Military Signal Corps manual

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Signal Corps.

MILITARY SIGNAL CORPS MANUAL

COMPILED BY

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260 Illustrations

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TO

Major General George O. Squier

CHIEF SIGNAL OFFICER, U. S. ARMY

whose assistance made this volume possible

AUTHOR'S PREFACE

The ideal manual is a handbook crammed with information not easily obtainable.

The next best thing to having knowledge is knowing where to seek it. But very often when the guide posts are known—and carefully followed—nothing happens.

There is no result because, though the goal is reached with a high heart, the information sought for is not there. Or only part of it is on hand.

This condition is specially applicable to the Signal Corps. Its sudden expansion from a branch of Army Service numbering less than 2,000 to its present enormous proportions, has left it without means of coping with the demand from the ranks for complete information in printed form. Bridging this gap is the sole purpose of this volume.

Every effort has been made to produce a practical book. As a literary production, the text may be negligible, but as a work of patriotism, it hopes for approval. It has been prepared for three classes of men; those about to take the field to fight the nation's battles, those who are preparing by home study to join the ranks, and last, but not least, those who are training the next generation as cadets, so our nation may never again be found unprepared.

These three considerations were advanced when the volume was first outlined to a sympathetic signal officer. The writer admitted that he purposed covering in a small volume the information which represented years of his personal practice of beg-borrow-and-steal whenever a work relating to army signaling came in sight. This manual, so to speak, was to find its existence by moulding undulations of army technical publications, signal regulations and those of associated service branches, to a pinnacle, bringing the mountain in concentrated form to Mahomet—rookie in the Signal Corps.

The only comment on the project was a hesitant commendation for what was politely termed his "courage" . . . and then he was aided to accomplishment of the task with all the obliging thoroughness of the Army which is the chiefly cherished memory of those who have known the Service.

So the blame is easily placed if there are shortcomings in this, the first attempt to prepare a general manual for the Service of Information of the Army.

The aim has been to place between its covers material from official sources to embrace all the essentials of the diversified technical knowledge required for the intelligent discharge of duty as a signal officer.

The citizen-soldier has been kept in mind in the preparation of each page, and in some cases liberties have been taken with official phrasing that a clearer understanding may be had by the uninitiated. On the other hand, the book is primarily designed that it may serve as a reference book for those in the regular establishment and to aid all enlisted men to promotion.

It was found impracticable to include material on the care of horses and pack animals in this volume. Little has been said on aviation. These subjects could not possibly be included and the book kept to reasonable size; but there are several authoritative works on both which may be consulted and, in the Signal Corps, ample opportunity is given to learn by that best of teachers, experience. Other than the exceptions noted, however, it is believed that all the essentials of Signal Corps duty are fully covered in the pages following.

The author takes the opportunity to acknowledge the general obligation due every officer in the service of the Signal Corps, for in this technical branch of the Army progress rests on the co-operative effort of all to standardize instruction and improve apparatus. A heavy obligation is also due a far-seeing soldier-scientist, the Chief Signal Officer of the Army, for special facilities given the writer. Definitions of function and tactical information contained in the book are to be credited to Brigadier General George P. Scriven; for general advice and assistance, acknowledgment is made to Major Dennis C. Beatty and Lieutenant George H. Smith.

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PART I—ORGANIZATION

THE SIGNAL CORPS—AN AUXILIARY BRANCH OF THE ARMY

It is common knowledge that a soldier is a fighting man whose services are due to the state; that in the regular army there are soldiers of infantry who march and fight on foot, cavalry troopers who ride horses, and artillery-men who serve the guns. It may even be known that engineer troops exist who belong to the line and perform the ordinary duties of the soldier in addition to their special service as engineers.

But how few people realize, even if they know, that attached to all armies there must be, in addition to the men whose first duty is to fight, other bodies of troops whose services are absolutely needed for the proper conduct of military affairs; soldiers who are combatant troops but are charged primarily with duties technical in character and requiring special training and organization.

It is little known in fact that in every properly organized army there exist, in addition to the men who carry a rifle or a saber or who man the guns, certain auxiliary and special troops upon whom the success of the campaigns depend, and by whose services alone can the general in command hope to intelligently meet his enemy and oppose him with an adequate force properly supplied with food, ammunition, and the thousand needs of an army. These troops are not as essential to success when the shock of contact comes as are the guns and sabers of the fighting line, nevertheless they are indispensable to every armed force and without their aid no mobility can exist, no battle be engaged, no knowledge of conditions be obtained. An army fights with its guns, therefore it must have powder; in these days, too, it fights with its brain and the brain must be informed. In the United States Army this last function—that is, the service of military information—is placed in charge of one corps, the Signal Corps of the army. The service thus concentrated and not scattered among several branches of the army varying in intelligence, instruction and experience, as is the case generaly abroad, is believed to have an advantage in consolidation that has not only been proved, but that is increasing with the steady advances in the science of war.

Few people, however, know the character of this corps, fewer still the service it performs, the scope of its duties or the reasons for its existence; the name but vaguely indicates the nature of its work. Since the creation of a Signal Corps in the early days of the civil war, its then simple functions have greatly increased in scope and variety and its usefulness has been enormously enlarged until now it is evident that the importance of this service in military affairs, its necessity in the control of armies in the field, and its paramount value in the conduct of war have been proven beyond a doubt. Indeed, it is hardly too much to say that the great exten-

One method employed by the Signal Corps in acquainting a commander with knowledge of events as they occur, is illustrated here. Above is shown the operation of the combined telephone and telegraph buzzer; to the right a mounted man with pike used to lay the wire; lower left, a militia motorcycle with supplies, and lower right, a signalman receiving firing data

sion of fighting lines, the destructive power of enormous engines of war, and the control of the master mind seen in the present war of the nations, are made possible not only by the advance in mechanical arts but by the harnessing of electricity and by modern methods of transmitting intelligence, which we call the transmission of military information. It is true, however, that all this is merely a growth, and though to the fighting man the need of information is more urgent now than in the earlier days as the size and power of armies increase and the control of the master mind grows more imperative, the fundamentals have not changed since man became a thinking animal. The first need of a commander, now as then, is a knowledge of events as they occur, and of conditions as they exist. To transmit this knowledge, no matter how obtained, is in brief the primary function of the Signal Corps.

The service of the lines of information has become a major factor in the conduct of military affairs, if it is not now, indeed, the paramount element in the control of modern wars. Without information and knowledge of events and conditions as they arise, all else must fail.

It is probably true, as has been said, that the art of war has not changed with the passage of years, but it is true that the science of war has changed enormously since the days of the muzzle-loading guns, captive balloons and messenger service. To this change perhaps no elements have contributed more effectually than electricity and air navigation, which are the two functions that permit the rapid dissemination of information regarding events as they occur, and have replaced the slow groping in the dark of contending forces of former years. With the use of these elements the Signal Corps is charged, and as corps it may be said to exist for one main purpose: THE SPEEDY DISSEMINATION OF MILITARY INTELLIGENCE OR INFORMATION.

It has other duties, but the exchange of ideas in military affairs is the real reason for its existence. It is the nerve system of the army by which information is transmitted to its brains.

