoes, underclothing, socks, shirts, etc., just as could an enlisted man. This policy should be continued, not only as a convenience to the officer, but essentially because the officers' baggage can then be kept down to a reasonable limit. This is a very difficult thing to do if officers have to carry everything into the field that they may need during a campaign.

III. TRAINING

Our principal pre-war weaknesses in training were, broadly speaking: 1. Few or no manœuvres with the Infantry. 2. No field officer training. 3. No Artillery Staff Training. 4. No training of the Infantry Commanders, nor of General Officers in what they should know about artillery.

1. Manœuvres with the infantry needs no comment.

2. Field Officer's Training. While our pre-war training as Battery Commanders and as Battery Officers was excellent, training as Field Officers did not exist. A pre-war Artillery Field Officer was, in so far as training is concerned, a glorified Battery Commander. During the war we had no field officer training worthy of the name. Leaving out of consideration the Artillery Brigades which were sent to France in 1917, the average artillery field officer learned his duties at the Front as best he could. Now this self-training received at the Front varied according to the particular experiences undergone. The lessons of these experiences should be mulled over and consolidated before the details on which they are based have faded from memory. In other words, our Field Officers' School should have started functioning as soon as possible after the armistice with the student personnel, consisting of the officers who made the best record as Field Officers during the war, with the idea not so much of teaching them to be Field Officers, as of consolidating their knowledge to be passed on later to those who do need the instruction.

3. Artillery Staff Training. This also did not exist before the war, nor to all practical intents and purposes, during the war. Artillery Staff Officers learned their duties at the Front. Their experiences and the lessons gained therefrom should be consolidated before forgotten. It would seem that this Staff Officer instruction, in so far as the subordinate Staffs are concerned (to include the Divisional Artillery Brigade Staff), should be given during the so-called Battery Commanders' course at Fort Sill. Certainly the Basic Course at Camp Knox is no place for it for various reasons. Some service with troops should precede instruction in staff duties. Furthermore, Staff Training involves instruction in Tactics and an inexperienced officer, although interested in technic, is not interested in Tactics. On the other hand, an officer undergoing Field Officer Training should already know staff duties, because he should be learning how to handle the Battalion, the Regiment and the Brigade, and not learning how to be an Operations or Intelligence officer.

4. Training of Infantry Commanders and of General Officers in what they should know about artillery.

In no other way will there ever be *coöperation* between the infantry and artillery, except as a result of proper training not only of the artillery, but also of the infantry commanders. It certainly would pay to keep some very fine artilleryman at the Infantry Schools at Benning, to give such instruction as the Commandant of the Schools desires. There remains the instruction of General Officers. The Leavenworth Schools give instruction in artillery to a student personnel, a large number of whom will some day be General Officers. In the meantime those who are now General Officers should have an opportunity to learn what they should know about artillery. The

French early in the war perceived the importance of this instruction of General Officers in artillery. During the war a "Centre of Artillery Studies" was started, with this instruction as one of its main purposes. In the summer of 1919 this centre resumed functioning with a three months' course. (The wartime course being three weeks.)

A Consolidated Field Artillery School

At present the three courses of instruction for Field Artillery Officers, the Basic Course, the Battery Commanders' Course, and the Field Officers' Course, are given at three separate schools at Camp Knox, Kentucky, at Ft. Sill, Okla., and at Camp Bragg, N. C. It is proposed that these courses be given by a consolidated school at one camp or post. The advantages of such a consolidation are: 1. Coördination of instruction and training. 2. Economy in overhead personnel, Matériel, including animals, and school buildings.

At the present time the feature of poor coördination which is bound to result with separate schools is not apparent.

The Battery Commanders' Course at Ft. Sill necessarily includes instruction in subjects covered in the Basic Course, because the student personnel taking the Battery Commanders' Course has not previously taken the Basic Course. Similarly the Field Officers' Course at Camp Bragg will, during its first courses, necessarily have to cover ground which is covered in the lower schools, because the student personnel (especially field officers transferred from other arms) will not have previously been instructed in the subjects covered in the lower schools. Eventually, however, the students taking the Field Officers' Course and Battery Commanders' Course will have taken the lower courses. Coördination of the courses will then be very important and cannot be efficient unless the schools are under one head and at the same place.

The problem of three separate school regiments and detachments, of three sets of all types of matériel and of buildings is a serious one. None of the three schools has at present a riding hall, nor is there any prospect of getting one for each school. The temporary buildings at present used by the schools will not last forever, and it is doubtful if Congress can ever be persuaded to appropriate money to build three new plants.

All three of the schools, whether separate or combined, should be situated in a locality where outdoor work all year round is feasible; plenty of varied terrain should be available, and the strategic situation should be such that the locality would not have to be abandoned in case of any probable war.

Fort Sill's wintry blasts and its excessive summer heat cannot fail to influence the quality of training. Camp Knox is not suitable

for efficient all year round work. Only approximately half of the acreage at Camp Knox can be used in firing, this because of the relative location on the terrain of the highways and the camp buildings. Camp Bragg has a comparatively equable climate, a soil which does not become muddy, and a large acreage of varied terrain. If its location is strategically good, it would seem to be the ideal place.

As an argument against the consolidation of the three schools, it has been stated that one of the courses would suffer to the profit of others. If we followed this line of reasoning to the bitter end we would establish separate and distinct schools to give the instruction of each of the four or more departments of each of the three schools. As a matter of fact the present scheme violates a basic principle of organization in the case of at least one of the schools. This particular school is located at a station where there is also a Brigade of Field Artillery. The Brigade Commander is also the Commandant of the School. He is responsible to his Corps Area Commander for the efficiency of the Artillery Brigade, and to the Chief of Field Artillery for the efficiency of the Field Artillery School. This divided responsibility is a violation of the fundamental principles of organization.

Another element enters into consideration of the proper organization of the schools. There should be infantry available for the work in all three courses. If Infantry units can be provided for three separate schools all well and good; if not it is a strong argument in favor of a consolidated school.

IV. MOBILIZATION

Reserve Officers

Would it not be a good thing for the artillery to confine its R. O. T. C. functions to technical (engineering) schools, to the exclusion of the ordinary college? The instruction in these schools in Mathematics, Surveying, Electricity, Chemistry, Mechanics, etc., covers the basic education needed by the artilleryman better than does a liberal arts course.

Specialists

A careful system should be worked out whereby artillery units (and those of other arms also) get their share of specialists, such as tailors, stenographers, telephone men, surveyors, etc. In the last war the telephone men went to the Signal Corps, the surveyors to the Engineers, the shipping clerk to the Quartermaster Corps. The artillery needs these men just as much as the other arms do.

V. TECHNICAL METHODS AND TACTICS

The introduction of new weapons or even an improvement in a weapon is but preliminary to its proper technical and tactical use. After all very little entirely new equipment was developed during the World War. The war's beginning saw the employment of long range, high-powered cannon, of machine guns, of airplanes. It took four years of war to develop their proper technical and tactical use.

Since the war a great many improvements in equipment have been made. Self-contained mounts, longer ranged guns, improved radio, better gas, etc. These improvements will inevitably result in changed technical methods and tactics.

Now the larger the body of officers available the better will be the thought given to these subjects. Naturally in a larger body of officers we find more mentalities capable of this thought. Furthermore, with a small officer personnel, since all have their noses kept to the grindstone of routine business, an overhead of experimenters and investigators cannot be large. The larger the officer personnel, the larger the overhead concerned in investigation, maybe. For this reason, as well as for others, it seems that the Field and Coast Artillery should be combined (the functions of coast defense being eliminated from the arm thus formed).

This proposal is made with a keen realization that it will not meet with popularity.

When one looks at the new organization tables and sees the Field Artillery furnishing the personnel for some units, and the Coast Artillery the personnel for other units of our Field Armies, one cannot fail to be struck with the inefficiency of such a scheme, with the lack of coördination in training and in methods which will inevitably result.

After all are not most of the arguments against such a consolidation really based on the jealousies of politics—Army politics—while we forget that we are primarily army officers, and only secondarily field or coast artillerymen?

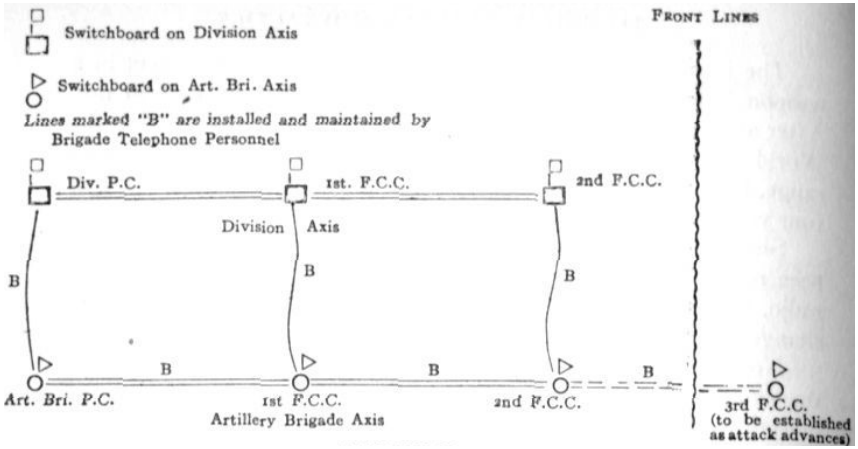
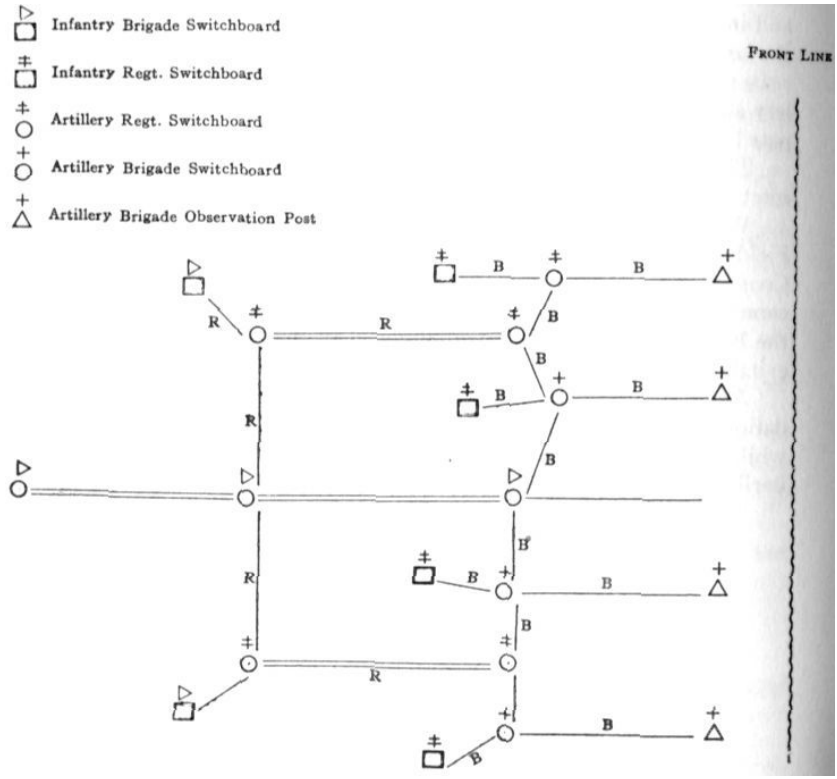


DIAGRAM No. 4



Note: Lines marked R are laid and maintained by the Art. Regt. Communications Personnel
" " B " " " " " " " " Bri. " "

DIAGRAM No. 5

REPORT ON FIELD TRAINING OF THE FIELD ARTILLERY OF THE NATIONAL GUARD

WAR DEPARTMENT MILITIA BUREAU, WASHINGTON

October 13, 1921

FROM: Director of Field Artillery, National Guard.
To: The Chief of Field Artillery (through the Chief, Militia Bureau).
SUBJECT: Field Artillery, National Guard.

1. The following information pertaining to the Field Artillery of the National Guard is furnished at this time as the field training for the fiscal year 1922 has been completed, and it is now possible to form a fairly intelligent opinion as to the effectiveness of units already organized.

2. The table below shows the organizations which attended a training camp during the summer of 1921 for a period of fifteen days:

FIRST CORPS AREA

Organization	Place	Dates	Present Officers	Present Men	Regular Army Units Assisting Instruction
Massachusetts					
101st F. A.					
Hq. & Hq. Btry.	W. Barnstable, Massachusetts.	July 16-30	5	47	Instructors and Sgt. Instructors
1st Battalion	W. Barnstable, Massachusetts.	July 9-23	18	337	
2nd Battalion	W. Barnstable, Massachusetts.	July 23-Aug. 6	17	354	
102 F.A.					
1st Battalion	W. Barnstable, Massachusetts.	Aug. 6-20	22	438	
2nd Battalion	W. Barnstable, Massachusetts.	Aug. 20-Sep. 3	21	357	
			83	1533	
Connecticut					
Battery A, 1st F.A.	Camp Devens, Mass.	June 11-25	5	107	Instructors and Sgt. Instructors
Rhode Island					
Battery A, 1st F. A.	Quonsett Pt., R. I.	June 16-30	4	81	Instructors and Sgt. Instructors

SECOND CORPS AREA

New York

Organization	Place	Dates	Present Officers	Present Men	Regular Army Units Assisting Instruction
104th F.A.	Camp Welsh, N. Y.	Aug. 7-21	34	666	6th and 7th F.A.
105th F.A.	Camp Welsh, N. Y.	July 10-24	41	506	6th and 7th F.A.
106th F.A.	Pine Camp. N. Y.	June 12-27	13	396	Instr. & Sgt. Instr.
258th F.A.	Camp Welsh, N. Y.	Aug. 14-28	35	622	6th F.A.
			123	2190	

New Jersey

1st Bn., 1st F.A.	Camp Welsh, N. Y.	July 24-Aug. 7	18	275	6th and 7th F.A.

THIRD CORPS AREA

Maryland

Btry. B, 1st F.A.	Saunders Range, Maryland	July 17-31	No report received.		

Pennsylvania

103d Am. Train	Tobyhanna, Penna.	Aug. 6-20	3	62	1st Bn., 19th F.A.
176th F.A.	Tobyhanna, Penna.	Aug. 6-20	45	592	1st Bn., 19th F.A.
107th F.A.	Tobyhanna, Penna.	July 9-23	42	748	1st Bn., 19th F.A.
108th F.A.	Tobyhanna, Penna.	Aug. 6-20	35	533	1st Bn., 19th F.A.
109th F.A.	Tobyhanna, Penna.	July 23-Aug. 6	43	506	1st Bn., 19th F.A.
			168	2441	

FOURTH CORPS AREA

Georgia

Officers only attended	Camp Jackson, S. C.	August 10-24			19th F.A.

Louisiana

Battery A	Camp Jackson, S. C.	July 25-Aug. 8	4	98	19th F.A.

FIFTH CORPS AREA

Ohio

134th F.A.					
Battery B & F	Camp Knox, Ky.	Field Inspections yet received.	Reports not		81st F.A.
135th F.A.					

Indiana

181st F.A.	Camp Knox, Ky.	Aug. 9-23	48	810	2d F.A. & 81st F.A.

SIXTH CORPS AREA

Illinois

1st F.A.	Camp Grant, Ill.	Aug. 11-25	24	360	3d F.A.
2nd F.A.	Camp Grant, Ill.	Aug. 11-25	17	276	3d F.A.
Bn. Hq. & Btry B. 3d F.A.	Camp Grant, Ill.	Aug. 26-Sept. 9	8	59	3d F.A.
			49	695	

Michigan

Organization	Place	Dates	Present Officers	Present Men	Regular Army Units Assisting Instruction
119th F.A.	Grayling, Mich.	Aug. 5-21	24	391	Instr. & Sgt. Instr.

Wisconsin

107th Am. Train	Camp Douglas, Wis.	July 25-Aug. 6	3	64	Instr. & Sgt. Instr.
120th F.A.	Camp Douglas, Wis.	July 25-Aug. 6	38	388	Instr. & Sgt. Instr.
121st F.A. (S.Btry & Btry.E)	Camp Douglas, Wis.	July 25-Aug. 6	8	142	Instr. & Sgt. Instr.
			49	594	

SEVENTH CORPS AREA

Missouri

1st F.A.	Camp Knox, Ky.	Aug. 29-Sept. 11	23	388	2d & 83d F.A.

Iowa

Btry. A & B	Camp Knox. Ky.	July 25-Aug. 8	17	194	2d F.A.

Kansas

1st F.A.	Ft. Sill, Okla.	Aug. 14-28	38	513	1st, 9th & 14th F.A.
Btry. A, 2d F.A.	Ft. Sill, Okla.	Aug. 14-28	4	54	1st, 9th & 14th F.A.
			42	567	

Minnesota

1st F.A. Battery A. 2d F.A.	Ft. Snelling, Minn.	Aug. 26-Sept. 9			Instr. & Sgt. Instr.

Field Inspection Reports not yet in.

EIGHTH CORPS AREA

Oklahoma

1st F.A.					
Battery A,	Fort Sill, Okla.	July 10-24	3	72	1st, 9th & 14th F.A.
Battery B,	Fort Sill, Okla.	July 20-Aug. 9	4	60	1st, 9th & 14th F.A.
Btry C & D,	Fort Sill, Okla.	Aug. 13-27	8	131	1st, 9th & 14th F.A.
2d F.A.					
Battery A,	Fort Sill, Okla.	July 10-24	4	74	1st, 9th & 14th F.A.
Battery B,	Fort Sill, Okla.	July 26-Aug. 9	4	66	1st, 9th & 14th F.A.
			23	403	

New Mexico

Battery A	Field Inspection Report not yet received.				

Arisona

1st F.A.					
Btry. A & B,	Fort Bliss, Tex.	Aug. 21-Sept. 6	7	138	82d F.A.