The *collection* of military information, also a function of the corps, though important, is secondary, since it is a duty shared by many persons in and out of the military service and does not belong to the Signal Corps alone.

In peace the Signal Corps is concerned with the management of military affairs; in war, with the control of troops and the conduct of campaigns.

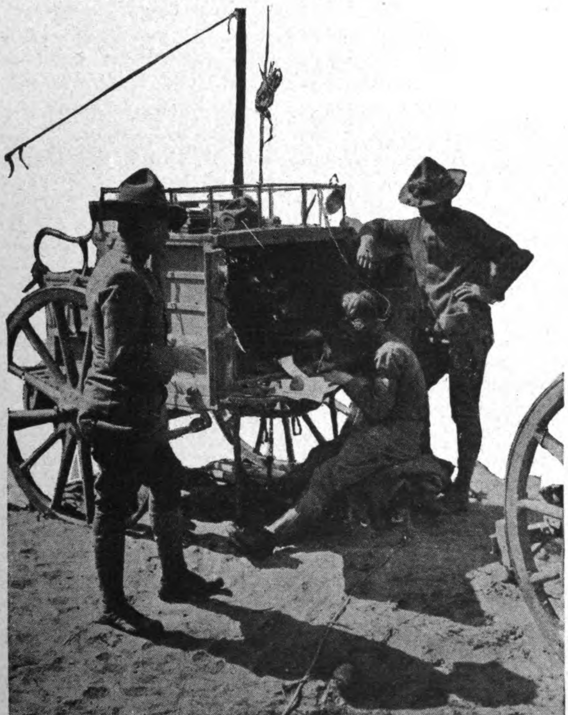
THE SIGNAL CORPS' RELATION TO THE LINE OF THE ARMY

The Signal Corps in reality, though not in law, is both a staff and a line corps and must be trained in the duties of both. The training for service with troops can only come through association with the line, to whom, in war, the signalmen are bound as closely as are the three arms of the service to each other, for it should be remembered that, like all staff and auxiliary troops, the Signal Corps is essentially an adjunct to the line of the army and can have no separate existence. Indeed if we omit its special functions with the coast defense, the value of the Signal Corps depends solely upon the use made of it by the line, and this in turn upon the knowledge and capacity of commanding officers, to whom familiarity with the scope and power of the corps is vital.

The means of acquiring knowledge of the use of a Signal Corps in a practical way are few; field exercise is almost the only school. Theoretical knowledge, however, may be acquired by other means than maneuvers, and such knowledge should be insisted upon, but instruction should not begin and end with senior officers. As with other military studies, the commencement must be made far down the scale of rank, in order that the general may put in use instinctively knowledge the beginnings of which were acquired as a subaltern. Obviously a knowledge of technical equipment can not be acquired between sunrise and sunset.

There can be no doubt that this corps in training should be associated as closely as possible with the line of the army. With the training of these troops, their methods and service, the signalmen must be familiar, for with them his duties in war will be intimately connected. Signalmen should serve habitually with troops of the mobile army, and especially with the field artillery for whom various forms of signal apparatus, the radio, and especially the airplane become most important auxiliaries, as have the telephone, the buzzer, and pyrotechnics.

In addition, detachments of signalmen should perform many duties in connection with the coast defense and its auxiliaries.



The wireless "Service of Information" at work in Mexico. Signal Corps men in actual service are shown here maintaining communication between the flying cavalry column and the headquarters of the American punitive expedition

Beside these two fields of work lies the still undefined service of the coast guard where the field apparatus of the Signal Corps—the land cables, the buzzer, radio, airplane, and perhaps the dirigible and captive balloon—perform a large and important function in the defense of the country.

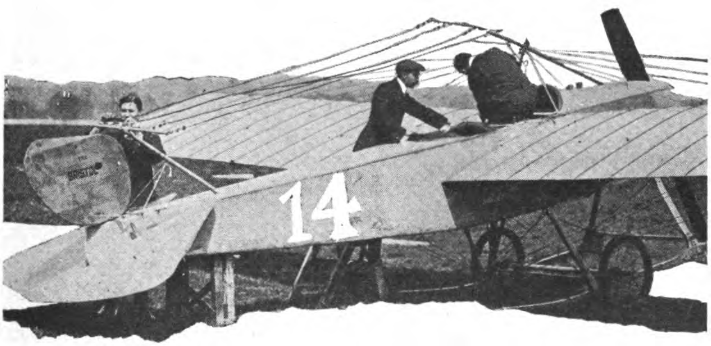
In addition to a general knowledge of the methods of transmitting military information, it appears that reasonable familiarity with the instruments and methods employed under varying circumstances must be possessed by those who will use them in the field, and especially by those in control. It is evident, for instance, that no officer about to assume command of an army or of an expeditionary force for service in a distant country would willingly lack information regarding the kinds of communication that should be used in the work before him and of the types of instruments necessary; nor would he care to leave the selection of the means of establishing his lines of information solely to the judgment of a subordinate, perhaps a stranger. He should know, from the nature of the country and the probable scope of his future operations the character of the lines that he will need and the kind and amount of material that he will use, and must provide himself, within the limits of his transportation, with everything that experience and knowledge may suggest as useful. For that reason he should know generally the amount of material to select, the type of lines of information to be established, and the number and kind of men necessary to use them. The commanding officer will have a signal officer on his staff, no doubt, to whom all details should be intrusted, as he will have an ordinance officer and an engineer, or a quartermaster; but he should assure *himself personally* that his means of transmitting information are sufficient for the work ahead, that they conform to his plans and to the probable field of action, just as of his own knowledge he will make sure of the arms carried by his men, the type of his artillery, the amount of his ammunition, the size of his pontoon train, and the character of his ration.

This preparatory work of a commander implies some knowledge of the service of the lines of information and of the instruments used, but only knowledge of a general nature. It is after he takes the field that his capacity and experience are called fully into play. Then, indeed, in addition to his own knowledge he will require all the assistance that the most skillful of his signal officers can render in determining the kind, scope, and plans of the lines of information, distribution of men, and location of stations. On the march, in camp, and in contact with the enemy such dispositions must be made by him as to not only secure the best service possible for himself as commander of the troops or expedition, but as will give, also, to those in subordinate command the fullest advantage of the lines and the quickest transmission of information and intelligence.

AIRCRAFT

The Signal Corps is intrusted with the air service of the army—undoubtedly the most important, as it is the most recent, auxiliary in the collection and transmission of military information. It has not been considered wise or practicable to attempt to include in this small volume instructional material on the use and mechanics of air craft, for the reason that the subject is exhaustive in scope and can only be properly mastered by personal application—by actual flying, in fact. Some definition of the function of military air craft will be useful, however.

Air craft are now employed for strategical and tactical reconnaissance and the prevention of reconnaissance by the enemy's air craft; for the direction and control of fire of the field artillery; for the destruction of the enemy's personnel and material by explosive and incendiary missiles and other means; and for the rapid transportation of superior commanding officers. The value of air craft, and especially of the airplane, in the field of reconnaissance has been proved beyond the shadow of a doubt. What-



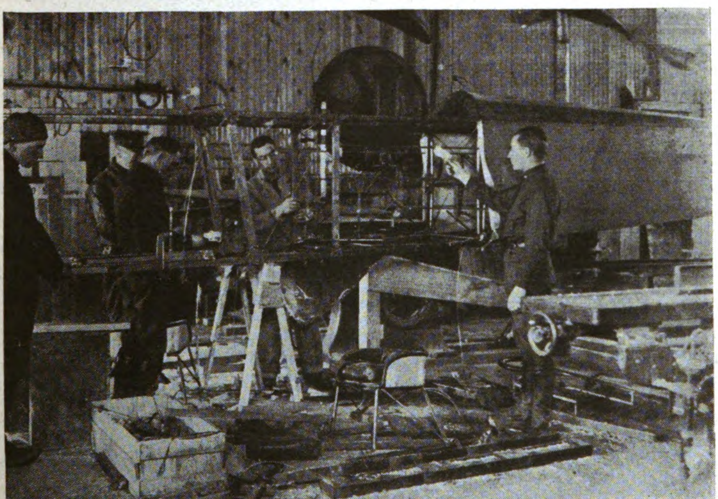
AN EARLY METHOD OF INSTALLING THE WIRELESS AERIAL, OR ANTENNA, ON AN AEROPLANE ever may be the opinions of military men as regards the offensive importance of air craft and the present standing of the dirigible there is no longer a question as to the value of the airplane in rapid and long-range reconnaissance work, and of its power to secure and to transmit by radio, visual signal or direct-flight, information of the utmost importance to armies in the field. So true is this that it seems probable the airplane and, to some smaller degree, all air craft, have altered not the principles of strategy, which are immutable, but the theory and application of grand tactics.

It now appears that the actual game of war is played openly with cards laid on the table, and opportunity no longer is given for inference as to concealed movements or for surprises, perhaps not even for the exercise of the high military quality of anticipation of the unseen movements of the adversary. It is now recognized that the possibility of brilliant and unexpected blows and surprises by enterprising commanders has been largely eliminated from modern operations of war by the information supplied by the aviators. It is proved that the modern air craft lays open to the field of mental view the whole visible area of the immediate theater of war and that the commander's vision reaches far beyond the limits of the actual sight of his marching troops. The air craft sees and indicates the larger operations of war and points out to the slowly moving men on the ground not only the object to be attacked or defended, but to reconnaissance troops, especially the cavalry, the objective to be sought, the localities to be searched, and the character of information to be obtained.

By no means does the air craft supersede, nor can it ever supersede, the work of obtaining detailed information which can be acquired only by close observation, by contact, and by development of the enemy's forces and positions. This remains the duty of the troops in the field; but the air craft does indicate to either commander the character, location, and general disposition of opposing forces, and of his own commands. Not only has it been proved that the airplane is invaluable in locating the position of the enemy, but it has especial value to a commander in finding his own troops, in keeping him informed when movements are taking place, and of the position of his flanks and center, his outposts, his cavalry, his artillery, of the positions attained by any detached body—in short, of keeping him constantly in touch with the locations and movements of all the units of his command under the changing conditions of war.

This much is proved, but it does not follow that the air craft curtails the work of reconnaissance of other arms of the service, the infantry, the Signal Corps, and, more especially, the cavalry.

On the contrary, it extends the usefulness and power of all, for if the general field of reconnaissance is outlined, it is obvious that the cavalry or infantry can more readily strike its objective and more quickly and accurately obtain information regarding any particular point than if obliged unseeingly to search the whole field of operations for locations and forces regarding which an intimate knowledge is desired or contact expected. In other words, by aid of air craft, and more especially of the airplane, a reconnaissance by troops moves less in the dark, knows better what to look for and search in detail, and loses less time and effort in accomplishing the object sought. No move of concentration from



AVIATORS OF THE SIGNAL CORPS RECEIVING INSTRUCTION IN THE ASSEMBLY OF AIR CRAFT

flank or center, no envelopment of a wing nor re-enforcement of a weak position should remain unknown to the adversary in the case where he possesses a thoroughly efficient flying corps. It would seem, therefore, that not only has the power of all reconnaissance troops been increased by the air craft, but also that the need and importance of the cavalry in reconnaissance work have not been lessened, but, on the contrary, have been greatly increased by them.

In addition to the influence exerted by air craft on grand operations, events now appear to show that their value in more detailed operations is great and may increase in the future to enormous proportions. It is well established that the accuracy, value, and effect in service of field and siege artillery and, indeed, of the heavy guns afloat and ashore have been greatly increased by this agency. It may almost be said that guns are fought by means of the eyes of the aviator. So clearly has this been shown that there now appears a noticeable change in artillery practice. Instead of the old-fashioned system of range finding by trial fire or of observation from the battery or elevations near by, the exact range is now found with the help of airplanes, by signaling positions and noting the fall or burst of the shrapnel.

Besides influence of this character, the airplane has undoubted use in the finding of concealed positions, in locating hidden howitzers or mortars, and in pursuit and rear-guard actions. It is useful in the location of ships at sea or at anchor within defenses, in the detection of submarines and submarine mines, and certainly in the enormous increased efficiency given to seacoast gun fire, and especially to the coast defense, the coast guard, and many other details of observation.

But the useful, approved, and most important work of air craft is to be found chiefly in reconnaissance and the collection and transmission of information in the theater of military operations. For this reason aviation must be reckoned as a vastly important branch of the Signal Corps of the army.

GOVERNMENT AND ADMINISTRATION

A successful commander of a company is required to give time and attention to its government, just as if it were a business. The supervision required naturally divides itself into two parts: government of the command, and administration of its affairs.

Government is represented by the discipline and instruction and the harmonious conduct of activities.

Administration comprises the provision and care of supplies and equipment, keeping of records and disbursement of company funds.

THE CAPTAIN

In all military organizations the captain's relation to the company approaches its highest ideal when he is considered as the father of a large family, responsible for the comfort and personal welfare of every member of his command, looking out for their development and providing for their pleasure, safeguarding their health, punishing the refractory and rewarding the deserving. By superior intelligence he is expected to give counsel to his men and display every interest in their triumphs and troubles. The progress of any organization will largely depend upon the captain's conscientious dischargc of duty.

But the captain should not attempt to do all the work; far better results will be obtained if capable subordinates are entrusted with full responsibility and with plenty of work in the duties prescribed for them. It is a mistake to attempt to try to command every squad in person, subordinate officers with practically nothing to do will soon lose their initiative and interest in the company. Once the duties of officers have been made clear to them they should be allowed to participate as fully as practicable in the government and administration, they should not be hampered with unnecessary instruction about detail, but encouraged to learn for themselves by experience the art of training and commanding men. Once the organization is well under way with its routine work the captain should have trained his subordinates so well that he will be able to give a large proportion of his time to the important matters of discipline, instruction and welfare of his command. Captains should exercise the greatest care in the appointment of lieutenants, for in this position an inefficient officer is a terrific handicap to overcome. It is absolutely essential to the success of the organization that the lieutenants be held to strict accountability for results. Lieutenants incapable or unwilling to discharge their duties with diligence and efficacy have no place in a body organized for military training.