NINTH CORPS AREA

Washington

Organization	Place	Dates	Present Officers	Present Men	Regular Army Units Assisting Instruction
146th F.A.	Camp Lewis, Wash.	July 16-30	42	640	16th & 77th F.A.
		Oregon			
Battery A	Camp Lewis, Wash.	June 15-27	3	57	16th & 77th F.A.
		Utah			
1st F.A.					
1st. Bn.,	Camp Lewis, Wash.	June 15-27	15	291	16th & 77th F.A.
		California			
1st F.A.					
Battery B	Camp Lewis, Wash.	Sept. 4-18	4	85	16th & 77th F.A.
Battery E	Camp Lewis, Wash.	Sept. 4-18	4	87	16th & 77th F.A.
			8	172	

The average present at camp in batteries was 4 officers and 82 enlisted men.

3. At all of the above-mentioned camps the batteries had service target practice except at Camp Devens, Massachusetts, Quonsett Point, Rhode Island, Camp Grant, Illinois, and Fort Snelling, Minnesota. In most cases the ranges were suitable for elementary practice and no other was attempted, the number of rounds fired varied with the state of preparedness of the batteries but in no case exceeded 200 rounds of shrapnel and 100 rounds of shell per battery, the allowance fixed by the Militia Bureau, and which for the present seems ample.

4. In a number of cases entire regiments and lesser units arrived in camp well qualified in every respect to function by themselves and proceed with the prescribed schedules of instruction, but in a large number much valuable time had to be spent by the instructors in teaching elementary details which should have been thoroughly covered at home stations during the armory training, the serious weakness was in gun drill, harnessing and draft; some of this is due to lack of equipment, recent organization and lack of proper armory facilities, but in several instances due to lack of interest or ability of the officers to give proper instruction at home stations; this last feature is one which it is hoped will soon be eliminated and has been commented upon by the inspectors in a number of the Inspection Reports. In some States remedial action has already been taken by the State authorities.

5. The state of training of Headquarters Batteries and Battalion Headquarters Detachments upon arrival at camp was below what it should have been in every organization, even in comparatively old ones. This feature was disappointing as it had been hoped that the experiences in war had shown the officers the vital necessity of having highly trained specialists. All instructors had been urged to place

great stress on this training but seemed to fail in getting thorough results; however, in most instances fine progress was reported while at camp.

6. With one or two exceptions the Field Inspections Reports showed most gratifying results and in some instances the progress made was quite remarkable, the predominating feature throughout all reports with the exception of those mentioned above was the enthusiasm, interest and desire to learn by both commissioned and enlisted personnel. The coöperation given the instructors by the National Guard officers left nothing to be desired in this respect except in one State.

7. In a large number of instances letters have been received from Regular officers of long service praising the state of efficiency and enthusiasm displayed by the National Guard Field Artillery and expressing surprise at the progress made by comparatively new organizations.

8. From every camp where Regular Army Field Artillery assisted in the instruction letters have been received from the State Adjutants General or individual commanding officers praising the assistance and coöperation given by the Regular troops. It is very evident that most cordial relations and mutual respect has been found between the Regular Army and National Guard Field Artillery wherever they have been thrown together this last summer.

9. I am firmly convinced that at all training camps for Field Artillery National Guard regular batteries should be present not only to assist in training, but as a matter of economy in being able to furnish matériel and horses to a great extent, thus saving enormous freight charges for shipment of same from the home stations of the Guard batteries, also the acquaintanceship and benefit to both Regulars and National Guardsmen is no small item of importance. It is an exception to the rule that "familiarity breeds contempt."

10. All batteries should be under canvas for field training; tentage is provided for that purpose and should be used even when barrack cantonments are available. It has always been the policy of the Militia Bureau to have the summer training of Field Artillery with the organizations in tents, not only for the experience gained, but it is a well-known fact that a battery commander has a much better grasp on his command and can get better discipline in a tent camp than when the men are scattered around in barracks and often at a distance from the officers.

11. It must be borne in mind that the Field Artillery National Guard, is less than two years old, although in a number of regiments we have a large proportion of old and highly trained field artillery officers as well as seasoned enlisted veterans, but many organizations have been recently transferred from infantry or have no members

with prior field artillery experience. The progress reported in some of these organizations is astonishing; many of the batteries have been handicapped in not receiving equipment promptly, lack of proper armory facilities and having no instructors or sergeant instructors from the Regular Army. It certainly speaks well for the officers and enlisted men of the Field Artillery National Guard that they have progressed to the extent indicated by reports with so little help from Regular Instructors.

12. It was my privilege to only see in camp this summer the New Jersey Field Artillery and part of Massachusetts and Pennsylvania, but I was surprised and gratified at the showing made.

13. Now to consider how we of the Regular Army can give the Guard more assistance.

(a) Get equipment, matériel and horses to an organization as soon after Federal recognition is extended as possible, providing proper facilities exist for protection of same.

(b) Reduce paper work required of the organization commander to a minimum.

(c) Furnish instructors and sergeant instructors in sufficient numbers so that no battery will be at a disadvantage due to lack of assistance in instruction.

(d) Attempt to secure larger appropriations for sending officers and enlisted men to the Field Artillery School.

(e) At every summer training camp have a large training cadre of Regular officers of whom as many as possible are recent graduates of some Field Artillery service school.

(f) At every training camp provide Regular organizations to assist in instruction.

14. To improve and become effective as Field Artillery the part of the National Guard should be as follows:

(a) Provide at home stations suitable armory, stable and storage facilities before attempting to organize with a view of Federal recognition. No organization can hope to have any efficiency, discipline or esprit when these facilities are not provided and the enlisted men realize they are Field Artillery in name only and have only to look forward to summer training for proper instruction.

(b) Better attendance at officers' and non-commissioned officers' schools at home stations.

(c) The insistence of all officers on requiring a full attendance at drill. The monthly reports indicate a woeful lack of attention in many organizations to this vital feature. Severe measures should be taken by State authorities to correct this greatest evil.

(d) All elementary subjects should be covered at home stations so that no time at all should be given to elementary training in camps on such subjects as foot drill, arm signals, first aid, guard duties,

military courtesy, standing gun drill, nomenclature, harnessing, grooming and draft.

(e) The prompt elimination by State authorities of officers who are manifestly inefficient or show lack of interest in their work.

15. The tendency was shown at some camps to proceed too rapidly and this only could have resulted in a loss of true efficiency in training, the desire to commence service target practice should not have caused the program of instruction as suggested by the Militia Bureau to be anticipated several days in the case of very recently organized batteries, it is believed that we must strive for accuracy first in all Field Artillery instruction and speed later.

16. On October 1, 1921, the number of organizations which have been extended Federal recognition as National Guard Field Artillery are as follows:

DIVISIONAL ARTILLERY

2	Brigade Headquarters.
1	Brigade Headquarters Battery.
3	Brigade Ammunition Trains.
8	Regimental Headquarters.
10	Regimental Headquarters Batteries.
10	Service Batteries.
20	Battalion Headquarters, Headquarters Detachment and Combat Trains.
136	Batteries.

CORPS ARTILLERY

2	Regimental Headquarters, 155-mm. Howitzer.
4	Regimental Headquarters Batteries, 155-mm. Howitzer.
5	Service Batteries, 155-mm. Howitzer.
7	Battalion Headquarters, Headquarters Detachment and Combat Trains, 155-mm. Howitzer.
33	Batteries, 155-mm. Howitzer.
2	Regimental Headquarters, 155-mm. G.P.F. guns.
2	Regimental Headquarters Batteries, 155-mm. G.P.F. guns.
2	Service Batteries, 155-mm. G.P.F. guns.
2	Headquarters, Headquarters Detachment and Combat Trains, 155-mm. G.P.F. guns.
13	Batteries, 155-mm. G.P.F. guns.

17. It can be stated in conclusion that as a whole the Field Artillery of the National Guard is in a very healthy condition and it is expected that by next summer most gratifying results will have been obtained and the allotment for the fiscal year 1922 completely filled.

D. W. HAND,
Lieutenant Colonel, Field Artillery.

THE EXPERIMENT OF EQUIPPING A LIGHT REGIMENT OF FIELD ARTILLERY WITH TRACTORS

BY MAJOR R. McT. PENNELL. FIELD ARTILLERY, U. S. ARMY

[EDITOR'S NOTE.—*Major Pennell commanded the First Field Artillery while the experiment of equipping the regiment with tractors was being made.*

Realizing the importance to the Field Artillery of the conclusions to be drawn from such an experiment, he states in his letter transmitting the report to the Chief of Field Artillery as follows: "I have endeavored to preserve an open mind, so far as possible, on the subject. The officers of the regiment have applied themselves conscientiously and earnestly to give the experiment a full and unbiased trial. They have done their loyal best always, even in the face of considerable discouragement, to 'make her go.'"

A great deal of the comment expressed in Major Pennell's report is based upon observations and conservations with tractor drivers, mechanics, motor sergeants and battery officers. "They are the men who really know the reasons why some tractor fails to arrive in camp until 2 A.M., *and are first to appreciate and suggest the improvement necessary in maintenance, upkeep or road discipline required to secure the desired results."*

Major Pennell comments with the authority of experience, having accompanied the first "Transcontinental Motor Convoy" made from Washington, D. C., to San Francisco, Cal., in 1919, as an observer. He has, since the following article was written, completed a trip as an observer with the 51st Tractor Artillery, from Camp Jackson, S. C., to Camp Eustis, Va., September 12th to October 20th, 1921. The conclusions reached in the First Field Artillery test were fully justified as a result of the observations made during the recent march.

We consider this to be the best paper written thus far upon this subject.]

1. Discussion of the subject of motive power for light field artillery with officers of that branch shows many of them divided into somewhat hostile camps. They are either very strongly anti-horse or anti-tractor. The reasons most given for the opposition are based on some one or more unfortunate occurrences with either tractors or horses.

2. The field artillery would be neglectful of its opportunities did it allow prejudice or sentiment to interfere with its search for the best motive power for its weapons. It must be always on the alert

to seize any advance in science that may permit the field artillery to "march rapidly and in good order, and to establish itself promptly and without confusion in such positions as will best utilize the available terrain." It would be no less neglectful did it desert tried and proven power for something of doubtful efficiency or of limited uses.

3. This search for the best motive power led to equipping the First Field Artillery and three other light regiments with tractor power. The equipment table of the First Field Artillery for this experiment is attached.[1] This equipment was issued in February, 1919. In November, 1919, one-half the 5-ton tractors were turned in and replaced with 2½-ton tractors. Until May, 1920, the regiment had two batteries each of Model 1897, 1916 and 1917 seventy-fives. After that date the first battalion was equipped with 5-ton tractors and Model 1916 seventy-fives, the second battalion was equipped with 2½-ton tractors and Model 1897 seventy-fives. During six months of this period one battery was equipped with 4.7″ guns. The battalion and regimental reels and carts were operated by 2½-ton tractors. The 158 horses were in the tables for use of B. C. and headquarters details. Early in the experiment it was found a mixed horse and tractor organization was not practical and the horses were never after used for the purpose for which originally issued.

4. The character of warfare, the probable theatre of operations and the availability at the outbreak of war of each type of motive power must influence our selection. Whatever the variations of these elements a satisfactory form of motive power should be:

(a) Reliable in operation.
(b) Durable under field service conditions.
(c) Simple in operation and upkeep.
(d) Able to use as its source of energy an element surely available, and easily transported.
(e) Capable of operating over limited distance after exhaustion of its source of energy.
(f) Economical in man power required for its operation and maintenance.
(g) Economical in road space.
(h) Suited to the varied demands and of power proportioned to the different requirements of the field artillery.
(i) Unaffected by climatic variations.
(j) Not excessive in first cost or upkeep.
(k) Available in large quantities at the outbreak of war.

5. At present only two sources of power are seriously considered, *viz.,* the horse, and the gas engine as exemplified in the caterpillar tractor. Neither of these fills all the requirements laid down

[1] See end of article.—Editor.

for a satisfactory form of motive power. It is the purpose of this paper to show as nearly as may be how closely the tractor fulfills these requirements so far as has been determined by the experience of the First Field Artillery. That experience has included marching over seventy-five thousand tractor miles and firing not quite eighty thousand rounds of ammunition. Due to poor design and structural weakness the 2½-ton tractor is not satisfactory and all discussion is based on experience with the 5-ton tractor.

(a) Reliability in operation.

The reliability of the present tractor is largely a function of the training of its personnel. The reliability may be said to increase as the square of the training. Given an officer personnel well grounded in the care and maintenance of the tractor, efficient motor sergeants and mechanics, drivers thoroughly trained, and a satisfactory supply system for oils, greases, gasoline, and parts, the tractor may be depended on to fulfill the qualification of reliability. Lacking any one of these elements its reliability falls away so rapidly as to at once eliminate it from serious consideration. For example, the quartermaster was unable in one of the winter months to furnish the proper grade of oil. In a couple of weeks the casualties among engines were so great as to overload the regimental repair shop for weeks. Today the development of the tractor is in advance of ability of the Field Artillery to take advantage of it. In other words, it is capable of a higher efficiency of performance than we are capable of extracting from it. Many officers apparently believe that in a tractor regiment one travels in a limousine, sleeps in a Motor Bungalow Deluxe and presses the button to start the column in the morning. If before the World War we had given one-half the thought and study to the horse as a draft animal that it will be necessary for us to give the tractor—that we must give to the tractor—a large percentage of the failures of the horses in France would never have occurred. In the future the tank, the aeroplane, the truck train, the tractor, and dozens of other uses for the gas engine will require that our officers be familiar with that engine and every adaptation of it to army uses. Instruction in this subject must begin at West Point. A basic course at that place given an amount of time in proportion to its importance is the first step. The life of the Navy depends on its ability to operate efficiently the highest development of the steam engine, the gas engine, the dynamo and all the applications of them. At Annapolis the foundation is laid. At every school the field artillery controls, similar work must be carried on until the necessary amount of practical knowledge has been absorbed and digested by all officers. Until that time we may not say for the light field artillery that the tractor is reliable in operation.

(b) Durability under field service conditions.

Damaged gasoline lines are most frequent causes of delay and comparatively simple to repair at least temporarily. The track system, which term is meant to include sprockets, truck and track rollers and all attached parts, is most subject to rapid wear and deterioration. Drive sprockets must be replaced about every eight or nine hundred miles. Track shoes somewhat oftener. The track support roller shafts will shear their cotter keys, lose their nuts and track rollers in a large majority of cases within a thousand miles even though well lubricated. If the roller is out of line with the track, the roller will go in the first two hundred miles. Truck roller-bearing cages come apart and must have the entire bearing replaced quite often. All these damages are repairable in the field if parts are available. The life of the rest of the tractor is not yet determined. It will probably run well up into the thousands of miles. The engine is a sturdy, reliable power unit that will stand much abuse and still function. A great deal of its endurance is due to the air cleaner installed on it. Run with poor spark adjustment, poor carburetor adjustment and great variations of oil in the crank case, yet bearings rarely burn out and the necessity of removing carbon arises only after long-continued use. Considerable improvement must be made in the gasoline system and the entire track system before the tractor possesses the desired durability. Many parts, such as steering clutches, are usually damaged beyond repair in case of failure of any element, because of difficulty and time involved in getting at them. The durability of other parts of the tractor is largely a function of the efficiency of the daily maintenance, and thoroughness of driver instruction.

(c) Simple in operation and upkeep.

The controls of the tractor are comparatively simple in operation. Their efficient use under field conditions is a matter of experience and requires considerable dexterity of the hands and feet. The tractor is not simple in upkeep. The daily maintenance is laborious and unusually complicated. For example, the greasing arrangement of the track system has four pipe plugs of one size for the track roller shafts, six pipe plugs of another size and requiring a special wrench for their removal for the truck rollers. A plug of a third size for the drive sprocket gears. Various other sizes of grease plugs are found throughout the tractor. For all these there is supplied a grease gun with one size connection. There being about 40 grease openings using pipe plugs for stoppers, the time consumed in merely removing and replacing them is considerable. Inaccessibility of parts is the greatest trouble in making field repairs. The steering clutches are a source of considerable trouble. If one gets out of order, the top must be removed, the entire superstructure with gasoline tanks removed and an improvised gin rigged up to lift out the transmission. This removing and replacing will take up about seven

hours while the repairs to the clutch itself, if caught in time, might not take 15 minutes. The tractor is simple in operation but not simple in upkeep.

(d) and (e) Source of energy and its availability.

Gasoline is the source of energy. It is at present surely available. It is not specially hard to transport. The tractor is not capable of operating any distance after exhaustion of its gasoline, oil or water supply. Because of this fact the service of supply must function with absolute certainty.

(f) Man power for operation and maintenance.

Tractor power is economical in man power required for its operation. If operated by trained personnel, it is also economical of man power for its maintenance. If operated by untrained or poorly disciplined personnel, it is very extravagant in man power required for its maintenance.

(g) Road space for tractors.

Over uneven ground or ordinary country roads ten yards is about the closest distance tractors can operate. Many advocate 40 yards between sections of seven or eight tractors. Owing to the necessity of halting to shift gears the column becomes like an accordeon on hilly ground. In general, road space should be no more with tractors than with horses. With poor march discipline elongation of the column is excessive and is hard to prevent, drivers alleging various minor troubles as the cause.

(h) Power unit size for field artillery.

The field artillery requires a power unit varying in size from one capable of transporting its heaviest guns to one capable of transporting a single man. With horse power this is accomplished by combining several power units for the heavier loads. With the tractor such a solution is not practicable. It must therefore be built of a size capable of performing the hardest work likely to arise in the organization or we must place in the same organization power units of different capacities. The latter solution complicates the repairs, replacements and spare parts problems. The tractor then does not lend itself readily to the various power requirements of the field artillery.

(i) Effect of climatic variations.

Heat has little effect on the tractor and the driver is protected by a cab. Cold much below freezing is a source of great damage to tractors. An untimely cold snap one night early in one November put about thirty-four vehicles of the regiment out of commission by frozen radiators. In garrison, water is easily obtained from underground pipes, so radiators may be drained each night. In the field

when water in water carts may freeze also, or when tractors must be held in readiness to move at a moment's notice, the only solution seems to be to keep the engines running at all times, which causes very high gasoline consumption. In very cold weather it requires from one-half to three-quarters of an hour to start all the tractors of a regiment. This does not include the time necessary to fill radiators. The use of anti-freeze solutions has not proven satisfactory, but it may be possible to develop something to overcome the present objections.