THE LIEUTENANT

Primarily, the lieutenant must strive to fit himself to be able to perform every duty of the captain when that officer is absent or, if for any other reason, has temporarily given him full responsibility. He is the captain's assistant in every sense of the word and should relieve his commander of work whenever possible. The captain should require him to drill the company, inspect quarters, instruct non-commissioned officers and thoroughly acquaint himself with all duties of administration by assisting in the keeping of records and preparation of reports.

Particular attention must be given to the captain's orders; what he asks of his lieutenants personally must be done, not passed along for execution to a non-commissioned officer. The captain will give his order direct if he wants it executed by a non-commissioned officer. And the lieutenant must not take it upon himself to make sweeping changes, even if temporarily in command, especially when reduction or promotion are concerned the captain's wishes should always be consulted in these matters. A full understanding should also exist on the amount of authority the captain is willing to grant to his lieutenants to inflict punishment, assign or relieve men from duty, in the absence of the commander. Permission should always be secured from the captain, too, if the lieutenant wants the use of a working party or any supplies not regularly distributed for routine work.

MILITARY COURTESY

In all walks of life men who are gentlemanly and of good breeding are always respectful and courteous to those about them. It helps to make life move along more smoothly. In civil life this courtesy is shown by the custom of lifting the hat to ladies, shaking hands with friends, and greeting persons with a nod or a friendly "Good morning," or other pleasant phrase.

In the Army courtesy is just as necessary, and for the same reasons. It helps to keep the great machine moving without friction.

"Courtesy among military men is indispensable to discipline; respect to superiors will not be confined to obedience on duty, but will be extended on all occasions," states Par. 4, Army Regulations, 1913.

One method of extending this courtesy is by saluting. When in ranks the question of what a private should do is simple—he obeys any command that is given. It is when out of ranks that a private must know how and when to salute.

SALUTING

In the old days the free men of Europe were all allowed to carry weapons, and when they met each would hold up his right hand to show that he had no weapon in it, and that they met as friends. Slaves or serfs, however, were not allowed to carry weapons, and slunk past the freeman without making any sign. In this way the salute came to be the symbol or sign by which soldiers (free men) might recognize each other. The lower classes began to imitate the soldiers in this respect, although in a clumsy, apologetic way, and thus there crept into civil life the custom of raising the hand or nodding as one passed an acquaintance. The soldiers, however, kept their individual salute, and purposely made it intricate and difficult to learn in order that it could be acquired only by the constant training all real soldiers received. To this day armies have preserved their salute, and when correctly done it is at once recognized and never mistaken for that of the civilian. All soldiers should be careful to execute the salute exactly as prescribed. The civilian, or the imitation soldier, who tries to imitate the military salute, invariably makes some mistake which shows that he is not a real soldier; he gives it in an apologetic manner, he fails to stand or march at attention, his blouse is unbuttoned or hat on awry, or he fails to look the person saluted in the eye. There is a wide difference in the method of rendering and meaning between the civilian salute as used by friends in passing, or by servants to their employers, and the *military salute*, the symbol and sign of the military profession.

Enlisted men under arms or with their hats on salute all officers of United States and foreign armies. Privates do not salute non-commissioned officers. The national color or standard, when not cased (i. e., in waterproof cover), is saluted by all officers and men.

THE SALUTE

To salute with the hand, first assume the position of a soldier or march at attention. Look the officer you are to salute straight in the eye. Then when the proper distance separates you raise the right hand smartly till the tip of the forefinger touches the lower part of the headdress above the right eye, thumb and fingers extended and joined, palm to the left, forearm inclined at about 45 degrees, hand and wrist straight. Continue to look the officer you are saluting straight in the eye, and keep your hand in the position of salute until the officer acknowledges the salute or until he has passed. Then drop the hand smartly to the side. The salute is given with the right hand only.

Saluting distance is that within which recognition of rank is easy. In general it is about 30 paces. In approaching or passing within saluting distance, individuals or bodies of troops exchange salutes when at a distance of about 6 paces. If they do not approach each other that closely, the salute is exchanged at the point of nearest approach within saluting distance.

Salute the national color or standard in the same way that you would an officer. (The national flag belonging to dismounted organizations is called a color; to mounted organizations, a standard.)

Uncovering is not a form of the prescribed salute, and the salute is executed only when covered. Do not salute when marching in double time.

Before addressing an officer, an enlisted man makes the prescribed salute with the rifle if he is armed with it, or, if unarmed and covered, with the right hand. He also makes the same salute after receiving a reply. If uncovered he stands at attention without saluting. A mounted soldier dismounts before addressing an officer not mounted.

A noncommissioned officer or private in command of a detachment without arms salutes all officers with the hand, but if the detachment is armed with the rifle he makes the rifle salute. If armed with the saber he salutes with it.

Indoors an unarmed enlisted man uncovers and stands at attention upon the approach of an officer. If armed, he salutes as heretofore prescribed. For the purpose of saluting, the drill floor of an armory is considered as outdoors, the remainder of the armory as indoors.

When an officer enters a room where there are soldiers, the word "Attention" is given by some one who perceives him, when all rise and remain standing in the position of a soldier, until the officer leaves the room or commands "Rest." Soldiers at meals do not rise but cease talking and eating.

Soldiers actually at work or engaged in athletic exercises do not salute unless spoken to. Prisoners are not permitted to salute; they merely come to attention if not actually at work.

Officers at all times acknowledge the courtesies of enlisted men by returning, in the manner prescribed, the salutes given. When several officers in company are saluted, all return it.

At retreat, when the "Star Spangled Banner" is played by the band, or "To the Color" is played by the field music, while the flag is being lowered, all officers and enlisted men out of ranks face toward the flag (the post or camp flag), stand at attention, and render the prescribed salute at the last note of the music.

Whenever the Star Spangled Banner is played at a formal occasion other than retreat all officers and enlisted men present stand at attention, facing toward the music, retaining that position until the last note of the air, and then salute. The playing of the Star Spangled Banner as a part of a medley is prohibited in the military service.

COURTESIES IN CONVERSATION

In speaking to an officer, always stand at attention and use the word "Sir." Examples:

"Sir, Private Brown, Company B, reports as orderly."
"Sir, the first sergeant directed me to report to the captain."

(Question by an officer:) "To what company do you belong?"
(Answer:) "Company A, sir."
(Question by an officer:) "Has first call for drill sounded?"
(Answer:) "No, sir"; or "Yes, sir; it sounded about five minutes ago."
(Question by an officer:) "Can you tell me, please, where Major Smith's tent is?"
(Answer:) "Yes, sir; I'll take you to it."
Use the third person in speaking to an officer. Examples:
"Does the Lieutenant wish," etc.
"Did the Captain send for me?"
In delivering a message from one officer to another, always use the form similar to the following: "Lieutenant A presents his compliments to Captain B and states," etc. This form is not used when the person sending or receiving the message is a private.

In all official conversation, refer to other soldiers by their titles, thus: Colonel A, Sergeant B, Private C.

Never go to any officer to make a request or complaint without first asking permission to do so from the first sergeant.

RANK AND PRECEDENCE OF OFFICERS AND NONCOMMISSIONED OFFICERS

The following are the grades of rank of officers and noncommissioned officers:

1. Lieutenant general.
2. Major general.
3. Brigadier general.
4. Colonel.
5. Lieutenant colonel.
6. Major.
7. Captain.
8. First lieutenant.
9. Second lieutenant.
10. Veterinarian, Cavalry, and Field Artillery; Pay Clerk, Quartermaster Corps.
11. Cadet.
12. (a) Sergeant major, regimental; sergeant major, senior grade Coast Artillery Corps; (b) master electrician, Quartermaster Corps; master electrician, Coast Artillery Corps; master signal electrician; chief musician; (c) engineer, Coast Artillery Corps.
13. (a) Ordnance sergeant; quartermaster sergeant, Quartermaster Corps; sergeant, first class, Hospital Corps; electrician sergeant, first class Coast Artillery Corps; (b) sergeant, first class, Quartermaster Corps; first-class signal sergeant.

14. Quartermaster sergeant and commissary sergeant regimental; electrician sergeant, second class, Coast Artillery Corps; master gunner, Coast Artillery Corps.

15. Sergeant major, squadron and battalion; sergeant major, junior grade, Coast Artillery Corps; color sergeant; battalion quartermaster sergeant, Engineers and Field Artillery Corps.

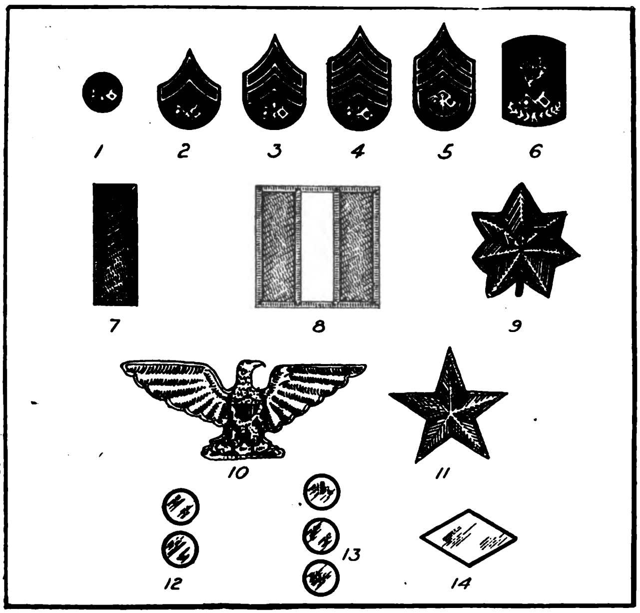
16. (a) First sergeant; drum major; (b) principal musician; chief trumpeter; fireman, Coast Artillery Corps.

17. Sergeant; quartermaster sergeant, company; stable sergeant.

18. Corporal.

In each grade and subgrade, date of commission, appointment, or warrant determines the order of precedence.

The grade of noncommissioned officers, indicated by chevrons worn on the sleeve, and the insignia of rank appearing on the shoulder straps, or shoulder loops of officers, are as follows:



SIGNAL CORPS CHEVRONS: 1—PRIVATE; 2—LANCE CORPORAL; 3—CORPORAL; 4—SERGEANT; 5—FIRST CLASS SERGEANT; 6—MASTER SIGNAL ELECTRICIAN.

OFFICERS' INSIGNIA: 7—FIRST LIEUTENANT; 8—CAPTAIN; 9—MAJOR (Gold), LIEUTENANT COLONEL (Silver); 10—COLONEL; 11—GENERAL OFFICERS; 12—FIRST LIEUTENANT, CADETS; 13—CAPTAIN, CADETS; 14—MAJOR, CADETS.

Rules and Regulations of Land Forces

The land forces of the United States consist of the Regular Army, the Organized Land Militia when called into the service of the United States, and such Volunteer forces as Congress may authorize.

The armies of the United States are governed by certain rules and regulations called "The Articles of War."

The Militia (National Guard) when called into the actual service of the United States is subject to the same rules and articles of war as the Regular troops of the United States.

When not in the actual service of the United States, the Militia is governed by such rules and regulations as may be prescribed by the State in which the Militia is organized.

The control of the Organized Militia when not in the service of the United States, which is vested in the Federal Government, through constitutional provisions in regard to organization, armament, and discipline (training) is laid down in the Regulations of the War Department for the Organized Militia, and in the various instruction manuals.

The following list includes the offenses most often committed by soldiers, generally through ignorance or carelessness rather than viciousness. Violations of any rule or regulation should be carefully guarded against, since they not only subject the offender to punishment, but also bring discredit on his comrades, his organization, and on the military profession.

1. Selling, pawning, or, through neglect, losing or spoiling any Government property, such as uniforms, blankets, equipment and ammunition.
2. Disobedience of the orders of any officer or non-commissioned officer.
3. Disrespect to an officer or non-commissioned officer.
4. Absence from camp without leave.
5. Absence from any drill, formation, or other duty without authority.
6. Noisy or disorderly conduct in camp or when absent either with or without leave.
7. Entering on private property, generally for the purpose of stealing fruit or similar errands.
8. Negligence or carelessness at drill or on other duty, particularly while on guard or as a sentinel over prisoners.
9. Wearing an unauthorized uniform or wearing the uniform in an improper manner.
10. Urinating in or around camp.
11. Failing to salute properly.
12. Disrespect or affront to a sentinel.

Uniforms

Wear the exact uniform prescribed by your commanding officer, whether you are on duty or off duty.

Never wear a mixed uniform, as, for instance, a part of the service uniform with the blue uniform.

Never wear any part of the uniform with civilian clothes. It is very unsoldierly, for example, to wear a civilian overcoat over the uniform, or to wear the uniform overcoat over a civilian suit.

Keep the uniform clean and neat and in good repair.

Grease spots and dust and dirt should be removed as soon as possible.

Rips and tears should be properly mended.

Missing buttons and cap and collar ornaments should be promptly replaced.

There is but one correct and soldierly way to wear the cap. Never wear it on the back or side of the head.

The service hat should be worn in the regulation shape, peaked with four indentations, and with hat cord neatly adjusted. Do not cover it with pen or pencilmarks.

Never appear outside your room or tent with your blouse unbuttoned or collar unhooked. Chevrons, service stripes, and campaign medals and badges are a part of the uniform and must be worn as prescribed.

When blouses are not worn with the service uniform, olive-drab shirts are prescribed.

Suspenders must never be worn exposed to view.

Never appear in breeches without leggings.

Leather leggings should be kept polished. Canvas leggings should be scrubbed when dirty.

Tan (russet leather) shoes should be kept clean and polished.

The overcoat when worn must be buttoned throughout and the collar hooked. When the belt is worn it is worn outside the overcoat.

PERSONNEL

It will probably be conceded, considering the duties they must perform, that the men who make up the Signal Corps should be intelligent and well instructed; furthermore, that both officers and men should remain long with the service and make it their profession. No matter how efficient may be the instruments and equipment of an army, no matter how good may be its telegraph lines, its radio, or its airplanes, it is certain that their value will depend almost wholly upon the men who use them.