(j) First cost and cost of upkeep.

The cost of the 5-ton tractor is not known. A rough estimate is that equipped ready to issue it is not much under ($5000) five thousand dollars. In time of war this is not important, but it has an important bearing on the number which will be available at the outbreak of war. The number of parts replaced per mile of travel is high. The cost of these parts is proportioned to the cost of the tractor. New tractors may be stored. Tractors once operated for any length of time must be constantly watched after storage to prevent damage. Present-day gasoline being almost kerosene, pistons and other moving parts soon rust in place.

(k) Availability at outbreak of war.

Tractors manufactured during the World War will hardly be efficient ten years later. Unless tractors used in commercial life are satisfactory for field artillery purposes, the number available at the outbreak of war will be only those which can be built from money provided by Congress in time of peace. Past experience indicates this number will not be large. It has been stated the rate of mobilization of man power in our next war will be governed by our ability to produce matériel and equipment for that force. If this is correct, the absorption of any portion of our mechanical capacity in producing a power unit to replace one already in existence is a point for consideration by the General Staff.

6. Speed has not been placed among the qualifications of the ideal power unit. It is believed that the maximum speeds now being developed are excessive and are paid for at too great a cost of weight, durability and fuel expenditure. The consumption of power at the high speeds is out of all proportion to that required for work at ordinary speeds. The maximum speed for the tractor for light artillery need not exceed ten miles, but it should be able to maintain that speed continuously, if road conditions permit. There is little use in rating a tractor at 15 or 20 miles per hour when it is known that one or two hundred miles at such a pace would surely put the tractor in the repair shop for an indefinite time. The field artillery needs a tractor capable of a train schedule performance day after day.

One simple in all its parts, easily maintained, stripped of useless or little needed attachments, but which will permit a battery with ordinary diligence and care to take its place in the column and maintain it intact. The field artillery pleads with the tractor designer to make reliability and simplicity his keynote in design.

The advantages of tractors which run on wheels, or crawl on tracks, which float as boats or carry loads as trucks, whose engines will operate as submarines, or whose armor will turn any projectile smaller than the 75 are fully appreciated and each of the characteristics is desirable at times. Yet we know that every one of them is purchased at the price of excessive weight, extra power demands, inaccessibility and complication of parts and reduction of reliability on the march.

7. The 5-ton tractor is not too powerful for the light gun. Its load should be one caisson body and one gun, or two caisson bodies. This load it can handle practically anywhere. It can not take two loaded caissons and a gun, or three loaded caissons over difficult ground. When it does become stalled with such a load, the work of extricating the load is harder and longer to accomplish. A tractor with a trailer load on six wheels is difficult to manœuvre. Its turning radius is large, and it can not be backed at all. With three caissons no reserve power is available. Tractors go out of commission on the march and will continue to do so for some time to come. With the lighter load, in case of a breakdown, the load of the disabled tractor is distributed between two other tractors, the load of a second tractor is distributed in the same manner and it then tows the dead tractor until repairs can be made or to the end of the day's march. In this way the organization is kept intact. If each tractor has already its maximum load no such redistribution of loads can be made and the crippled tractor with its load must be left behind. One difficulty encountered in using the tractor load recommended is the lack of seating space for cannoneers. The placing of a tractor towing two caissons in rear of each piece complicates the occupation of position and adds too much to the size of target when going into position.

8. The types of power-driven vehicles required in tractor organizations are two, a passenger-carrying vehicle, of comparatively high speed and a track-laying draft unit. It must be accepted that the organization of a tractor battery as a fighting unit will not follow exactly the lines of a horse-drawn battery. Different conditions require different treatment for the accomplishment of the same result. The organization of the battery commander's details, the order in

column of march, the reconnaissance and occupation of position, all require variations from horse units to adapt them to tractor conditions. Field work must determine the best solution of these problems.

9. The weakest element of tractor artillery is the wheeled power vehicle. The ability of tractor artillery to travel in any kind of weather and on almost any sort of road has been proven. That truck transportation, whether two-wheel or four-wheel drive, cannot accompany it except in dry weather and over at least fair roads has been proven just as conclusively.

The truck should be entirely and completely eliminated from the tractorized Field Artillery Regiment. No change can do more to make tractorization a practical success than the elimination of trucks from the equipment of the regiment. At this time a passenger vehicle of the Dodge type is necessary. The Dodge light repair and the Dodge light delivery being so far as upkeep goes identical with the passenger car, are not considered trucks in the usual sense of the term. They are very light, are equipped with pneumatic tires, and capable of going practically anywhere the Dodge passenger car can go. For all cargo trucks, supply trucks, personnel trucks and equipment trucks, four-wheel trailers drawn by tractors should be substituted. The use of trailers with caterpillar treads is not recommended at present because of:

(a) The great increase in gross weight necessitated by their use.
(b) The inability to man such a vehicle by hand.
(c) The difficulty of steering.
(d) The excessive power required under ordinary circumstances to move a vehicle so equipped as compared with a wheeled vehicle. Future developments looking to the simplification of the track and decrease in its weight may remove present objections.

10. If for any reason the elimination of the truck cannot be accomplished at this time it should be limited to one type in the regiment. When one considers all the complications introduced, the assignment of ¾-ton, 1½-ton, and 3-ton trucks all of different makes to the same regiment cannot be justified. The F. W. D.[1] is a very satisfactory truck, and as we have it we should stick to it. In case of the adoption of another truck for tractor field artillery, I recommend the 1½-ton White with pneumatic tires. However, the point is the kinds of trucks must be cut to one per regiment, and it can be done with little or no inconvenience of operation. The light repair truck is not considered as an additional type because it is mounted on the same chassis as the Dodge passenger car. In any case, I urge

[1] Four Wheel Drive.

the adoption of pneumatic tires for trucks having any connection with the field artillery.

11. Automobiles.

Service of supply, simplicity of maintenance and efficiency require that only one type of passenger-carrying vehicle be prescribed in the regiment. Present experience indicates the Dodge 5-passenger car as satisfactory. Any good car will do so long as there is only one kind in the regiment. Two types of cars double the problem of maintenance of spare parts from tires to tail lights. The number of automobiles per battery will be determined largely by the scheme of reconnaissance decided on. It should be limited to one per battery if possible.

12. Motorcycles.

The present type of motorcycle finds no use for itself in the battery and little in the regiment that can not be more efficiently performed by other means of transportation. Experience has proven motorcycles cannot travel at the rate of march of tractors on any but hard-surfaced roads, nor at any speed on very muddy roads. Towing motorcycles soon tears them to pieces and is very tiring on the driver. The assignment of motorcycles to chiefs of section, and chiefs of platoon, or any other personnel who have a more or less fixed place in column, is not a practical solution of the transportation of these individuals. For messenger work in the battery the bicycle is recommended, or a very light machine similar to the Harley-Davidson, with horizontal opposed cylinders. Either of these is light enough to be picked up by one man and hung on brackets on the side of the tractor or rear of a caisson. It will habitually be carried there, except when the driver leaves the column. In the regiment, the motorcycle should be limited to the requirements for messenger service, if possible, it should be eliminated entirely. This is not a general condemnation of the heavy motorcycle with side car. It may be very useful when it is not required to regulate its speed on other vehicles, in other words, is an independent unit, provided the roads are good or better. It must not be forgotten that the motorcycle deteriorates rapidly in service and is not a trustworthy means of transportation or communication after a comparatively short time. A few careful drivers get excellent service, but the average driver, even if constantly watched, soon has his machine in the repair shop. The motorcycle in any form is not a sturdy vehicle.

13. Fuel Supply.

A satisfactory system of transporting and issuing gasoline has not been developed. Two principal methods are in use. The first method is the gasoline truck carrying three tanks of 250 gallons

capacity each, for gasoline, and two smaller tanks of about 40 gallons capacity each, for oil. This truck loaded and equipped for the field weighs a little more than ten tons. The second method is to transport gasoline in drums in a cargo truck. A drum has a capacity of about 55 gallons and weighs about 85 pounds empty. By either method the gross weight per gallon of gasoline is about 26 pounds.

The tank truck method has the advantage of ease of issue, ease of filling and requires no man-handling of heavy weights. With it the issue of gasoline to a battery will occupy about one-half the time required for the second method of transportation. The disadvantages are that the great weight of the truck renders it most unreliable except on excellent roads. It is necessary to have a tractor constantly available to extricate it from broken bridges, mud holes, and ditches.

The second method has the advantage of being able to lighten the load by unloading drums, and of offering a means of issuing gasoline to widely separated units at the same time. The great disadvantage is that a drum of gasoline weighing approximately 450 pounds is a very awkward load to handle. The wastage from issuing gasoline from them in the field unless great care is exercised will amount to 10 per cent. The installation of a crane on each truck for handling them is hardly practicable, though some sort of mechanical power for loading and unloading seems necessary if this method is used.

For the present equipment the gasoline expenditure of the 1st Field Artillery is approximately 135 to 150 gallons per mile. This includes losses by evaporation, leakage, etc. In addition oil and grease consumption will run from one-tenth to one-fifteenth of the gasoline consumption. Consideration of the transportation required for gasoline and oils and for spare parts indicates that the statement that less transportation is required for fuel in a motor organization than for forage in a horse organization is not well founded. If the division ordnance company needed principally for the upkeep of artillery motor vehicles in the division, together with their equipment and personnel are considered, it is probable that the transportation and impedimenta actually necessary is greater in a division whose artillery brigade is tractor drawn than in one whose artillery is horse drawn.

15. Two other methods of transporting gasoline are available. The 300-gallon water trailer makes a convenient vehicle for transporting gasoline. If one be issued to each battery and battalion combat train, we have gasoline with each unit and 1200 gallons of fuel in the battalion against 750 if we have one gasoline truck with

each battalion. The other method is that much employed in the vicinity of refineries. It consists in using ten-gallon milk cans. These weigh full 85 to 90 pounds. In the "A" cargo body about 36 may be carried. These cans are light enough to be handled by one man, but the dead weight per gallon of gasoline is greater than when the 55-gallon drum is used. The milk can has many advantages over the drum and few of its disadvantages.

16. Lubricants.

Oils and greases are issued in barrels. From these it is placed in buckets for filling grease guns, grease cups, etc. In dusty weather, the lubricants are filled with dust and grit and become in effect a liquid grinding compound. One grease and oil gun with two nozzles is supplied with each tractor. Unfortunately changing the nozzle does not also change the grease in the gun to oil. The handbook neglects to state how one grease gun can fit three sizes of plug holes and apply the different kinds of lubricant specified to be applied with the grease gun. The Alemito system of lubrication had been tried on several tractors. It is satisfactory. Its adoption is recommended. Oil should be issued in cans not exceeding one gallon in size. Grease in 1-pound or 25-pound cans with covers easily replaced.

17. Repairs and upkeep in war and peace are under somewhat different conditions. The regiment should maintain in peace a very complete regimental repair shop. It should have two machine-shop trailers, with their complete equipment and the best mechanics in the regiment on duty in it. The Ordnance tractor shop stationed with the regiment has been under command of officers who have coöperated in every way possible. This shop was manned by expert civilian mechanics. Nevertheless it soon developed that repairs made by them were not satisfactory, that they take three or four times as long as the regimental shop, often sent tractors back with parts missing, and the work had to be done over. The reason is the Ordnance shop is interested mainly in "getting a job out." In the regiment the repair man is in effect the user. If the work is poor, that same mechanic is the man who is going to be up all night on a practice march making the repair and the officer in charge of the shop is going to be along to receive the blessing of the regimental commander if everything goes fine.

18. The supply truck body.

It is remarkable that heretofore no provisions have been made for the transportation of tractor spare parts. Four Supply Trucks are issued to the Service Battery to carry truck parts, but in no place is adequate provision made for tractor spare parts. The supply body is extravagant in proportion of total to useful load. It should be eliminated. If trucks are used an ordinary cargo body is greatly preferable. A trailer behind a tractor is superior to either.

19. The five-ton tractor is an admirable machine if the conditions under which it was produced are considered. It is to be expected that continued field service would develop certain deficiencies and weaknesses. The remarkable part is that so radically new a machine as the 5-ton tractor should have developed so few. Certain changes and improvements are suggested to better adapt the tractor to the use of the field artillery. Doubtless most of these have already been considered by the Ordnance Department.

20. While the present engine is generally satisfactory of its type, further experiments with steam power are urged. Steam power requires no complicated transmission, the fuel range is much wider, maximum power may be obtained at any speed, the number of parts is greatly reduced, the prevention of freezing in cold weather is cared for at little cost. Certain disadvantages are also apparent, but a thorough test of this type of power should be made. New types of transmissions recently brought out are undoubtedly being investigated by the Ordnance Department. Thorough consideration of the hydraulic type is recommended. In any new design of tractor, consideration should be given to its transportation in the truck body used by the truck section of the division trains. The 5-ton tractor is a few inches wider than the "A" type cargo body.

21. Gasoline Supply System.

The present fuel supply system is unsatisfactory. It has about fifteen connections in it. Prevention of leaks at all these joints is a problem not yet solved. The gasoline tank capacity must be increased to not less than 50 gallons. The emergency tank should be eliminated. If possible, all gasoline should be in one tank with one lead to the carburator or vacuum tank. Much trouble has been experienced with the three-way valve. It should be eliminated if possible. If gasoline is to be transported in the field in drums it might be possble to use the drum itself as the gasoline tank, fuel supply being replenished by substituting a full drum for the empty one on the tractor. This would eliminate one source of great waste, drawing gasoline from one receptacle to pour in another. If no emergency tank is used this method would be objectionable, because it would be necessary to replace a drum before all gasoline in it had been consumed.

22. Armor.

The use of armor as at present designed does not seem to be warranted. The most vulnerable part of the tractor is the driver. If he is enclosed, the tractor becomes a tank and the driver has not the necessary field of view. The poor performance of the 2½-ton tractor is largely due to the fact that the armor prevents proper

cooling of the engine. It is necessary in hot weather to open all the doors in the armor of the 5-ton tractor.

23. Speedometers.

Speedometers are unnecessary on tractors. At speeds under ten miles an hour, they are not accurate within 25 per cent. Mileage counters or odometers fulfill all requirements. It is not possible to read the speedometers on the present 5-ton tractor without removing the footboard. Its use in its present location as a speedometer is, therefore, impossible.

24. The various sizes of nuts and bolts used in the construction of the tractor should be held to the smallest number possible. The allowance of nuts, bolts and lock washers should be unlimited. For any exposed nut, the lock washer and ordinary nut is much preferred to the castillated nut and cotter pin. In field repairs, it is often impossible to see the bolt well enough to line up holes in bolt and nut or to insert cotter pin after lining up. Mechanics will use lock washers, while they will not use pins unless constantly checked up.

25. The tractor should be provided with a suitable place for carrying the rolls and haversacks of the chief of section, the driver, and the assistant driver. The haversack may not be worn comfortably while sitting on the tractor seat.

26. An attached bracket for carrying the guidon should be provided on the tractor. The method or place of carrying the Standards has not been prescribed. An attachment for carrying them on a trailer or passenger car is desirable.

27. The arrangement for track lubrication consists of a reservoir with pipes leading over the track through which oil is permitted to trickle down at the will of the operator. The track is made up of shoes carrying a pin fixed at one end of the shoe, this pin passing through a bushing in the adjacent shoe called a space block. In theory, all relative motion between two shoes and therefore all wear is between the pin and the space block. Actually almost no wear takes place at this point, but all wear occurs between the pin and the shoe to which it is supposedly fixed. Lubrication of track is of little use in preventing this wear; it is of some value in preventing wear on the sprocket by the hardened space block. In any case, the present track-oiling system is not efficient. Little of the large amount of oil spilled about by it actually reaches the surface between the block and pin or the track sprocket. If lubrication is desired it should be done with an oil can and application of oil direct to each pin space block and sprocket. One scheme proposed of oiling the track with a slush brush is wasteful and inefficient. The tractor can not be kept clean—and it must be kept clean—if oil is slopped about in this way.

28. Weight of Track.

The weight of the track is 1405 pounds. The weight of the grousers is 555 pounds. Total weight of track 1960 pounds, or nearly one-fifth of gross weight of the tractor. It is unnecessary to point out the large amount of engine energy spent in overcoming the inertia of this great weight which passes from zero velocity to twice that of the tractor in a very short space of time.

29. Grousers.

The grousers weigh 555 pounds. They require from one-half to two and one-half hours to install, depending on the number put in, when the shoes become worn they are also deformed enough to prevent seating of the grousers. Grousers can not be used on macadam or concrete roads. Their use is therefore prevented on marches over part improved and part unimproved road. In ground very muddy and without a hard subsoil, the grousers operate similarly to the spades on a ditch-digging machine. On ice or frozen ground, they operate satisfactorily and are necessary in some form. A shoe which will operate as a grouser in mud or a lighter and more easily attached grouser are much to be desired.

30. Placing of Muffler.

The present position of the muffler interferes seriously with the vision of the driver. In a light head wind on a hot day, the exhaust gasses strike him fairly in the face, causing much discomfort. The exhaust at night of a tractor with engine heavily loaded is plainly visible. The muffler should be placed below the armor and exhaust behind the driver.

31. The hand starter is rarely used even in summer time by the best drivers. A kick back usually results in breaking the starter housing and sometimes in injury to the driver. It is an unnecessary complication. It should be omitted from the engine. It sometimes engages when the front starting crank is being used and strikes the arm of the assistant driver holding the choker handle.

32. Front Starting Crank.

The present starting crank when disengaged by the engine starting is sometimes driven up against the shroud, forcing it in turn against the fan and breaking the fan or cutting up the shroud. A crank permanently attached, as in the case of trucks, would be preferable if no objection exists.

33. Kerosene lamps are simplest and surest in operation. The present type of lamps is too easily damaged. One similar to the lantern issued by the Ordnance Department is preferable.

The placing of lantern and oil-can brackets in the position usually reserved for bumpers on trucks should be discontinued. The slightest

deforming of these brackets prevents the removal of lantern or oil can.

34. Tools and Tool Kits.

Each tractor is equipped with a very expensive and complete tool box. This leads to much unauthorized tampering by poor mechanics, and many charges on the pay rolls for expensive tools lost. Each tractor should have a simple tool roll containing double end wrenches for tightening bolts, a spark plug wrench, one monkey wrench, one screw driver, one pair pliers, one ball pean hammer, one cold chisel, two grease guns and two oil cans. A very complete tool roll, not tool box, of the best grade of tools should be furnished for each mechanic.

35. Tools and equipment of tractors are costly and easily misplaced. They cannot be marked with any marking outfit now issued. A cheap etching outfit is desirable.

36. Tow chains have proven themselves much more satisfactory than tow cables. Chains are stronger, less easily kinked or broken and more easily repaired. Chains only should be issued.

37. The unionall is universally used by motor mechanics and is greatly preferable to the two-piece fatigue suit for all tractor organizations. They cost about 40 cents less than the fatigue clothes usually issued.

3. A handbook written in clear language, stripped of unessential technical matters of interest only to manufacturers and covering completely those problems met in the repair, maintenance, and upkeep of the tractor will do much to shorten the time now necessary to train a tractor regiment and to maintain it efficiently in the field. The lubricating chart in the handbook indicates for certain places, "grease No. 6," "oil No. 2," etc. In another place it is indicated that oil No. 2 is ordnance specification No. 3502, and grease No. 5 is ordnance specification No. 3506. No issuing office has yet been found having any knowledge of what these numbers mean and a requisition using these terms for lubricants would be returned to state what sort of lubricants were desired. Manufacturers sell greases and oils under more or less well-known names, and it is lubricants marked with some of these trade names with which a requisition is filled. The handbook for tractors should be prepared by a field artilleryman and an officer of the tractor division of the Ordnance Department. The present handbook for 5-ton tractors contains much uncoördinated information of which only a small part is useful in service. Highly desirable instructions are omitted and the same information repeated a number of times in succeeding chapters. Commercial manufacturers issue large, detailed, easily read lubricating diagrams. Something of the same sort should be issued for the 5-ton tractor.

EQUIPMENT FOR 75-MM. GUN REGIMENT (MOTORIZED)

	1 Battery	6 Batteries	Supply Co.	Hq. Co.	Total
Guns, 75 mm. (rubber tired) without limbers	4	24			24
Caisson bodies (rubber tired)	20	120			120
Carts, reel and fire control (rubber tired)	1	6		3	9
Guns, Machine, Anti-aircraft	2	12			12
Rifles, Automatic, light, Browning	8	48	8	8	64
Carts, Water, Trailmobile, 300 gal			8		8
Kitchens, rolling trailmobile			8		8
Cars, Motor, 5-Passenger Type D	1	6	1	4	11
Cars, reconnaissance, White Tebo	1	6			6
Cars, Staff, Obs. White, Tebo				3	3
Trailer, Anti-aircraft Machine Gun, Sector	1	6			6
Tractors, 2½-ton or 5-ton	13	78		3	81
Trucks, Ammunition, F.W.D.	2	12	1	8e	21
Trucks, Artillery Repair, F.W.D.			2		2
Trucks, Cargo, F.W.D.	3	18	3	3	24
Trucks, Artillery Supply, F.W.D.	1a	6	4b-d	1c	11
Trucks, Tank, F.W.D.			2		2
Trucks, Repair, Light Type D	1	6	1		7
Motorcycles, solo	1	6		2	8
Bicycles	1	6		1	7
Horses, riding	23	138	2	18	158
Motorcycles, with side-cars	2	12	9	8	29

NOTES.—a, Load A. b, 2 Load B. c, Load C. d, 2 Load D. e, 1 as wireless and 1 as telephone truck.

STUDENT MILITARY TRAINING

AN ADDRESS BY THE HONORABLE JOHN W. WEEKS,
SECRETARY OF WAR

PRESENTED AT LEHIGH UNIVERSITY, OCTOBER 8, 1921. BY MAJOR GENERAL JAMES G. HARBOARD, DEPUTY CHIEF OF STAFF

ON BEHALF OF THE SECRETARY OF WAR

THIS is a day set apart at Lehigh University for the expression of a tribute of appreciation and gratitude to those to whom the University owes its origin and its upbuilding in the fifty-five years of its existence.

Lehigh University has been and is noted or its promotion of matters of national public service. I am therefore glad to have this opportunity to speak on the subject of Student Military Training here, because the time has now arrived when it is possible to speak of military training in the schools and colleges as a part of the comprehensive program of national defense. I am particulary glad to speak on this subject at Lehigh University because Doctor Drinker has not only been one of the pioneers in developing student military training but through his leadership he has had no small part in organizing and developing the public opinion that has finally crystallized into a settled national military policy.

In my capacity as Secretary of War I am officially disposed to emphasize the importance of student military training from the standpoint of its value to the national defense. It means an assured supply of highly intelligent reserve officers. It means that the requirements of national service are to have proper consideration in the education of our future thinkers and men of affairs. It means that a new public value is being developed in the graduates of our schools and colleges. It means a more intelligent public opinion with reference to military economics and international affairs. This alone will justify student military training in the minds of all patriotic citizens.

But student military training does not involve a sacrifice for the public good without return to the individual. It has a positive educational value for each student. Our most eminent educators have agreed that, aside from its physical benefits, time devoted to the military studies in the R. O. T. C., is fully entitled to credit in the general scheme of mental culture. The student of engineering will be a better civil engineer for some knowledge of the military applications of his profession to the nation. In subjecting themselves to the discipline which is essential to military teamwork, young men soon learn the real secret of modern civilization which depends upon the combined action of human beings to common ends.

There is also a distinct moral advantage in the contemplation of patriotic service to the nation and in preparing to meet its obligations. But perhaps the greatest benefit of military training is found in the opportunity it gives a young man to develop his gift of leadership and to acquire a sense of its responsibility. No man can prepare himself to serve his country in war without making himself more valuable for all of the relations of civil life. The student who avails himself of the opportunity offered by the military department of this University will graduate a better man for himself, for his family and for his country. He will go out better prepared for peace as well as for war.

The progress of military training in our schools and colleges is already most encouraging. At the close of the past academic year, the total enrolment in the Reserve Officers' Training Corps was 90,811. There were 227 Senior Units with 5,025 students enrolled in the Advanced Courses and 39,228 students enrolled in the Basic Courses. There were 116 Junior Units with an enrolment of 46,558. Of these Junior Units, 51 with an enrolment of 34,472 were organized in the High Schools of the country. Of the 5,025 students in the Advanced Courses; 1,069 qualified for commissions in the Officers' Reserve Corps at the close of the academic year.

I am particularly impressed by the record of Lehigh University during the past year. The total enrolment in the University's R. O. T. C. was 545. It is expected that this year's enrolment will be about 700, with at least 70 in the Advanced Courses. Lehigh sent 17 advanced students and 130 basic students to this year's R. O. T. C. Camp at Plattsburgh. I am informed that the Lehigh students had a higher average of marks than those of any other institution represented at the camp. This gave Lehigh the Efficiency Cup. The Seventh Company composed exclusively of Lehigh men was officially rated as the best company at the camp. The Eighth Company with a fifty per cent. membership of Lehigh men was rated as the second best company at the camp. The Lehigh Rifle Team won the Intercollegiate rifle match and with it the honor of representing the R. O. T. C., Units of the 1st, 2nd, and 3rd Corps Areas in the National Matches at Camp Perry.

It is my good fortune to be the first Secretary of War who has been able to announce the establishment in time of peace of a national defense organization sanctioned by the Congress and defined by the President of the United States. It has always been understood that in the event of serious national emergency we would expand a small professional peace Army into a great non-professional War Army. The defect of this policy in the past has been that we have always deferred the organization of this national War Army until danger has actually come. Our new national defense law does not

change the type of this traditional American institution. It simply prescribes that the defect be corrected—that our traditional Citizen Army be organized in time of peace so that the actual units which may be required upon mobilization shall be permanently constituted and localized. This is the realization of Washington's words to Congress in 1790, when he said, "To be prepared for war is one of the most effectual means of preserving peace. A free people ought not only to be armed, but disciplined; to which end a uniform and well-digested plan is requisite."

This simplifies and defines the problem of preparedness for all of us and it particularly defines the purpose and objective of the training system in our schools and colleges. It has always been the mission of the Reserve Officers' Training Corps to train young men to serve as officers in the event of emergency. In the past this mission has been vague and its obligations uncertain. It has always been understood that they would serve as officers in such an Army as we might require in the event of war. But that Army did not exist as a vital national institution and therefore the reserve officer could have no definite conception as to the unit with which he might serve or the character of duty which might be expected of him.

The important constructive features of our military law were originally contained in the so-called Wadsworth Bill which was prepared by the Senate Military Affairs Committee during the last session of Congress. This Bill provided for a National Citizen Army and for a system of universal military training through which all of the units of that Army would be filled with trained men with an ample surplus for replacements. The military system proposed in this measure was similar in form to the military system of Switzerland but adapted to American conditions. This bill was not accepted in its entirety by Congress. Congress did provide for the national Citizen Army composed of the National Guard and Organized Reserves but it rejected compulsory military training. It provided, however, in the Citizens' Military Training Camps, for the germ of a national system of voluntary training. Through the development of these camps and of the system of training already established in our schools we may hope that the day is coming when every young man who is willing to take it will have an opportunity to prepare himself for service in one component or other of the Army of the United States. Under universal training all of the units of the Army of the United States would be filled to overflowing. Under voluntary training the number of trained citizens will, of course, be less, but I believe that we may reasonably expect enough of them to maintain the Regular Army and National Guard at effective strength and to provide the officers, non-commissioned officers and specialists and a considerable

number of the private soldiers required for the units of the Organized Reserves.

It is impossible to predict the number of young men who will undergo voluntary training. But I take it that as the system develops a number of influences will tend to increase its popularity. In the first place with an organized Citizen Army localized and officered in time of peace, it must soon become apparent that only those can hope to lead in war who prepare themselves for the responsibility of leadership in time of peace. Therefore, the young man who aspires to be any higher than a rear rank private upon mobilization will be impelled to prepare himself for leadership in time of peace. Another influence and I think a most potent one, will be the gradual development of the idea that it is the proper action for every self-respecting young American to give a portion of his time during his youth to preparation for effective service if his country should ever need it. I expect to see the development of a feeling of *Noblesse oblige* that will spur all patriotic young men to prepare for national service.

With our military policy and organization definitely settled by law, the mission of the Reserve Officers' Training Corps is clarified. We can now say that the young men of the Reserve Officers' Training Corps are being trained to serve in a definitely organized Army of the United States. After they receive their reserve commissions they will have an opportunity to join definite territorial units organized and established in the neighborhood of their homes. They will be officers of local units of the organized Citizen Army. They will know precisely what is to be expected of them upon mobilization. This will enable each reserve officer with the greatest possible economy of time to prepare for his assigned mission. This means more definite organization for the nation and a more precise understanding of the obligation incurred by the individual citizen soldier.

In the future, when a graduate of the Reserve Officers' Training Corps receives his commission and returns to his home he will find in that vicinity an organization either of the National Guard or of the Organized Reserves with which he can identify himself. His duty of preparedness will thus crystallize into the very definite duty of helping to prepare this particular organization for service in an emergency. When he joins this unit he will probably find enrolled in it older men of his acquaintance who have served in the World War and it will be a part of his mission to receive from them and to transmit to the future, the experience and traditions of the great War Army of 1918. He will report to this unit as a junior officer but a well defined pathway of promotion will be open to him, through which, if he has the time, the ability and the industry, he can prepare himself for the highest rank and the greatest responsibility in any future emergency.

The establishment of this national military organization will go far towards funding the cost of the World War as a permanent national investment. At several times in our past history it has been necessary at great cost of money and energy to create a great national military organization and then, after the emergency, we have demolished that organization without making any provision for making it available for the next generation that may be subjected to the burden of war. It is the great feature of our new military law that this defect in our national policy is corrected for all time. In our new organization we will actually perpetuate the principal military units that fought in the World War. We will assign each such unit to a definite locality. We will enroll in these units those veterans of the neighborhood who are willing to serve for a time until they can be replaced by younger men. The initial officer corps of this great Citizen Army will thus be provided by the veteran officers of the war. The problem of the R. O. T. C. has become the well-defined problem of providing gradual replacement for this veteran officer corps. In any future emergency, mobilization will not be a process of hasty organization and classification of millions of untrained and unprepared men but the much simpler process of filling the ranks of organized units assigned to definite localities and provided with competent officers and non-commissioned officers.

I have explained that the new law provides for an Army of the United States comprising the Regular Army, the National Guard and the Organized Reserves. It is very important for all of us to form a clear conception of this force as a whole and of its several components. The Regular Army comprises those organized military units which are always ready for immediate military service and it also includes the corps of professional officers and enlisted men who are required to train and develop the Citizen Army which comprises the National Guard and the Organized Reserves. The sub-division of this Citizen Army into two separate parts is a logical one. But there should be no rivalry between these two parts. The National Guard is that part of the Citizen Army prepared for any sudden emergency as a first reënforcement of the Regular Army and is composed of those citizen soldiers who voluntarily assume that special obligation. The Organized Reserves will comprise those citizen soldiers who obligate themselves to serve only in the event of a great national emergency. There must be harmonious relation between these two forces. The proper development of either should advance the development of the other. Those young men who desire continuous military service for a time will find their place in the Regular Army. Those who desire service only in periods of emergency but who are prepared for any emergency will find their place in the National Guard. Those who are able to obligate themselves only in

the event of a great war will find their proper place in the Organized Reserves. In practice there should be an interchange of personnel between these two forces. Every young man who desires to become a member of the Army of the United States and who is free to take the special obligation involved, should be encouraged to enter the National Guard. Later, the same man, when business and family obligations restrict his freedom for military service, will transfer to the Organized Reserves.

There has been an impression in some quarters that the development of the Citizen Army will tend to reduce the importance of the Regular Army. It is indeed true that by the development of effective citizen forces, we make it possible to reduce our regular establishment to a safe minimum. But the development of the Citizen Army in time of peace provides the greatest field for constructive work that our regular officers have ever had. Considering the Army of the United States as a whole, the Reguar Army forms the keystone of the arch. But its trained officers and men serving in institutions like this and with the National Guard and the Organized Reserves form the cement which binds all of the members of the structure into one complete and permanent whole.

Thus we find that the Reserve Officers' Training Corps has a more definite mission than was anticipated at the time of its inception. It was proposed then to prepare young men for an undefined service in the event of an emergency. It is proposed now, under the new law, to prepare young men to be officers in a definitely organized Citizen Army. The Reserve Officers' Training Corps will always be one of the most important agencies for training our citizen officers but it will not be the only agency. Through attendance at training camps and by actual membership in the Organized Reserves and National Guard, any young American with sufficient ability and industry will be able to prepare himself for a commission in the Citizen Army whether he is able to go to college or not. With this conception in mind it is important that we should not permit the R. O. T. C., to regard itself as a separate agency of preparedness. It is an important part but only a part of the machinery for developing leaders for the Army of the United States. Its members should, therefore, take every means of identifying themselves with the National Guard and Organized Reserves. I take it that the time is coming when many young men who come to college expecting to prepare themselves as reserve officers will come as members of the local military organizations formed at or near their homes. They will come here and enjoy exceptional opportunities to prepare themselves for leadership. But they will retain their identification with their home organizations and they will return to these organizations after their graduation. Their real title to leadership will be determined there.

Today the Government of the United States is determined to take such measures in time of peace as a prudent nation should take, not in the interest of, or with the thought of military aggrandizement, or military aggression against other nations, which the sentiment of our people and the fixed policy of our Government forbid, but in the interest of the preservation of peace among the nations of the earth, and the War Department appeals to the Universities and Colleges—the Institutions of Higher Education in our land—to give effective aid to this end by giving our intelligent educated college-bred men such reasonable means of military training and knowledge as will make better men of them, and prepare them to efficiently serve the country if need should arise.

FROM CIVILIAN CLOTHES TO SAM BROWNES

BY CAPTAIN ELBRIGE COLBY, INFANTRY, U. S. ARMY

"Your fitness for all future trust depends upon what you are now. No good soldier in his old age was ever careless or indolent in his youth. Many a giddy and thoughtless boy has become a good bishop, or a good lawyer, or a good merchant; but no such a one ever became a good general. I challenge you, in all history, to find a record of a good soldier who was not grave and earnest in his youth.—RUSKIN."

From what sources are the officers of the Army drawn? What are the necessary qualifications? These are probably the questions which first confront any young man who thinks of choosing the Army as a career.

Though the impression has got abroad that a West Point course is essential, this is not the case. Prior to 1917 those appointed from the Military Academy comprised only about 40 per cent. of our commissioned personnel, and now the figure is much nearer 10 per cent. There are other ways. You may spend four years in cadet gray before donning the Army blue. You may be appointed from the ranks. Or you may come direct from civil life. In any event, though, you have to be a male citizen of the United States and be between twenty-one and thirty years of age.

Each of these methods has its advantages. The West Pointer studies many subjects similar to those given in other colleges; yet he cannot wander vaguely around in a maze of "electives" and cannot seek for "snap" courses. He takes certain broadening cultural studies and also certain studies which have been found valuable for purely military purposes. He drills. He is subject to rigid discipline. He develops a definite military character. The four years by the Hudson in an Army atmosphere leave their stamp indelibly on a man; the prestige of the Academy is tremendous; and the training received there is undoubtedly valuable. Then, vacancies in the Army list are reserved for graduates, and others will only be appointed when there is room after the West Pointers have been commissioned.

To be commissioned from the ranks likewise has its advantages. Warrant officers and enlisted men, when commissioned, are given precedence when determining their initial rank over all but graduates of West Point. Many a high officer served his "hitch" as an enlisted

man. He who lives the life of a soldier before donning the insigna of an officer understands more keenly the soldier's point of view. The psychology of the squad room is part of his knowledge—acquired from intimate personal experience and not merely from a sympathetic understanding. If you have been a "buck" private yourself, you know how the mind of the "buck" private works. You know the inside of things; you have "learned the game from the inside" as they say. You appreciate the capabilities and the limitations of the average private and non-commissioned officer. Some of our most dependable officers learned the ropes in this fashion. A large number of successful military leaders attribute their success to their having served first as an enlisted man.