In the United States the transmission of military information is wisely placed in charge of the Signal Corps and not scattered among several branches of service. The advantage of this concentration has been proved; and it is not perhaps saying too much in claiming for the men of this corps as high a standard of faithfulness, industry, intelligence, and efficiency as exists among any body of soldiers the world over. The enlisted force is recruited from intelligent men in civil life, they are given severe training, and practical instruction as telegraph, telephone, and radio men; as automobile drivers; in telegraph construction and maintenance; in cable laying and testing; the use of scientific and electrical apparatus; in the inflation and handling of balloons and scouting and reconnaissance work of airplanes; in the use of visual methods of signaling; riding and the care of horses and pack animals with the field companies; in fact, in the almost innumerable duties which fall to their lot in service with their corps. The theater of operations is widely extending; the march of military service is rapidly progressing; electricity and the mechanical arts have changed the very face of war; and so a technical corps such as is the Signal Corps must use its utmost endeavor to keep up with the progress of ideas.

It has been said that recent field experiments with troops have conclusively proved that for every specially trained Signal Corps soldier provided, not only is the field information service many times increased in efficiency, but that at least two men are returned to the firing line who would otherwise be removed therefrom to perform the inefficient and often impossible work of the orderly of the past. Since this messenger service must be provided, either through orderlies or trained signal troops, it is manifest that the provision of a minimum per cent of the total strength for this purpose results in increasing the number of men for the firing line instead of taking from that line.

The duties of a corps for intelligence communication are not, however, confined to the transmission of information alone, though that is its principal function. For in addition to this service its troops will have plenty of fighting to do, not only with the infantry at the outposts and at detached stations, but with the cavalry in reconnaissance work, and with both when serving with contact troops and with patrols. The chief duty of signalmen is, of course, to transmit information collected, but they are by no means to remain blind and deaf to the events taking place around them. They should gather all the information possible and transmit it, through the proper channels, to headquarters, as is the duty of all soldiers. Obviously, while signalmen have unusual opportunities for the collection of information in the enemy's country, they have at hand the means of transmission as well, and thus form one of the strongest corps of observers with an army. Still it is not to be forgotten that an army has eyes and ears everywhere, and that the duty of obtaining information is imposed upon all. The chance observation of a sentinel, a report from an outpost, the story of a prisoner or native may have value if sent in time to the proper authority. This is the first duty of the signalmen; but in addition signal troops, and especially the aviators, have become, even more than the cavalry, the eyes and ears of the army.

The need for training and experience on the part of the officers and men engaged in this service is too obvious to need more than a mere mention and it will be sufficient to quote here, as an indication of expert opinion on this subject, the following remarks of a distinguished French officer:

"Information service fails especially because the world is ignorant of its principles, processes, and modes of action. The transmission of intelligence demands special organs. Most armies give some telegraphic training to noncommissioned officers and troopers; it is lost time. Those partly informed are always incompetent; special-trained men are necessary."

This brief statement might be well considered a military axiom to be placed at the head of all treatises and laws affecting the army.

PROFICIENCY TEST FOR COMPANIES OF SIGNAL TROOPS

Companies of signal troops should be tested technically and administratively from time to time by specially qualified signal officers, preferably of field rank. These tests act as stimulants to the work of the companies and make possible a very accurate rating of them as regards their efficiency in the performance of field duty.

The test outlined is prescribed as a guide; suitable variations from it should be employed if necessity therefor arises.

1. Individual tests:

(*a*) Telegraphy wire or radio. Rating as to ability to send and receive regular messages in speed of words per minute. Office practice. Message forms, checks, blanks, and rules pertaining to telegraph operation and the handling of messages.

(*b*) Visual signaling: Wigwag—rate per minute sending and receiving code. Visual signaling: Semaphore—rate per minute sending and receiving code.

(*c*) Lineman (wire and outpost companies): General duties, tying, splicing, cutting in. Lineman (telegraph companies): Details of semi-permanent and permanent telegraph and telephone construction.

(*d*) Radio operation (radio companies): Adjustments, nomenclature, and care of apparatus.

(*c*) Telephony (outpost and telegraph companies): Telephones and telephone swichboards. Operation, adjustment, and repairs.

(*f*) Motor vehicles (telegraph companies): Operation, adjustment, and repairs.

(*g*) First aid and personal hygiene.

(*h*) Care of arms and equipment.

2. Section (platoon outpost companies) test: To include the

handling of the section in a simple practical problem calculated to test the efficiency of the section, both technically and in self-maintenance in the field.

3. Company test:

(*a*) Technical inspection (with full packs): Drill, horsemanship, marching, camping, inspection of arms and equipment.

(*b*) Administrative inspection: Condition of records, mess administration, stable management.

(*c*) Field problem: An advanced problem in the establishment of lines of information under given tactical conditions. Organizations as a whole to be rated as to methods and results.

4. Special test: Examination of specially qualified enlisted men.

(*a*) Heliograph: Setting up and adjustments. Sending and receiving.

(*b*) Acetylene lantern: Setting up and adjustments. Sending and receiving.

(*c*) Code and cipher: Knowledge and use of cipher disk.

PART II—DRILL INSTRUCTION

DRILL REGULATIONS

General Principles and Object of Instruction

The certain transmission of information and orders from commanding officers to their subordinates and information from subordinates to commanding officers, regardless of conditions or terrain (the country in which the military unit is operating), is the ultimate object of all training.

The special qualifications required of Signal Corps troops in war are that they be fully equipped with efficient men and material to carry out the orders of the commanding officer, that they are able to maintain, uninterruptedly, such communications, either by electricity or visual signaling, or both, without regard to change of headquarters, to keep the commander fully and continuously informed as to the progress of the action, the position of his troops, supply trains and hospital departments.

To meet these requirements, the Signal Corps must have members technically trained in time of peace, and it must also be prepared to cover long distances quickly and to overcome all the difficulties and obstacles of the route, and still keep in touch with such subordinate commanders as orders require.

The members must understand thoroughly all classes of signaling; must know how to make necessary repairs and be prepared to meet, tactically, the shifting requirements of the battle field and the strategical conditions of the occupied territory.

It is essential that mobility be acquired through thorough theoretical training and extensive practice in establishing and maintaining lines of information over varied country under conditions approximating those of service.

The instruction is designed to develop resourcefulness, initiative, and self-reliance for Signal Corps men of all grades. The regulations prescribe the method of training in the ordinary duties of field companies and battalions of the Signal

Corps, and all soldiers must be so thoroughly drilled in these duties that in the excitement of action they may be performed readily, naturally, and as a matter of second nature.

Since varied conditions arise in handling Signal Corps troops, no hard and fast rules can be laid down to cover all conditions; much is left to the energy and ingenuity of the officers and non-commissioned officers.

Instruction must therefore be conducted with a view, first, to drilling the personnel thoroughly in their habitual duties; and second, to afford officers and men practical experience in dealing with the situations and difficulties which arise in campaign.

Solutions of practical problems, involving at first simple tactical situations with appropriate units should be required. This instruction should be progressive and include the use of the highest tactical unit available. Signal troops can carry out this instruction to advantage without the assistance of other troops, but it is always desirable that field conditions be duplicated, where possible, with infantry, cavalry and artillery units.

A progressive order is to be followed in all instruction, commencing with theoretical instruction in the smallest unit and proceeding to the larger one, culminating in field maneuvers.

Thorough training of the individual soldier is the basis of efficiency. Precision and attention to detail are required in this instruction, for from it the soldier must acquire that habit of implicit obedience to orders, and of accurate performance of his individual duties, which is the indispensable requisite for efficiency in combined training. Drills should be frequent, but short.