Coming into the Army direct from civil life is a more abrupt transition than either of these. You start under a slight handicap and without the thorough grounding of the "Pointer" or the "Old-timer." They are rated higher on the first list. They have the solid military background and have already developed the essential military traits. True, according to law, you must first be a reserve officer, or you must be an officer, warrant officer, or enlisted man in the National Guard, or you must be a member of the Enlisted Reserve Corps; or else a graduate of a satisfactory technical university, college or school. But, for the purpose of securing an appointment, you can enroll in the Enlisted Reserve Corps, or may even apply for a commission as a Reserve Officer, in which case your appointment will be expedited to make you eligible. But, even at that you're really a civilian. In general, in spite of the disadvantages of entering the Army in this way, there are definite advantages. A broader training, a wider experience, some varied work in civil life, act to prevent narrowness of viewpoint and may teach you many things that your friend who has never been anything but a soldier never learns.

Almost any Army officer will stoutly defend that method of entering the service which he himself chose, and will declare that he would not want to have done differently. Then there are some who have mixed the methods, and will defend their mixture. Some serve in the ranks, and then go to West Point. Some expose themselves to a liberal arts course at college, and then secure an appointment to the Academy. Some college men serve in the ranks and then go up for a commission. There are many ways, and it is difficult to say categorically which is best. If I should try to lay down a definite rule, exceptions—notable exceptions—would immediately spring to mind to deny the generalization. The method of entry really matters little. What does matter is yourself. Once the President of the United States has declared that he reposes "special trust and

confidence" in the "patriotism, valor, fidelity, and abilities" of the young lieutenant and signs the commission, a place on the lineal list is filled and, without prejudice to previous condition of servitude, the game is on. Thenceforth performance counts. The door of opportunity is always open. Whatever his early schooling, everyone may pass by promotion to the highest rank.

All the Army wants to know is your fitness in certain special things. If you go to West Point, the War Department will prescribe courses and assign duties to make you fit. If you come from the ranks or from civil life, you must pass examinations to demonstrate that you have learned these necessary things elsewhere.

There is a basic examination, which is the same for all branches of the service, covering mental, moral, physical, and professional matters. For some branches of the service there are special qualifications and a special type of training required; and additional mental and professional examinations are given for them. And all of these examinations are important. After the West Pointers and those from the ranks are taken care of, positions on the Promotion List are assigned in accordance with the marks received on the basic examination.

First is a physical examination. A man does not have to be a powerful athlete, or a fighter. But he must be sound. He must have no defects of sight or hearing, and no organic defects. Army duties are sometimes physically exacting. They require abundant vitality and a good, sound constitution. Of course, for the Air Service, there are additional requirements. Yet the normal examination is such as any active, healthy person who is fond of energetic outdoor life and outdoor sports can easily pass, provided he has not hurt himself seriously by overtraining of one sort or another.

The examination into moral character and general fitness is based naturally on letters of recommendation. However, it does not stop there. Anyone seems to be able to get plausible "recommendations." The examination board therefore takes advantage of their proximity to the applicant's home and of personal contact, and do not at all confine their inquiry to a mere perusal of the usual laudatory letter, going always to some pains to learn his general reputation. The boards investigate and observe his personality, his appearance, his tactfulness, his bearing, his past history, and his general adaptability to military service.

The mental examination is in two parts. Part one consists of such elementary subjects as: United States History, English Grammar and Composition; General History; Geography, Arithmetic, Algebra (equivalent to College Algebra), Plain and Solid Geometry, Plane and Spherical Trigonometry, and Elementary Physics. College

graduates, or graduates of schools maintaining senior units of the R. O. T. C. may be exempted from these subjects on showing that they have studied them in school with credit.

Part two of the examination is somewhat more exacting. Under certain limitations, which are probably subject to slight changes from time to time, the applicant selects three subjects from among the following: Analytical Geometry, Differential and Integral Calculus, Advanced Mechanics, Surveying, French, Spanish, English and American Literature, Electricity, American Constitutional Law and International Law, Military Law, Chemistry, Minor Tactics and Military Engineering. Certain exemptions, from time to time defined in orders, are granted in these subjects, notably to "honor graduates" at "distinguished" R. O. T. C. colleges.

Such is the nature of the basic examination. A general average of 75 per cent., with no grade lower than 65 per cent., is required to qualify for appointment. The relative position you will occupy on the Promotion List, which remains unchanged through the whole of your military career, is determined from the marks you receive on this examination.

If you seek an appointment in certain other branches of the service, there are additional requirements as follows:

Each candidate for appointment in the Air Service will be examined in one of the following subjects: Meteorology, Internal-Combustion Engines, Navigation, Advanced Physics.

For the Chemical Warfare Service, each candidate must submit proof of graduation from a college or university in a technical or scientific course satisfactory to the Chief of the Chemical Warfare Service.

For the Corps of Engineers, the following subjects are required, except that specially recommended graduates of R. O. T. C. senior units may be exempted: Physics, including electricity and magetism, heat, sound, and light; Chemistry, Geology, and Minerology; Topographic, Hydrographic, and Geodetic Surveying, including the elements of practical astronomy; Theoretical and Applied Mechanics; and Theory and Practice of Engineering Construction, including buildings, highways, retaining walls, dams, foundations, water supply and sewerage systems, and materials of construction.

For the Ordnance Department the subjects (from which, however, engineering graduates may be exempted by the Chief of Ordnance) are: Advanced Electricity, Chemistry of Explosives. Shop Practice and Power Application, and Science of Ordnance and Gunnery.

For the Signal Corps candidates must be graduates (or members of the senior class about to graduate[1]) of four-year courses conferring degrees in electrical engineering and in physics, except that if they are more than four years out of college, they must have since been employed in electrical industries or must stand an examination in Electricity and Magnetism, Telephone and Telegraph Engineering, or Radio Engineering.

Having passed these tests and received your commission, you are then ready for the hard life and the slender income that go with the work of a soldier. But are you? The education may be satisfactory. Yet there is more to the military career than mere education. Have you those habits of mind and that shape of soul which are necessary? It is a matter of temperament, a matter of the form of your character. Look yourself over carefully. Look into yourself carefully. Look backwards over your past life, recalling little incidents here and there. Determine finally if you have the real necessities.

There was once a time when all except graduates of West Point were appointed provisionally only. For two years they were on probation. During these two years their superiors determined if they were really adaptable to military life, and made certain that there would be no mistakes. This two-year provisional period has now been eliminated, and everyone receives his permanent appointment at the start. Still, it can hardly be said that any appointment is in reality permanent. Now we have frequent efficiency reports, and he who does not receive satisfactory ratings is placed in "Class B." That is, he is put on probation for a time. For indifference, for inefficiency, for the retention of avoidable bad habits, he may then be dropped from the rolls of the Army. As a matter of fact, then, the probationary period instead of being abolished has actually been extended to cover your whole military service. So it is all the more necessary that at the beginning you be the right type and have the proper inclinations, have the desires and aversions, the manner of mind and the code of conduct the Army needs.

Do not be allured by the mere glitter of accoutrements and the neatness of a uniform. Army life is not a dress parade; it is more likely to be grimy field service. Do not go into post life like a sentimental school-girl into a convent. Do not let a fervent love of war, a "thirst for some appointed field of action," or wild fancies as to "the passion and peril of battle" decide your career for you. There is little real fighting for any officer. During most of your years in uniform, our Army will be "a potential rather than an active, aggressive force," and the troops will spend most of their time

[1] This amplification extends to other requirements as to graduation mentioned above.

training and organizing for the combat to come, "constantly playing a game, perfecting their efficiency in fighting, their skill in tactics, but always in preparation for some future emergency."

Remember the Major General in the comic opera? The one who sings:

"When I first put this uniform on,
Said I as I looked in the glass,
'Tis one in a million, not any civilian My
form and my figure'll surpass."

He adopted the Army as a marvelous playground, as a fine passion, because like so many other gentlemen of England, younger sons especially, he had nothing else to do. He probably had a brother in the Church, and another in the Navy, and another "a diplomatic swell." All honorable professions, and fit for well-bred gentlemen. And as far as ambition went—well, they chose the Army, these fine gentlemen of England of whom we read such fantastic things in literature, largely for the reasons set forth by a famous man of letters:

> "On the whole it is love of adventure, of excitement, of fine dress and of the pride of fame, all of which are sentimental motives which largely make a boy like going into the Guards better than into a counting house."

All very fine and pretty, but it is not true. It may have been true of the British Army. It may even have been true of ours many years ago. If you insist on literature, look into your volume of Wordsworth and find his poem on the "Character of the Happy Warrior." Read it studiously and think over every phrase of it. Recall as you read that it is not metaphorical at all. It is related how one of the best soldiers of the last century went over it with a friend and pointed out, phrase by phrase, word by word, what his friend might well have known if he had watched the details of that great soldier's life: that it was entirely literal.

In other words, do not get too imaginative about Army life and the glamor of its ceremony. Do not fancy yourself Sir Philip Sidney giving away his last drop of water, or Alexander in the desert refusing a drink because his soldiers could have none, or Cæsar writing Latin conjugations home from Spain, or Napoleon hurling his splendid cavalry against the enemy at Friedland. Do not even imagine yourself performing prodigious feats of valor and accomplishing the impossible, to be decorated afterwards by the Commander-in-Chief. Get down to hard facts. Think not of what you would like to do. Think yourself over and see what you actually can do. You may be afraid of snakes or nauseated by a

butcher shop, as was one great general, and yet a successful soldier. Army life is not all dash and courage and death and glory. He who is to be an officer in the Army will spend most of his time instructing and training and leading others. In order to do this effectively he must have certain basic qualities to make him efficient. He must have these in addition to "the military instinct, the knowledge of the science and art of war, and the elasticity of mind and body" essential to a commander of troops on the battle-field.

An officer must be a gentleman. Sometimes one has the characteristics and character of a gentleman because he is "to the manner born." Sometimes breeding is acquired. There is one way it is not acquired. "Fur fourteen years, have Oi stood before yez as a sarjint," said Kelley to the troop, "but now I stand before yez as an orcifer an' a jintleman, by Act of Congress." It is not acquired by Act of Congress, though Congress must confirm your appointment. It is acquired by early training. It is closely akin to morals. It is evidenced by courtesy, ordinary courtesy and politeness, based on proper respect for the rights of others, proper regard for their rights, and refinement of conduct—avoiding anything gross in language, action, and intention. An officer should have this. The commissioned personnel is composed of gentlemen living like gentlemen. The officer should not be "hard-boiled" even to his subordinates, for the discipline of fear and the rule of bluff are not near so effective as the discipline and the rule based on an admiration and respect which others should have for everything he does. An officer is superior in rank, he should be so in character.

An officer must have a facile mind, practical, quick to perceive, ready and sure at analysis. Whether it is a tactical problem as to how to circumvent an enemy, or a psychological problem of tact as to how to handle a complex mix-up in his company, the officer must have a rigid impartiality, a fairness of spirit, and a zeal for the facts. He should want to get at every possible detail and want "to know all about it." If it is a company manœuvre, he must learn all the details; and just so certainly if it is "company punishment," he must hear both sides. In neither case must he jump at conclusions or settle the thing off-hand by rule. Neither must he hesitate. He must think clearly and decide without floundering. We have a saying in the words of our Field Service Regulations: "It is better to do any intelligent thing in conformity with the common plan, than to search hesitatingly for the ideal." This clear-cut thinking, exact and thorough, though rapid, is characteristic of the military mind. It decides rapidly, but never hurriedly, for hurry is not intelligent, and things done in haste are invariably badly done. Above all, facts count, results, practical results. The great commander

who always insisted on the practical and the real, said to his friends cooped up with him at St. Helena: "Why talk. There is no result in it; it comes to nothing that one can do. *Say* nothing if one can *do* nothing."

An officer must have a keen interest in his work. His interest must be solid and enduring, as befits the dignity of his profession. He is a participant, not a spectator. He must be serious and thorough, for it is deadly business when the lives of men are at stake. Not only in time of war, but also in time of peace. A false step in training means bad training, or poor spirit. He should not mistake facility for ability. He should fulfill his obligations toward the Army cheerfully, as a good citizen fulfills his social and community obligations, because he is interested in it, interested not only in his own progress, not only in the progress of the men under him, but interested in the progress of the Army as a whole and in the progress of military art as a whole. A famous and successful general has remarked:

> "My good fortune was the result of my close attention to all duties, no matter how small, that bore upon military work; to my insatiable greed for information upon war, its science and its practice; to my study of military history. I threw my whole heart and soul into the occupation, and deserved no credit for doing it, because in itself the work was a delight to me."

An officer must have personality. Personality is the outward expression of the other basic qualities, aided by certain minor characteristics. He must look and act like a soldier, for he is an example. He must be enthusiastic, openly so, but not unnaturally or flambuoyantly enthusiastic. He must want to do the things he has to do, and show satisfaction in getting things finished. Confidence is another attribute of personality, and it is very necessary; for if the leader vacillates and does not trust the truth of his own judgment, his followers will straggle off after other false truths of their own. The officer who sensibly and intelligently makes sure he is right and then fights it out along that line with force and firmness—he will be a real leader.

An officer must be loyal, loyal to the Army, loyal to his superiors, loyal to the interests of his subordinates, and loyal to his own self-respect. Think of the knights of old, their loyalty to their King, the vows, and their God. Their outstanding characteristics was their loyalty. A knight in the early sense of the word was a serving man. He served with the best that was in him. If you have the habit of loyalty, well and good. You obey orders because, however

inconvenient they may be to you, they have been devised by wiser minds than yours for the good of the common cause. One of the queerest things about the world today is the way in which ordinary people arrive at conclusions, usually wrong, on insufficent evidence, the way they speak general phrases with only isolated facts at hand in proof thereof, the way they would rearrange the whole government, or even the universe, if they had an opportunity, on the basis of the experience of two or three men, these people are often wrong. It is better to accept the authoritative doctrine. Accept it as dogma. Dogma is not the absence of thought, but the end of thought, as Chesterton has said. The thing has all been settled by careful thorough thinking, and further thought is useless. It is best for all concerned to obey the wise orders.

The youth with this frame of mind who can accept his authoritative orders cheerfully, not because he thinks them good, but because he knows that they cannot be anything else but good coming whence they do and being orders of the Army—he is the one who will make a loyal soldier. The soldier is proud of the Army. He is sure of the Army. He stands by the Army, in word, thought, and deed. He acts and thinks always in the interest of the Army. He stands by his superiors and works for them to bring about the results they desire. He likewise stands by, and never betrays, his subordinates, because he knows they will stand by him. All of the officers and enlisted men of the Army have a common object—success in battle. All work together. Cooperation is the rule of Army life in peace-time as well as in war. It is the rule of camp and station among individuals as it is the rule of campaign where regiments and divisions are concerned. Teamwork is the Order of the Day. Teamwork is necessary in garrison and in field. It is necessary for a civilian community to have discipline and uniformity, from the wearing of clothes to not committing murder. It is necessary for the Army to have discipline and uniformity so as to deliver the maximum man power and shell power at the time and place of battle. Obedience to orders produces teamwork. Loyalty to the common plan produces teamwork. Teamwork is the essence of tactics, or drill, or company administration, or battalion efficiency. Loyalty to the team, learned on college or school gridiron or diamond, loyalty in performance, not mere lip-loyalty—this has prepared many an athlete to be a good officer.

Such are the things the Army requires. Such are the things the Army demands. You might think that the old proverb held here as so often elsewhere, that "the sea-wall you build, and what main floodgates you establish in it, will depend on the state of the outer sea." Yet it is not so in the Army. We have decided on the qualifications which an officer should have—educational and temperamental.

We scrutinize and test carefully all applicants for admission—both before and after admission. In fact, we never cease to observe and to test them. If you are contemplating an Army career as a commissioned officer, study and ponder well the ideals we hold. If you can adjust yourself to them, good. Let us hope that they will fall upon you with the grace of a garment cut to fit your frame. The Army is inexorable. To its customs, traditions, spirit, and ideals, the character of the young officer must be "wax to receive and marble to retain."

EVOLUTION OF THE ARTILLERY WHEEL*

BY D. A. GURNEY, MEMBER A. O. A.

THE use of the present type of artillery wheel dates from the adoption of the Archibald type of wheel on the 3.18-inch iron gun carriage in 1881. Prior to that time the wheels used on artillery matériel had wooden hubs, spokes and felloes of the commercial type, still used to some extent on farm wagons, etc. The distinct features of the Archibald type of wheel are the hub construction, consisting of an inner flange integral with the hub box and an outer flange fitting around the cylindrical portion of the hub box and secured to the inner flange by bolts passing through the spokes, and the triangular metal dowels used at the joints of the felloes. The wheel used on the 3.18-inch iron gun carriage was 57 inches in diameter, had a tire width of about 3 inches, and 12 spokes. The felloe was made up of 7 sawed sections, and the total weight was about 180 pounds. The wheel was secured to the axle by means of a linch pin. This type of wheel was definitely adopted as the result of a series of tests by the Board of Light Artillery Officers, the report being dated April 28, 1881. The following claims were made by the Archibald Wheel company as to the advantages of this type of wheel.

(a) Every joint in both spokes and felloes is pressed together with such force and accuracy that the wheels will stand always in any climate.

(b) Each wheel is put together with a pressure 25 times greater than any weight it will have on it afterwards, and consequently it cannot be crushed by overloading.

(c) On account of this pressure the spokes can never work in the hub, nor can any moisture get within the hub to rust it or rot the spokes.

(d) They will stand more abuse and climatic changes than any other wheel.

(e) Hub box can be replaced readily.

(f) On account of the peculiar dowel used, the spoke can be replaced easier than with any other wheel.

The standard artillery wheel now used on all light artillery carriages and vehicles is a development of the original type of wheel above referred to, and while it has been greatly modified and improved, it still retains the distinctive features of the metal hub box described above and the triangular metal dowels. Numerous changes

* Reprint from *Army Ordnance* September-October, 1921.

have been made in the design of this wheel since its adoption with the idea of making it stronger and more serviceable, and of keeping its weight within a reasonable limit.

The more important of these changes are enumerated in detail below. In 1889 a comparative test was run of light and heavy wheels of this type, as a result of which the light wheels failed in the test. The weight of the wheels tested and adopted was about 188 pounds. In 1892 the wheels then used on the 3.2-inch gun carriage developed serious defects in the arrangement of the linch-pin washer and the hub-ring nut. The linch-pin washer was found to rotate with the wheel, producing wear, so this washer was modified by adding a stud, which prevented its revolving with the wheel. The hub-ring nut unscrewed at times and jammed the wheels between the linch-pin and the shoulder of the axle, accordingly it was secured to the hub box by a spline screw. The wheel used on the 3.2-inch gun carriages was 57.75 inches outside diameter with 2.75-inch tires, had 8 sawed felloes, 16 spokes, and was lubricated by applying grease to the axle arm with a paddle.

In 1898 the Ordnance Department undertook the design of an experimental 3-inch gun carriage. In order to lighten the wheel the tire and felloe widths were reduced .25 inch and the felloe thickness from 2.875 inches to 2.25 inches. The thickness of the hub flanges was reduced from .75 inch to .5 inch for the outer flange, and from .75 inch to .625 inch for the inner flange. A change was also made in the felloe to make it of 2 bent sections. The method of fastening was changed from a linch pin to a nut screwed to the end of the axle, and the wheel was lubricated from an oil chamber in the hub. In 1900 the wheel was changed to 56 inches outside diameter and 3 inches tire width, which is the same as the present steel-tired wheel. This wheel was used on the experimental short recoil 3-inch gun carriage. The tire thickness was reduced to 7/16 inch and the felloe thickness to 21/16 inches. The diameters and thicknesses of the hub flanges were also reduced. The wheel was secured by means of an inside wheel fastening similar to that shown in Fig. 2, and was lubricated from an oil reservoir in the axle.

In 1902, for use on the 3-inch gun carriage, model of 1902 (long recoil), the outside diameter of the wheel was reduced to 48 inches and the felloe thickness to 1.75 inches. The diameter and thickness of the hub flanges was also decreased, and the number of spokes was changed from 16 to 14. The weight of this wheel was 142.5 pounds. As the result of road tests of the experimental carriage and limber, it was decided that 48-inch wheels were too small. Due to their relatively poor showing in the road trials, a report was made that increased tractive force and consequent horse fatigue were necessary

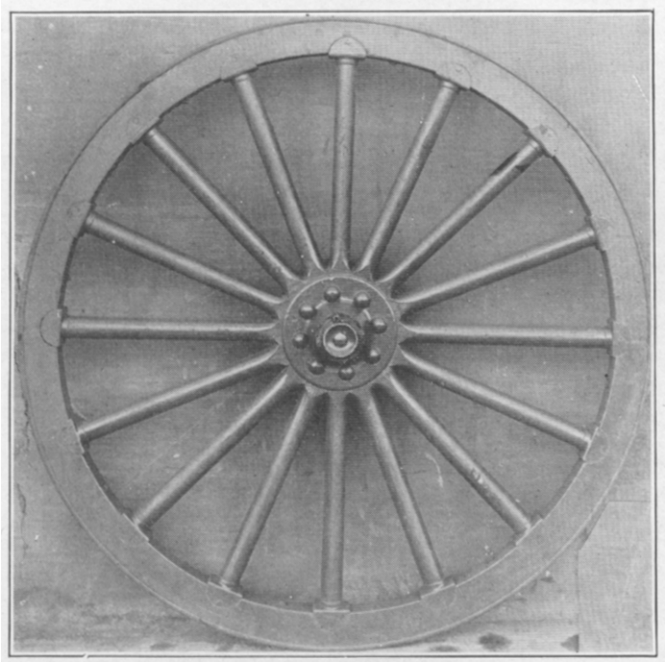
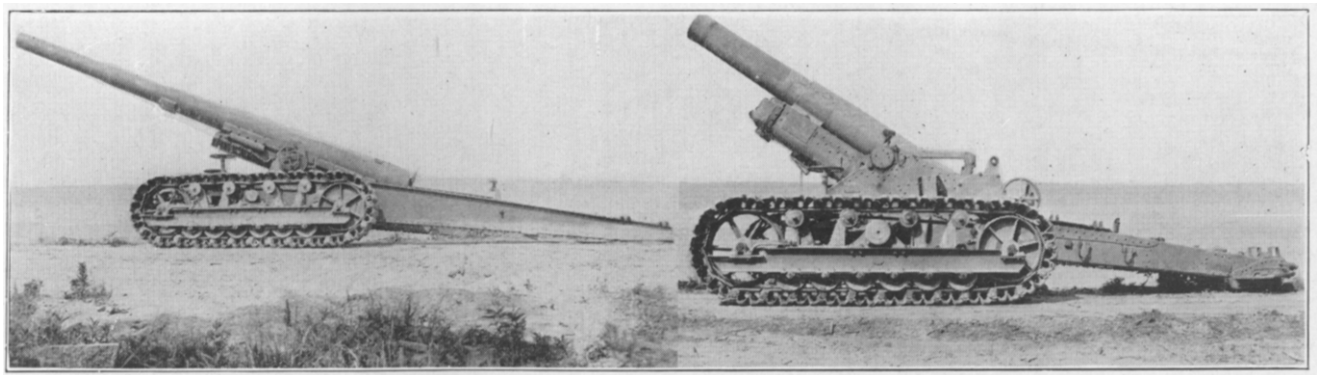


FIG. I. – THE STANDARD 56-INCH ARTILLERY WHEEL



LEFT: 155 G. P. F. GUN CARRIAGE EQUIPPED WITH CATERPILLAR ADAPTERS

RIGHT: 8-INCH HOWITZER CARRIAGE EQUIPPED WITH CATERPILLAR ADAPTERS

See Ordnance Notes II

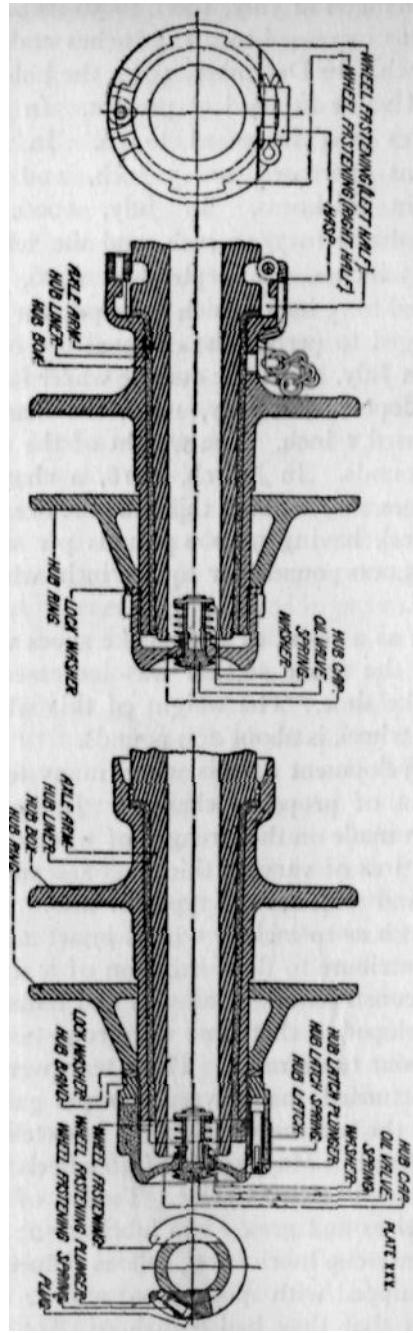


FIG.2.—LEFT: HUB WITH INSIDE WHEEL FASTENING. RIGHT: HUB WITH OUTSIDE WHEEL FASTENING

consequences of the reduced size of the wheels. In view of this fact, the wheels were changed in July, 1902, to 56 inches in diameter, the felloe thickness was increased to 2.125 inches and the tire thickness reduced to .375 inch. In December, 1902, the hub cap was modified by adding the oil valve as used at present. In March, 1904, the number of spokes was increased to 16. In April, 1905, the tire thickness was increased to .5 inch, and the hub flanges were increased in thickness. In July, 1906, the tire thickness was again reduced to 7/16 inch, and the felloe thickness was increased to 2.875 inches. In September, 1906, the tire thickness was again increased to .5 inch, which is its present thickness, and the felloes were changed to permit the optional use of 8 sawed felloes or 2 bent ones. In July, 1908, the outside wheel fastening, as shown in Fig. 2, was adopted. In July, 1912, the diameter of the hub flanges was increased 1 inch. The weight of the wheel at this time was about 185 pounds. In March, 1916, a change was made to prescribe bent felloes, and at about this time the tire steel was changed to high carbon steel, having 50,000 pounds per square inch elastic limit instead of 35,000 pounds per square inch, which had been previously prescribed.

In June, 1917, as a result of test, spoke shoes were adopted, and in August, 1917, the spoke section was increased to improve the design of the spoke shoe. The weight of this wheel, which is the present steel-tired wheel, is about 209 pounds.

During the development of this wheel many tests were made to ascertain the effect of proposed changes. In 1905 an exhaustive series of tests were made on the strength of wheels having 14 and 16 spokes, each with tires of varying thickness assembled with different amounts of dish and with several types of hub. The general scope of the tests was such as to include wheels intact and the elements of strength which contribute to the formation of a strong combination with lightness of construction. Caissons and limbers equipped with the wheels as developed at that time were road-tested for 6 months to a distance of about 1,000 miles. These tests were very severe, the vehicles being overturned, manœuvred at rapid gaits over obstacles, etc. At the end of the test the wheels were in excellent condition.

Tests were ordered in May, 1916, of 36 wheels which were made up specially and issued to the service. Twelve of these wheels had high carbon steel tires and grease-cup lubrication; 12 had high carbon steel tires, grease-cup lubrication, felloes reduced to 2.375 inches thick and were equipped with spoke shoe; and 12 were the same as the last 12, except that they had a dish of .875 inch per foot of diameter instead of .25 as has the standard wheel. This test was not entirely completed, due to the Mexican trouble and the outbreak of

war. Report was, however, received from one battery, and it was recommended that the grease-cup system of lubrication be not used. The wheel having the large dish, carbon steel tire, bent felloe and spoke shoes gave the most satisfactory service. The vehicles on which these wheels were tested were provided with tire brakes; and, due to the large dish, the brake shoe bore only on the inner portion of the tire. Due to this fact, the dish of the wheel was not changed, but the other features were adopted for war manufacture.

Numerous tests have also been made of wheels of cast steel, pressed steel, and with steel spokes and steel rims. None of these wheels has been found as satisfactory as the service wheel. They are in general considerably heavier, and failure occurs after a short road test. Good results were, however, obtained with a wheel for heavy artillery, having wooden spokes and metal rims. This type of wheel could possibly be developed for light artillery, although it might be heavier than the service wheel.

As artillery wheels are subject to very severe service, dish is given to the spokes to place them in better position to withstand side blows and side pressure caused by making sharp turns at rapid gaits. The dish of a wheel is generally expressed in inches per foot of radius of the wheel. The dish of the standard artillery wheel is ¼ inch per foot of radius and corresponds to an agle of approximately 1° 12′. One-half of this dish, or 36′, is obtained by making the hub flanges conical, and the other half of the dish by bending the spokes when the tire is shrunk in place. This latter part is called the "spring dish." One advantage of the spring dish is to assist in taking up shrinkage of the wooden parts of the wheel, since the spokes tend to return to their original straight position. In order to bring that spoke, which is in contact with the ground, into vertical position when the gun is fired, the axle arm is inclined downyard at an angle of 1° 12′. This inclination of the axle is called "set." The bottom element of the axle arm, which supports the traveling load in the hub box, must be horizontal in order to prevent longitudinal thrust of the wheel on the wheel fastening or on the shoulder of the axle. This is accomplished by making the axle arm conical to the same angle as the angle of set. This conical shape of the axle arm also facilitates the assembling and disassembling of the wheel. The seat for the spoke in the wheel hub should be, as nearly as practicable, normal to the axis of the spoke; that is, this seat should be a cone instead of a cylinder, in order that the thrust of the spoke should be as nearly normal to the surface of the hub as possible, and that the hub might be removed from the spokes easily in the case of making replacements.

For manufacturing reasons it is desirable that the tire should be a true cylinder in the finished wheel. This, of course, causes the

wheel to rest on the outer edge of the tire only when the vehicle is on a perfectly level platform, but for road conditions no practical difficulties are experienced with this construction. The felloe is made of rectangular section, well rounded at the inner corners.

The greatest improvement which has been made in artillery wheels in recent years is the addition of the spoke shoe. Prior to the adoption of the spoke shoe a great deal of trouble was experienced with the wear and breakage of the tenons of the spokes in the felloes and in the crushing of the wood of the felloe by the shoulder of the spoke. The spoke shoe provides greatly increased bearing between the spoke end and the felloe, and eliminates practically all wear at this point; also the felloe is strengthened, due to the fact that the hole for the spoke tenon is not required. With the design of spoke shoe adopted, it is a comparatively simple matter to replace broken spokes in wheels without the necessity of removing and resetting the tires.

The lubrication of artillery wheels is very important, since they are required to run for long distances with very little attention. The method of lubrication used on the standard artillery wheel is accomplishd by providing an oil reservoir in the axle which is filled through an oil valve in the hub cap, and this filling can be done without removing the wheel. The oil from this reservoir gradually seeps out around the end of the axle and back on to the bearing surface; dust is excluded from the bearing by the use of a leather and sheep-skin dust guard strapped to the axle at the inner end of the hub box.

While the standard 56-inch wheel (Fig. 1) is, in general, satisfactory for use at the highest speeds which may be expected with horse-drawn artillery, this wheel cannot be expected to give satisfactory service when the artillery is drawn behind motor trucks or high-speed tractors, unless the vehicles are spring supported. In order to provide a wheel which would be suitable for this high-speed service the 56-inch wheel has been cut down to 52 inches outside diameter and equipped with a 3.5-inch solid rubber tire, making the outside diameter 57 inches. This wheel weighs about 368 pounds and is known as the 57 by 3½-inch rubber-tired wheel. It is standard equipment for 75-mm. Gun Carriages, Model of 1916, Motorized. The hubs of these wheels and the general construction are identical with that of the standard 56-inch wheel.

For the new divisional split-trail carriages, a wheel of this same construction, but 48 inches in diameter with a 4-inch rubber tire, is being furnished. This wheel weighs 296 pounds. For the new divisional box-trail carriages, 75-mm. Gun Carriage, Model of 1921, and 105-mm. Howitzer Carriage, Model of 1921, this wheel has been reduced in weight by equipping it with a 3½-inch rubber tire, decreasing the thickness of the steel tire on felloe band, reducing

the felloe thickness to 1.5 inch, and cutting down the spoke sections and the thickness and diameter of the hub flanges. This latter wheel weighs 233 pounds complete with rubber tire. It has not been tested as yet, and, consequently, it is not known whether it will be satisfactory. It is thought that, due to the resiliency of the rubber tire, it may be strong enough, notwithstanding the considerable reduction in weight.

In view of the great difficulty experienced in obtaining satisfactory wood stock for artillery wheels during the recent war, it is very desirable to develop all-metal wheels for artillery purposes. This trouble has been solved in the case of the wheels used on Corps and Army Artillery, but no satisfactory solution of the problem for light artillery wheels has as yet been found. Various types of metal wheels have been experimented with, including the so-called resilient wheel, which depends for its action upon the use of springs, but none of the wheels tested possess the serviceability and shock-absorbing qualities of the wooden wheel. It is hoped at some time in the future to undertake the development of an all-metal wheel for this purpose, but, due to reduced appropriations and the press of other development work, this is not practicable at present.

NOTES ON THE RAPID INSTRUCTION OF FIRING BATTERIES FROM UNTRAINED PERSONNEL*

BY MAJOR H. C. VANDERVEER, FIELD ARTILLERY, U. S. ARMY

1. THE suggestions outlined below are the result of experience in training batteries of National Guard Field Artillery, in their armories and in camp, during 1921. The method has been applied to the training of some twenty batteries, has given good results in every case, and in several instances has produced firing batteries which, considering their very short period of training, were exceptionally accurate and smooth working.

2. In no case is it claimed that this method is at all superior to the methods generally in practice when the drill of the battery goes on daily over several weeks or months, as in the case of Regular Batteries.

3. The whole purpose of this method is to produce a firing battery in an extremely short time, from personnel often entirely untrained, and when there is a great shortage of competent instructors; as must be done when National Guard batteries arrive at their summer training camps without ever having seen their guns, and when it is desired to have them fire service ammunition at the beginning of their second week in camp.

4. In general it is necessary to have as instructors, for each firing battery to be trained, one commissioned officer, and four non-commissioned officers, preferably from the Regular Army. At any rate, the commissioned officer must be thoroughly familiar with the matériel to be used and with the proper drill and handling of the firing battery. He must put into the work a tremendous amount of "Pep" and must devote all his attention to it every day, being constantly present and in charge of the instruction.

5. The non-commissioned officers should preferably all be chiefs of section, and very thoroughly familiar with the type matériel used, and with the drill of the cannoneers on that matériel. However, two firing batteries have recently been trained upon the 155-mm. howitzer matériel, when only one non-commissioned officer was available who was at all familiar with the matériel. The other non-commissioned officers were selected from Chiefs of Regular 75-mm. gun sections, and did the best they could on unfamiliar guns. The

* The following scheme is not intended for use in Armory Instruction but rather for perfecting gun detachments at camps where organizations have had little previous training.—EDITOR.

result was quite successful; both batteries firing satisfactorily after six days training.

6. Before starting this instruction, the organization commander whose firing battery is to be trained is called upon to detail personnel for the firing battery, and is given clearly to understand that there is to be no change in this personnel during the entire training period, and that all men detailed must be present for the instruction all day every day. Except in the case of sickness or injury, no changes in the personnel are permitted, and it is not allowed that the men be absent from the gun squads because of guard, fatigue, etc. An effort should be made to detail the most suitable men in the first place, but it is not permitted to change a man after the instruction has begun, merely because it is thought that some other man may, prove more suitable.