Recruits are assembled in small squads for the beginning of their instruction. As the instruction progresses it may be consistently carried on by sections, platoons, or by the entire company. This principle also applies to technical training, particularly to visual signaling, telegraphy and telephony. Grouping according to progress and efficiency should be strictly carried out; those who lack aptitude and quickness should be placed under experienced instructors.

The training of the recruit includes instruction in the duties of sentinels, the care of equipment, packing of field kits, tent pitching, pistol practice, and the customs and courtesies of the service, in addition to his training as a signalman.

The instructor of each unit is its immediate chief, and should be given all due latitude in conducting the instruction, and be held to strict accountability for results attained. The habit of self-reliance and a feeling of responsibility for the instruction of their respective units, as well as the proper feeling of pride in these, may thus be developed among the subordinate commanders.

The instructor always maintains a military bearing, and by a quiet, firm demeanor, sets a proper example to the men. Faults should be corrected without nagging.

Instruction in establishing wire, wireless, or visual lines of information, telegraphy, and tent pitching may be appropriately given by section, or by platoon, as a healthy rivalry among the units may thus be developed.

Commanding officers are accountable for the proper training of their respective organizations within the limits prescribed by regulations and orders.

The excellence of an organization is judged by its field efficiency. The field efficiency of an organization depends primarily upon its effectiveness as a whole. Thoroughness and uniformity in the training of units of an organization are indispensable to the efficiency of the whole; it is by such means alone that the requisite team work may be developed.

The drill regulations are furnished as the guide. In the interpretation of the regulations, the spirit must be sought. Quibbling over the minutiae of form is indicative of failure to grasp the spirit. Drills and ceremonies are disciplinary exercises designed to teach precisive soldiery movements, and to inculcate that prompt subconscious obedience which is essential to proper military control. To this end, smartness and precision should be exacted in the execution of every detail.

General Rules

Movements that may be executed toward either flank are explained as toward but one flank, it being necessary merely to substitute *left* for *right*, or the reverse, to have the explanation of the corresponding movement toward the other flank.

Any movement may be executed either from the halt, or when marching, unless otherwise prescribed.

All movements on foot not especially excepted may be executed in double time. If the movement be from the halt, or when marching in quick time, the command *double time* precedes the command *march;* if marching in double time, the command *double time* is omitted.

In successive movements executed in double time the leading or base unit marches in *quick time* when not otherwise prescribed; the other units march in *double time* to their places in the formation ordered, and then conform to the gait of the leading or base unit. If marching in double time, the command double time is omitted. The leading or base unit marches in quick time; the other units continue at double time to their places in the formation ordered, and then conform to the gait of the leading or base unit.

To hasten the execution of a movement begun in quick time, the command:

1. Double time, 2. MARCH

is given. The leading or base unit continues to march at quick time, or remains at halt if already halted; the other units complete the execution of the movements at double time and then conform to the gait of the leading or base unit.

If, in forming elements abreast of each other, the command:

1. Company (platoon, etc.), 2. HALT

be given during the movements, only those elements halt which have reached their new positions; the others continue the march and halt on reaching their positions.

For the purpose of correcting errors while marching, the instructor may command:

1. In place, 2. HALT

when all halt and stand fast. To resume the movement the commands:

1. Resume, 2. MARCH

are given.

To revoke a preparatory command, or being at a halt, to begin anew a movement improperly begun, the instructor commands: **AS YOU WERE,** at which the movement ceases and the former position is resumed.

If the change of formation requires a change of post of officers and non-commissioned officers, they proceed by the shortest route to their posts in the new formation.

While the posts of officers and non-commissioned officers are specified as instructors, they go wherever their presence is necessary.

Officers and non-commissioned officers who are absent are replaced ordinarily by the next lower rank. In a company, chiefs of platoons are replaced by the chiefs of sections of the platoons in the order of rank. Sergeants and corporals replace absent chiefs of sections.

The numerical designation of units does not change, as their relative order in line or column is changed.

DEFINITIONS

(Alphabetically Arranged.)

Alignment: A straight line upon which elements are formed, or will be formed, is called an alignment. The act of dressing troops on a straight line is called an alignment.

Base: The element on which a movement is regulated.

Center: The middle point, or element, of a command.

Column: A formation with the elements placed one behind another.

Deploy: To extend the front. To exchange from column to line, or close order to extended order.

Depth: The space from head to rear of any formation, including the leading and rear elements.

Distance: The space between elements as measured from the backs of men in front to breast of men in rear, or from the croup of the horse in front to the head of the horse in rear.

Element: Any component part of a larger unit, a file, squad, platoon, cart, wagon, section or company.

File: Two men, the front-rank man, and the corresponding man of the rear rank. The front-rank man is known as the **file leader.** The term **file** also applies to individual men in a single-rank formation. When a file has no rear-rank man it is termed a **blank file.**

File Closers: The officers or non-commissioned officers who are posted in the rear of the line. The term is also used, for convenience, to designate all men posted in the line of file closers.

Flank: The right or left of a command in line or in column: also the element on the right or left of the line.

Formation: Arrangement of the element of a command, in their order in line or in column.

Front: The space in width occupied by an element in line or in column.

(The front of a man is figured as 22 inches.)

Guide: A soldier upon whom the element regulates its march.

Head: The leading element of a column.

Interval: The open space between elements abreast of each other, or on the same line. The interval between men in ranks is 4 inches, measured from elbow to elbow. Between squads, companies, etc., it is measured from the left elbow of the left man or guide of the group on the right, to the right elbow of the right man or guide of the group on the left.

Leap frog: A method of maintaining constant communication with a moving command by using two or more instruments with a single unit, keeping one in operation while another is moving past it to a position in front. Commonly used with radio sets and buzzer instruments. The system may be used in dividing up the construction of telegraph lines.

Left: The left extremity or element of a body of troops.

Line: A formation in which the different elements are abreast of each other.

Lines of Information: Channels along which military information may be transmitted, such as by wire, wireless, visual signaling, or messenger.

Maneuvers: Operations against an assumed, outlined, or actual force under a separate commander, who, within the limits of the assumed situation, is free to adopt any formations and make any movement he chooses.

Rank: A line of men or carts abreast of each other.

Right: The right extremity or element of a body of troops.

COMMANDS AND SIGNALS

Commands

It is important for the beginner in the work of military instruction to note that commands are of two kinds:

The *preparatory* command, such as **forward,** tells the movement that is to be executed.

The command of *execution,* such as **MARCH,** or **HALT** causes the execution of the movement.

Preparatory commands are distinguished in type by **bold face,** commands of execution by **CAPITALS.**

When the preparatory command has been given, an interval of time is allowed sufficient for it to to be properly understood before the command of execution is given. The tone of command is animated, distinct, and sufficiently loud to be clearly heard by every man in the ranks. Indifference in giving commands leads to laxity in execution; each preparatory command should be pronounced with a rising inflection of voice, in such manner that the command of execution may be more energetic and elevated.

The command of execution is firm in tone and brief.

When giving commands to troops it is usually best to face them.