7. For a French 75-mm. battery, the following personnel is detailed from the organization to be trained:

One executive officer.
Four sergeants, chiefs of section.
Four corporals, gunners.
Two recorders.
Four gun squads of 5 privates each.

Personnel for heavy batteries is selected on the same plan with obvious modifications. In no case are more cannoneers detailed than are needed for the operation of the guns, and in every case each cannoneer is assigned a particular number in a certain gun squad, in which post he works throughout the training period.

8. Of course, it is very seldom possible to secure as instructors four chiefs of section of equal ability, and this method of instruction is based entirely upon the effort to keep the instruction completely in the hands of the one commissioned instructor from start to finish.

9. For that reason it is prescribed at the start that no instruction whatever will be given to the sections individually. Even in the most elementary instruction the battery is drilled as a firing battery complete, and at every moment every man is entirely under the control of the commissioned instructor.

10. At the beginning of the first day's instruction the executive officer is told to watch the instructor, the chiefs of section are told each to watch the non-commissioned instructor with his section, and the two recorders are told to listen and become familiar with the commands. The remaining personnel is then divided up, with one corporal and five privates to each gun squad (assuming a French 75-mm. battery) and one non-commissioned instructor assigned to each section.

11. The cannoneers are then assigned individual posts, each in accordance with his own ability, as well as can be determined. From that time onward no changes in assignment are permitted.

12. The instructor then calls the battery to "Attention," gives "At Ease," and announces "The command will be, 'In Rear of the Piece—Fall In.' The sergeants will explain."

13. Each non-commissioned instructor then explains and demonstrates to his gun squad the formation of the squad, in rear of the piece. The instructor then commands "In Rear of the Piece—Fall In."

14. When this has been repeated until all the gun squads are thoroughly familiar with the formation, the instructor announces, "The next command will be 'Call Off,'" and the non-commissioned instructors again explain. When this has been sufficiently practiced, the command "Cannoneers' Posts" is similarly demonstrated, and after that the command "Prepare for Action" and "March Order."

15. In the training periods during the summer just ended, firing batteries have been drilled for about seven to eight hours daily. It has been found that the movements listed above, *i.e.,* "In Rear of the Piece—Fall In," "Call Off," "Cannoneers' Posts," "Prepare for Action" and "March Order" are about all that can be covered during the first day's instruction. To the end of securing smartness, these movements have been repeated more or less, during the instruction of all the subsequent days, and in all the instruction the utmost emphasis has been placed upon extreme precision, upon executing all movements at a run, and upon the most absolute silence and immobility of the cannoneers at attention. This has been insisted upon throughout with excellent effect. This insistence upon detail has been found necessary to hold the attention of uninstructed and undisciplined gun squads.

16. On the contrary, the cannoneers have never been held at attention longer than was absolutely necessary for the execution of a command or commands—never kept at attention needlessly, the shortest word of explanation or caution having been always preceded by the command "At Ease."

17. On the second morning of instruction, it has generally been found possible to begin instruction in firing data proper. The commands for this instruction have always been given in complete strings. That is, the command given has always covered all the items of data as would be done in actual firing, in such a way as generally to give each cannoneer something to do at each command. This has been found wiser than to give a long string of (for example) deflection changes, keeping the gunner busy while all the other cannoneers sit idle and gather a wrong impression of what actual service practice will be like.

18. For example, the instructor announces "My next command will be 'Right Ten, Up Five, 3400.'" After the non-commissioned instructors have explained the settings, this command is given and the fire simulated. Another string of data is then given, explained, and fired, in the same way, and so on.

19. This method of instruction is at first very slow, and the data must be very simple. But if absolute precision is insisted upon throughout it has been found that, after about the second day, the need to pause for explanations no longer exists. The battery can go through a simulated fire problem moderately well, and needing only supervision rather than explanation by the non-commissioned instructors.

20. Just as early in the instruction as possible, the chiefs of section should be required to perform their functions, the non-commissioned instructors exercising constant supervision over them, and making every effort to force them to realize their responsibility, and to "Get on the job."

21. Similarly, the commissioned instructor should put the executive in command of the firing battery just as soon as he is able to give the commands, and from that time onward should make every effort toward teaching him the duties of an executive and toward making him command the firing battery in a forceful and aggressive manner. This is of extreme importance—satisfactory results can never be expected from the firing battery unless its executive has not only a thorough knowledge of the drill regulations and of the proper sequence of commands, but also the force of manner and the willingness to insist upon proper and exact compliance with the commands given. The commissioned instructor must direct constant effort to assure that the executive officer under instruction will assert sufficient force of manner to properly command the firing battery and to make it work at top pitch.

22. While every effort should be made to make the executive and the chiefs of section perform their duties as early as possible, still this must not be done until their familiarity with their duties is such that the firing battery as a whole will profit by their instruction. In general, the best results seem to have been obtained by using the instructor and non-commissioned instructors entirely during the first two days, or in some cases three days, and thereafter alternating these instructors with the battery's own executive and chiefs of section, while the instructors endeavor by example to instill force of manner into the executive and chiefs of section. Whether actually exercising command or not, the instructors, both commissioned and non-commissioned, must remain in constant supervision and instantly correct every slightest irregularity.

23. At about this time the work should be made more complicated by frequent commands for deflection difference, by setting out aiming stakes, by establishing parallel fire on one piece, by marking the basic deflection, and by frequent changes in the method of fire, also by instruction in the preparation of fuses for shell. This should be continued, and made increasingly difficult from day to day, until the battery is ready for service practice.

24. During all the commands for firing data the recorders are required to keep a proper record, being instructed by the commissioned instructor. This record is used throughout in checking data, and the same recorders are used when the battery later fires service ammunition.

25. In general it has been thought wise to leave out any instruction in commands not absolutely necessary to train the men to shoot the guns. For this reason no instruction has been given in "Change Posts, March," or in falling in the squads in any position except in rear of the pieces.

26. It is frequently necessary to extend such training as this over many hours daily—of course great care must be taken to provide frequent rests and diversity of instruction. This can well be done with periods of instruction in care of the gun, care of ammunition, dismounting wheels, breech blocks, etc., and by dismounting the gun from the cradle; as well as by short talks illustrated with sectionalized ammunition and fuses, etc.

27. It has been found that the resulting service practice is improved if the standing gun drill is carried on with the trail holes dug, trail logs in position, etc. And with these comparatively inexperienced cannoneers, a very considerable increase in accuracy of height of burst can be obtained if all the numbers three are required to call out the new corrector setting after each corrector change. This same result can be still further advanced during service practice by taking the time to have each number three call out the time of burning set on his fuse after cutting.

28. Most of the units to which this system of instruction has been applied during the past summer have had practically no previous instruction of the firing battery, and many of them had never before seen their guns. In every instance the firing battery has been ready for service practice before the drivers (or tractor drivers) were sufficiently instructed to haul the guns to the firing point. In general, the time necessary to make the firing battery ready for service practice has ranged from four to six days of instruction, and the service practice which has followed has certainly been as good as could be expected after this very brief period of training—the firing batteries have always been better than were either the drivers or the special details.

29. The instruction received by the cannoneers seems to have been sufficient throughout. In every case the resulting firing battery has corresponded exactly to its executive. The poorer of the firing batteries have been those whose executive officers lacked capacity—those firing batteries whose executive officers were already "made," or whose executive officers, though inexperienced, had natural capacity, have done surprisingly well. That is, the firing batteries, given each the same amount of training, have varied exactly with the ability of their executive officers.

30. There have been instances when not enough regular non-commissioned officers were available, and the more experienced National Guard non-coms were used in their places. In several instances there were not enough regular commissioned officers, and each Regular Officer had to handle three firing batteries, the guns being put on three sides of a hollow square, with the Regular Officer taking post between. In one instance, two Howitzer Batteries were trained with only one non-commissioned officer who had experience on the gun being used—the others learning as they went along. In each case the result seemed better than could reasonably have been expected.

31. Two things only seem to be absolutely necessary. The commissioned instructor must know his business thoroughly, and be forceful and on his toes every instant. And the guns in use must be completely equipped before the instruction begins, with sights, fuse setters, drill cartridges, etc. It is impossible to train cannoneers by asking them to imagine an instrument which they have never seen.

32. It is not claimed that the methods set forth above are anything new or that they have not been used many times before. This is merely a report upon an effort to train firing batteries in a very brief time from entirely uninstructed personnel and with an extreme shortage of competent instructors. The method's outstanding advantage is that it keeps all the instruction directly in the hands of one instructor who is competent and that it develops one firing battery evenly, rather than four gun squads unevenly.

A SOLUTION OF THE THREE POINT PROBLEM

BY MAJOR C. L. CLARK, 17th FIELD ARTILLERY

IN the past, in the solution of the three-point problem for the location of artillery positions, various graphical methods have generally been used.

An attempt is made herein to give a simple and practical solution of the same problem by analytical geometry.

Let A, B and C be three points, whose plotted positions, or rectangular coördinates are known, and α and β the angles subtended by the lines AB and BC, respectively, as they are viewed from P, the position of the observer (Fig. 1).

The location of the point P is desired.

The graphical method upon which the analytical method is based is found in Trigonometry as follows:

"Construct on AB the segment of a circle AX′B that shall contain the measured angle α, and on BC, the segment of a circle BX″C that shall contain the angle β. Their point of intersection will be the position of the observer."[1]

All the angles constructed on AB in the segment AX′B will equal the angle α; all angles constructed on BC in the segment BX″C will equal the angle β. At the point of intersection of the two segments, P, and at this point only, will AB and CD simultaneously subtend the measured angles α and β, respectively.

The analytical solution is adapted only to problems involving rectangular coördinates.

Assume rectangular axes at B. For convenience in writing the new coördinates of the points A and C, the axes should be taken either parallel or perpendicular to the axes with relation to which the points A, B and C were formerly located.

The solution consists in finding the point of intersection P (x, y) of the circle, passing through A (d′, e′), B (o, o) and X′ (b′, o), and the circle passing through C (d″, e″), B (o, o), and X″ (b″, o) by solving simultaneously for x and y.

Since the angles α and β are known the values of b′ and b″ may be found from the equations

$$b' = d' + e' \cot \alpha$$
$$b'' = d'' - e'' \cot \beta.$$

[1] This graphical solution is described in paragraph 214, Document 51A, School of Fire.

The general equation of a circle is

$$x^2 + y^2 + 2gx + 2fy + C = O \qquad \text{I}$$

The values of g, f, and c are desired.

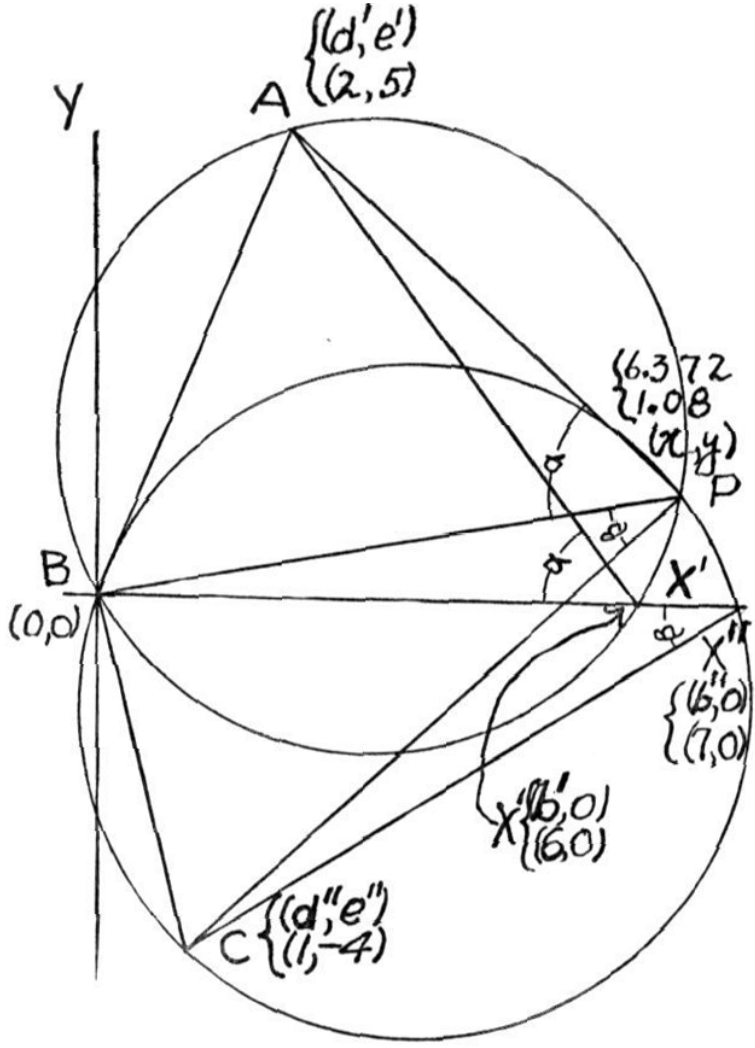


Fig 1.

Substituting coördinates of points:

B (o, o) gives C = O.

X (b′, o) and c = o gives $g = -\frac{b'}{2}$

A (d′, e′), c = o, and $g = -\frac{b'}{2}$, gives $f = \frac{b'd' - d'^2 - e'^2}{2e'}$

Substituting these values in I circle ABX′ is represented by

$$x^2 + y^2 - b'x + \left(\frac{b'd' - d'^2 - e'^2}{e'}\right) y = o \qquad \text{II}$$

Similarly circle BCX″ is represented by

$$x^2 + y^2 - b''x + \left(\frac{b''d'' - d''^2 - e''^2}{e''}\right) y = o \qquad \text{III}$$

Subtracting II from III

$$x = y\left(\frac{\frac{b'd' - d'^2 - e'^2}{e'} - \frac{b''d'' - d''^2 - e''^2}{e''}}{b' - b''}\right) \qquad \text{IV}$$

Letting $M = \frac{b'd' - d'^2 - e'^2}{e'}$

and $N = \frac{b''d'' - d''^2 - e''^2}{e''}$

II, III and IV become

$$x^2 + y^2 - b'x + My = o \qquad \text{(a)}$$

$$x^2 + y^2 - b''x + Ny = o \qquad \text{(b)}$$

$$x = \left(\frac{M - N}{b' - b''}\right) y \qquad \text{(c)}$$

Letting $\frac{M - N}{b' - b''} = K$, (c) becomes $x = Ky$ (d)

∴ Substituting value of x in (a) gives

$$y = \frac{b'K - M}{K^2 + 1}$$

and substituting value of y in (d) gives

$$x = K\,\frac{b'K - M}{K^2 + 1}$$

Numerical solution:

Let A (d′e′) be (2, 5)
B be (o, o)
C (d″e″) be (1, – 4)
C (d″ e″) be (1, – 4)

$\alpha = \tan^{-1}\frac{5}{4}$

$\beta = \tan^{-1}\frac{2}{3}$

$b' = d' + e' \cot \alpha = 2 + 5 \cdot \frac{4}{5} = 6$

$b'' = d'' - e'' \cot \beta = 1 + 4 \cdot \frac{3}{2} = 7$

$M = \frac{b'd' - d'^2 - e'^2}{e'} = \frac{12 - 4 - 25}{5} = -3.4$

$$N = \frac{b''d'' - d''^2 - e''^2}{e''} = \frac{7 - 1 - 16}{-4} = 2.5$$

$$K = \frac{M - N}{b' - b''} = \frac{-3.4 - 2.5}{6 - 7} = 5.9$$

Therefore
$$\begin{cases} y = \dfrac{b'K - M}{K^2 + 1} = \dfrac{6 \times 5.9 + 3.4}{34.8 + 1} = 1.08 \\ x = K\dfrac{b'K - M}{K^2 + 1} = 5.9 \times 1.08 = 6.372 \end{cases}$$

The coördinates of P with reference to B are thus known, and the coördinates with reference to the former origin may be written.

DISCUSSIONS

A Criticism of "A Study—Types and Proportions of Projectiles and Fuses Required as a War Reserve for Field Artillery," as Published in the November-December Issue of the Field Artillery Journal

BY BRIGADIER-GENERAL AMOS A. FRIES, U. S. ARMY
CHIEF CHEMICAL WARFARE SERVICE

THE great leaders of all time have studied the past in order to discover the big underlying causes that lead to success. They paid little attention to exceptional cases or minor details. When they found the causes of success, they did not copy the methods learned but used them as guides to develop means of winning their own battles. Each *military* genius has realized that all methods of war change with improvements in weapons and with the growth of general knowledge. Each realized that the individualities of the opposing commanders often had as much to do with the outcome of battles as the methods and weapons used. Each also realized the racial characteristics, physical vigor, patriotism, and training were powerful factors in every war. In short, they studied not to get fixed rules of combat but to train their own minds along proper military thought, and for guides to help them in solving their own peculiar problems.

And every one of them who stands out today as a great leader developed some new method, or applied some old method in a different and more efficient manner than hitherto, always taking into consideration the character of his opponents. This was true of the Greeks and Alexander, of Hannibal and Hasdrubal, of Napoleon and Frederick the Great, and of Stonewall Jackson and Grant.

And so it will be in the future. The general who wins will be the one who is the most progressive along sound lines, who sizes up correctly his opponent and who then pushes his own carefully considered methods with the greatest energy and persistence.

Applying these rules to the study in question, we find almost every one of them violated so far as Chemical Warfare materials are concerned. I have not tried to analyze the rest of the study, so will content myself with a discussion of Chemical Warfare matters only.

The first paragraph is excellent, the outstanding thought being that simplicity always goes with greatest efficiency. The second paragraph is also excellent, as it sets forth clearly the usual missions of artillery and then defines the terms used to designate those

missions. But the instant the writer left generalities and definitions and passed to details in paragraph three he went wrong. He went wrong because he used the facts gleaned from the World War as exact patterns for the future, thereby violating the first rule of all proper historical study—*i.e.,* the events of history are *guide posts,* not *roads*.

So much for generalities—now for details of specific mistakes. In sub-paragraph three of paragraph (3), the writer says "smoke shell are not tactically used against either matériel or personnel." What about white phosphorus—the material that burns with an unquenchable flame, wet or dry, and which cannot be brushed off clothing or flesh? Did the writer never hear of the dread of white phosphorus instilled into the minds of every German during the latter part of the war by white phosphorus fired from four-inch Stokes mortars by the Chemical Warfare Troops? There is no known instance where the Gas Troops, once they got in range, failed to drive the Germans from their machine guns with white phosphorus. And yet white phosphorus is one of the best smoke materials ever tried in war.

Beginning with line 7, page 620, the statement is made that "gas can be only used under certain conditions. In general, winds must be favorable; the area gassed cannot be immediately occupied, etc." These statements are utterly wrong not only as regards the future, but as to the actual happenings of the World War. The Germans in the very first days of the Great Drive across the Picardy plains in March, 1918, used gas under practically all conditions, regardless of weather, wind or the character of the advance. It is a well-known fact that the Germans used diphosgene, a nonpersistent gas, during the advance almost to the moment when their troops reached the English lines. At first they used mustard gas before the attack only along those fronts they were not going to attack heavily, or not attack at all. But it was only a few days later when they used mustard gas during the attack itself on strong points which they wished to avoid. In that manner they took Armentieres without loss.

Later the statement is made on the same page that high explosive and in some cases shrapnel can be substituted for gas where ordinarily gas would be used. The idea conveyed is that high explosive is as good practically in all cases as gas. Then why use gas at all? Half-hearted action anywhere, at any time, invites disaster. Why is gas being considered everywhere—Army, Navy, Air Service and by every nation today? There is just one reason. The World War proved beyond a shadow of a doubt that gas will get more casualties per ton of matériel transported to the front than any other element of war ever invented. Our gas casualties were 27.3 per cent. of all

our casualties—killed and wounded—and if we consider only the wounded admitted to hospitals, over 31 per cent. were gas alone; and that in spite of the fact that the German probably on an average fired less than one-sixth the number of gas shell as high explosive and shrapnel. Perhaps you wonder why he did not fire more gas. The answer is simple: he didn't have it. During the first four days of the Argonne fight he fired almost no gas shell whatever. And yet he never in the whole war had so fine a chance to make a killing with mustard gas as during that time. Again the answer—no mustard gas. He had used all his reserves on the British and French earlier in the season and thus had only his daily production to fall back on. The army in the future that uses the most gas efficiently will win.

On page 621, near the bottom, while discussing the use of the 75-mm. gun in barrages, the statement is made that "*Gas* shell will probably not be used on account of the difficulties it would cause our troops." Napoleon said, "It is necessary to break some eggs in order to make an omelet." We recognized that fact when we drove our men so close to our high explosive and shrapnel barrages that we had many casualties from our own shells. Why did we do that? So our men could get into the German trenches before the German machine gunners hiding in deep dugouts could man the trenches and mow our men down with machine-gun fire at short range. Then why fear gas for the same purpose? If you can make the enemy wear masks all during the advance, including the attempt to get out and man the trenches after the barrage has lifted, you add an additional burden of discomfort and danger to your high explosive and thereby aid powerfully in overcoming those of the enemy who still have the nerve to fight. And the danger to our own troops from gas is far less than that from high explosive. Should our men run into a pocket of their own gas, they only have to put on their masks to be perfectly safe. If they have to fight in the masks when they get to the trenches they will be no worse off than the enemy. Indeed they will be much better off, because the enemy will have had to wear his mask all during the artillery preparation as well as during the actual advance.

But above all let us not forget this fact. The enemy will be drenching our infantry with a counter-barrage of gas during every step of the advance. Are we then going to let him force our men to face that danger and wear masks while avoiding that additional burden himself? If we win, the artillery will fire gas during every movement of troops no matter what the weather or the direction of the wind. And let us not forget that our mask will be better than that of the enemy. That is one of the Chemical Warfare Service's jobs and I have just enough confidence in the ingenuity and energy

of the American to guarantee that the American Chemical Warfare Service will be just a little ahead of the rest of the world in masks as in gases.

In the middle of page 622 the statement is made that "* * * gas shells for the 75-mm. are not as effective for interdiction as for harassing." But why?

The writer on page 619 defined interdiction fire as "all fire delivered for the purpose of preventing or impeding the movement of supplies, matériel, or personnel." What could be more effective for that purpose than the so-called "high-explosive" mustard-gas shell introduced during the last days of the World War by the Germans? Now all know that the death-rate from mustard gas in our Army was very low—probably below one per cent. of those injured. But that was not true of the high-explosive mustard-gas shell. Just as an example, a German dugout captured by our troops during the Argonne advance and occupied by seven Chemical Warfare Service officers was struck by one of those shells fired by the retreating Germans. It struck just at the entrance to the dugout. Five of those officers died and one was blinded. The reason? Because the large amount of high explosive atomized the liquid mustard into millions of minute particles that were still liquid but which were readily drawn into the lungs. In that way a man will draw in a single breath or two a quantity of mustard gas which it would take hours to get as a true gas under the usual concentrations encountered in the field. It is recalled, of course, that mustard gas evaporates so slowly that in the warmest, driest summer days it will linger where spilled on the ground for about two days, while in cool, moist weather it may be dangerous for two to four weeks.

But even the nonpersistent gases such as phosgene are more useful often than any high explosive for interdiction. And the larger the shell the more effective, since the concentration is greater. Then, too, in long-range, high-powered guns where the finest ballistic qualities are desirable, solid gases can be used to fill say only 15 per cent. of the cavity of the shell. In such cases you will get almost the maximum effect of the high explosive in addition to the terrible harassing effect of the gas.

The statement made on the bottom of page 623 to the effect that gas will not be used in the offensive barrage is answered by the previous criticism of similar remarks in regard to the 75-mm. gun. The same is true of the remark of the same nature in the seventh and tenth lines of page 624. As they used to say when reporting us at West Point for various infractions of discipline "same at same" for the fifteenth and sixteenth lines of the same page.

Later, in the middle paragraph of that same page, the high explosive expert comes to the front. We of the Chemical Warfare

Service heartily agree with all sentiments expressed to the effect that high-exposive shell only will be used for destruction of matériel. But it is only rarely that matériel useful to the enemy and dangerous to ourselves is not accompanied by personnel of some kind at least a part of every twenty-four hours. And when there is flesh present—whether human, animal, or fowl—gas is indicated, as the doctors say, and we will be negligent if we fail to prepare ourselves to so use it.

Again on page 625, in the middle paragraph, the statement is made that "Gas shell is not provided in the offensive barrage as its use might limit the movements of our own infantry." It will not limit the movements of our own infantry unless we make our troops afraid of gas by failing to practice with it in peace on the score that it is too dangerous.

CURRENT FIELD ARTILLERY NOTES

Notes on Computing Triangles

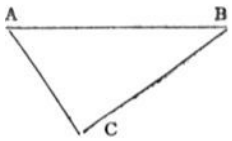
BY CLAUDE GILBERT BENHAM, JUN. AM. SOC. C.E., CAPTAIN, 21st FIELD ARTILLERY

I SUBMIT below two forms for solving triangles and some notes thereon. They should be helpful for those who have no system of their own, as it is well known that many officers and engineers who have the requisite knowledge seem unable to solve triangles rapidly and with certainty, they go from one side of the page to another with a lot of disconnected figures.

First Case Form No. 1. Having given one side and the angles; to find the remaining sides.

Rule.—Add the log. of the known side, A - B; the co-log. sine of the angle opposite that side, C, to the log. sine of the angle opposite the required side, A. This sum is the log. of the required side, CB.

Note.—The known parts are set down in the form following. It will be seen that all figures above the double line are known. The addition for both sides can be quickly done by placing a pencil, laid flat over the log. sine not being used in the calculation.

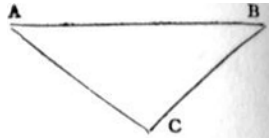


	Angles	Sides	Function	
A-B		880.1	log.	2.9445324
C	100º-05′-40″		a. c. log. sin	0.0067716
A	57º-02′-20″		log. sin	9.9237827-10
B	22º-52′		log. sin	9.5894893-10
Check	180º-00′-00″			
C-B		750.1	log.	12.8750867-10
C-A		353.1	log.	12.5407933-10

FORM NO. 1

Second Case Form No. 2. Having given the sides and an angle opposite one of the sides; to find the remaining angles.

Rule.—Arrange the known parts in the form given below. Add the co-log. of the side B – C; the log. sine of the angle opposite that side, A; and the log. of the side A -C. This sum is the log. sine of the angle opposite the side A – C.



	Angles	Sides		
B-C		165.8′	a.c. of log.	7.780414
A	37º-42′		log. sin.	9.786416
A-C		119.5	log.	2.077368
A-B		243.7	log.	2.386856
B	24º-17′		log. sin.	19.614198–10
C	115º-59′	(supl.)	log. sin.	19.953686–10
Check	179º-58′	—		

FORM NO. 2

Angle C is similarly found by substituting the side A – B for A – C in the addition.

It may be seen that the work is compact, easily checked, and in convenient form to be laid away for future reference. The logs. and log. functions of the known elements of the triangle are taken from the tables at one time before making the addition.

No claim is made that the methods given herein are original with me. Credit for much of the matter herein is due to Mr. Shirley Carter, Senior Engineer, Engineer Department at large.

Ordnance Notes

I

EXPERIMENTAL SIGHT MOUNTINGS FOR THE 75-MM. GUN CARRIAGE MODEL OF 1897, MI.*

THE sight used at present on the above mentioned gun carriage is the original sight, model of 1901, of French design (Fig. 1). It consists principally of the sight bracket (A) which is bolted to the left hand rocker arm, the azimuth or deflection mechanism (B), the angle of site mechanism (C) and the collimator sights (D) and (E).

The collimator sight not being of the telescope type renders the

* Reprint from *Army Ordnance,* July-August, 1921.

observing of objects not discernible by the normal eye impracticable; therefore direct fire on such objects is rendered somewhat difficult. With the above mentioned conditions prevalent, it will therefore be necessary to equip the carriages with a more suitable sighting system, preferably one using the panoramic sight, model of 1917.

The experimental sight mountings, types A and B shown in Figs. 2 and 3 respectively, have been manufactured to meet the requirements and have been shipped to Aberdeen Proving Ground for application to the gun carriages and tests.

The experimental sight mounting, type A, Fig. 2, consists of the bracket (A) into which is inserted the extension (B) upon which is mounted the angle of site mechanism (C) and the sight support (D) which can be cross-leveled by the knob (E) and clamped by the lever (G). (F) is the cross-level. (H) is the panoramic sight, model of 1917. The extension (B) can be withdrawn from the bracket (A) by releasing the clamp screw (J).

The experimental sight mounting, type B, Fig. 3, is practically similar to the type A, except that the extension pieces are of sheet steel which are in turn riveted fast to the left hand rocker.

Modified Quadrant Sight, Model 1918.—The Schneider Quadrant Sight, or Quadrant Sight, Model 1918, which will be used with the 8-inch Howitzer and 155-mm. Gun Carriages, Model of 1920E, has, for these carriages, been modified in certain respects to overcome difficulties experienced with the original sight. If the modifications made prove satisfactory, it is probable that they will be applied to all quadrant sights, model 1918, used with new matériel and possibly to sights now used with existing carriages.

The changes which are shown in the accompanying photograph, Fig. 4, consisting chiefly in the application of an improved method for holding the panoramic sight and the addition of a magnifying lens to assist in reading the elevation scale.

The improved method of holding the panoramic sight consists in the substitution of the socket (B) for the original type of panoramic sight holder. The addition of the socket (B) has been accomplished by cutting off the original panoramic sight stud, threading the upper part of the curved shank (A) and screwing the bracket (B) firmly into place, where it is held by a taper pin. The bracket (B), as indicated, supports the panoramic sight (H) both by its T-lug and by means of the recess machined in the underpart of the panoramic sight body. The panoramic sight is held securely in the socket by the clamp shown, which is provided with a strong spring for holding the sight rigidly in place. This method of holding the panoramic sight is far more rigid than the older method where the

T-lug alone was used, and insures that the panoramic sight will always take the same position.

On account of the fineness of the graduations on the elevation scale of this sight, it was found quite difficult to set the sight quickly and accurately. For this reason the magnifying lens carried by the housing (F) has been added, which increases the apparent size of the graduation to about twice the original size and renders it possible to see the graduations distinctly at the normal eye distance. A spring cover (G) is provided for the protection of the reading lens when not in use.

II

CATERPILLAR ADAPTERS FOR THE 155-MM. GUN CARRIAGE, MODEL 1918 (FILLOUX) AND 8-INCH HOWITZER CARRIAGE, MARK VI AND VII.†

THERE was recently completed at the plant of the Harrisburg, Manufacturing and Boiler Company, Harrisburg, Pa., and shipped to the Aberdeen Proving Ground, Maryland, for test, caterpillar adapters sufficient to equip gun carriages of one battery of 155-mm. gun carriages, model of 1918 (Filloux), and two batteries of 8-inch Howitzer carriages, Mark VI and VII.‡ The purpose of caterpillar adapters for these two types of field carriages is to distribute the heavy axle load over a greater surface on the ground and thereby permit the manœuvring of these heavy carriages over soft, swampy ground which would be impassable for the regular field carriage provided with the round wheels. These caterpillar adapters, designed in the office of the Chief of Ordnance, carry out the approved recommendations of the Westervelt Board Program.

The caterpillar adapters are a redesign of those developed during the World War. The truck roller frame, axle brackets and brake mechanism have been redesigned, but the track, links, blank sprocket, truck rollers, supporting rollers, roller bearings and other minor parts are standard 10-ton artillery tractor parts.

The internal expanding brake encased within the sprocket is actuated by a cam, which receives its motion from a hand wheel through a set of helical gears and a lever connected by a brake rod.

Application of these caterpillar adapters to the 8-inch Howitzer carriages, Mark VI and VII, necessitates removal of the wheels and brake mechanism and replacing with corresponding parts, the axles, axle brackets, traversing pivot and gear box, cover and traversing hand wheel and shaft.

Application of the caterpillar adapters to the 155-mm. gun carriage,

† Reprint from *Army Ordnance* September-October, 1921.

‡ See illustration under "Evolution of the Artillery Wheel."

model of 1918 (Filloux), necessitates the removal of the wheels and brake mechanisms. The axle bracket on these adapters differs slightly from those applied to the 8-inch Howitzer carriages. It consists of two parts, an axle bearing pivot plate bolted rigidly to the roller frame and an axle bracket bolted to and pivoted in this plate, thereby permitting the spreading of the adapters when the mount is in firing position and split trail spread.

EDITORIAL

CHANGES IN THE JOURNAL

SEVERAL months ago at a meeting of the Executive Council of The U. S. Field Artillery Association it was recommended, for economical reasons, that certain changes be made in the composition of THE FIELD ARTILLERY JOURNAL. The changes were made in the May-June edition of the magazine, by reducing the size of the type used, thereby enabling the management to cut down the number of pages, while at the same time giving our readers approximately the same amount of reading matter as before.

By keeping the number of pages of text down to ninety-six a considerable saving has been effected in cost of printing and weighed charges.

So far no adverse criticism has been received, and we trust that our efforts in this direction will meet with the approval of our subscribers. It is believed that a certain amount of explanation is due those of our readers who have noticed a change in the appearance of the magazine.

PROXIES WANTED

We take this opportunity of bringing to the attention of the members of the Association the fact that by the time this issue of THE JOURNAL reaches them the proxy cards for the annual meeting will have been received. The constitution requires that one-half of the active membership of the Association in the United States is necessary to constitute a quorum for the transaction of business. It is therefore urged that members who can not attend the meeting in person this year send in their proxies at once.

CHANGE OF ADDRESS

On June 9th the Secretary informed members of the Association by postal card that the address of the headquarters of the Association had been changed from the War Department to the Mills Building, in Washington. Sufficient space in that building could not, however, be retained, and the management has secured offices to be occupied jointly with the Cavalry Association at 1624 H Street, N. W., one square north of the State, War and Navy Department building. The *particular attention* of members is therefore invited to

the fact that hereafter the address of the Association and THE FIELD ARTILLERY JOURNAL will be *1624 H Street, N. W., Washington, D. C.*

A WORD TO THE WISE

When your eye, gentle reader, falls upon this there will be approximately but sixty days left in which to knock off the rough corners of your 1922 Prize Essay, if you have written one. If you have put the writing of it off until *now* you have none too much time in which to get your massive brain under weigh if you are like most of the great literary lights in the Field Artillery we have had the pleasure of meeting in the past.

A word therefore to the wise should be sufficient. Go after that one hundred and fifty dollars; if you don't need it your wife does, or if you haven't a better nine-tenths, well, she can spend it for you. Last year but ten scribes faced the typewriter. Let us hope for better results this time.

Recently we were informed by one of our brightest young majors that he did not know we had a prize essay competition, although he by some chance happened to be a subscriber.

Full details of the trouble will be found on the inside page of the back cover of each issue of THE JOURNAL. "Drive on"!

BOOK NOTICES

CHEMICAL WARFARE. By Brigadier General Amos A. Fries, Chief, Chemical Warfare Service, U. S. Army, and Major Clarence J. West, C. W. S., Reserve Corps, U. S. Army. McGraw-Hill Book Company, Inc., 1921, 370 7th Avenue, New York, N. Y., and 6 and 8 Bouverie Street E. C. 4 London, England. Review later.

THE DESTINY OF AMERICA—WITH AN APPENDIX WHO ARE THE JAPANESE? By the Roadbuilder. T. H. Best, Printing Co., Ltd., Toronto, Canada, and A. A. Beauchamp, 603 Boylston St., Boston, Mass.

IN OCCUPIED BELGIUM. By Robert Withington. The Cornhill Company, 2a Park Street, Boston, Mass. $1.50. Review later.

ME,—AN' WAR GOIN' ON. By John Palmer Cumming. The Cornhill Publishing Co., Boston, Mass. $1.50. Review later.