Arm Signals

Commands are given by the officer in charge of the squad, platoon, or company, as the case may be. In company formation commands given verbally by the captain may be supplemented by trumpet or bugle signals, or by signals made by the arm. A short blast of the whistle is sometimes used on the march or in combat to fix the attention of troops, their commanders or leaders, preparatory to giving commands, orders, or signals. These supplementary signals are primarily designed to facilitate the movement of mounted troops, but their value in battle is at once obvious and knowledge of their meaning and execution should be possessed by every man in the signal service who desires to be prepared for any emergency.

Commands given by the captain are repeated by chiefs of platoons, or appropriate commands are given to their platoons in time to insure the proper execution of the movement. The chiefs of platoons ordinarily give their commands verbally, supplemented, if necessary, by the appropriate arm signal. Chiefs of sections repeat the commands in the same manner.

Arm signals are ordinarily made with the right arm, but may be made with the left arm when convenient.

The arm signals illustrated and described are regulation with the U. S. Army Signal Corps, mounted. The infantry arm signals are slightly different in character and must not be confused when observing the maneuvers of companies of infantry. Only the preparatory signals are shown; for the signal of execution the arm is extended vertically and then lowered quickly to the side in every case.

Preparatory Signals

Attention.—Extend the arm vertically and move it slowly back and forth from right to left.

Forward.—Extend the arm vertically and lower it to the front until horizontal.

By the right (left) flank.—Extend the arm vertically and lower it to the right (left) until horizontal.

Right (left) about.—Extend the arm vertically and describe slowly a large horizontal circle with the hand; then extend the arm to the left (right) and describe a horizontal arc to front and right (left).

Right (left) oblique.—Extend the arm obliquely upward to the right (left) and front, and then lower the arm, describing a vertical circle on the right (left) side of the horse.

To increase the gait.—Carry the hand to the shoulder, forearm vertical; extend the arm vertically from this position and repeat several times.

To decrease the gait.—Hold the arm horizontally above and in front of the forehead.

To indicate an increased or decreased gait for a maneuver, the appropriate signal is made just after the preparatory signal for the maneuver.

To halt.—Extend the arm vertically and hold it there until the signal is obeyed.

To change direction to the right (left).—Extend the arm vertically; lower it to the left (right) until horizontal and describe a horizontal arc to the front and right (left).

Right (left) by section.—Point at the right (left) section and signal forward.

Right (left) front into line.—Extend the arm vertically and describe several large vertical circles on the right (left) side of the horse.

Bugle Calls

Bugle or trumpet calls fall into the following classifications:

Warning calls.

Formation calls.

Alarm calls.

Service calls.

Drill signals are also included for mounted troops.

Warning Calls

First call and guard mounting precede the assembly by such intervals as may be prescribed by the commanding officer.

Mess, church and fatigue, though classed as service calls, may be used as warning calls.

First call is the signal for formation dismounted; it does not precede, and is not used in connection with other warning calls.

Guard mounting is the first signal for guard mounting.

Call to quarters is the signal for men to repair to their quarters.

Formation Calls

Assembly is the signal for companies or details to fall in.

Adjutant's call is the signal for companies to form battalion; also for the guard details to form for guard mounting on the parade ground; it follows the assembly at such interval as may be prescribed by the commanding officer.

To the standard is sounded when the standard salutes.

Alarm Calls

Fire call is the signal for falling in, without arms, to extinguish fire.

To arms is the signal for falling in, under arms, as quickly as possible.

Service Calls

Tatoo, taps, mess, sick, church, recall, officers, captains, first sergeants, fatigue, school and the general are service calls.

The general is the signal for striking tents and loading wagons preparatory to marching.

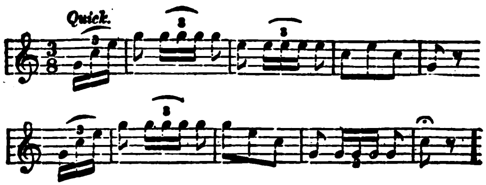
Reveille precedes the assembly for roll call; retreat follows the assembly; the interval being only that required for formation and roll call except when there is a parade.

Taps is the signal for extinguishing lights; it is usually preceded by call to quarters.

BUGLE CALLS

The music which follows should be memorized by enlisted men and, particularly, noncommissioned officers. The calls are warning, formation, alarm and service calls, also drill signals for mounted troops.

1. First Call.

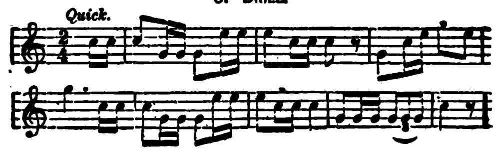


2. Guard Mounting.

3. Full Dress.

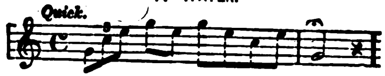
4. Overcoats.

5. Drill.

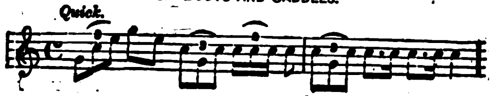


6. Stable.

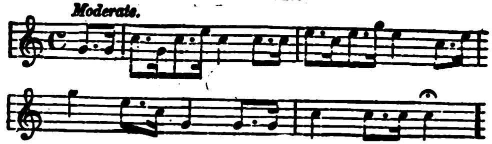
7. WATER.



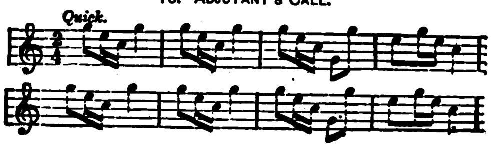
8. BOOTS AND SADDLES.



9. ASSEMBLY.



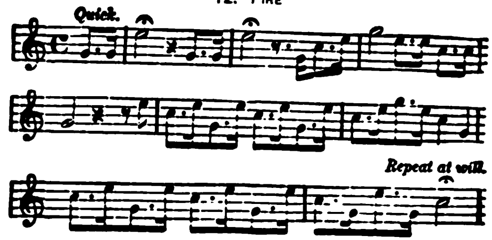
10. ADJUTANT'S CALL.



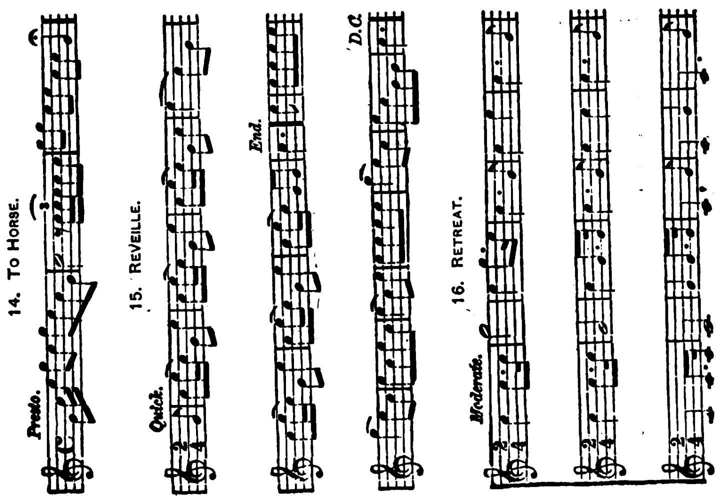
11. TO THE STANDARD.

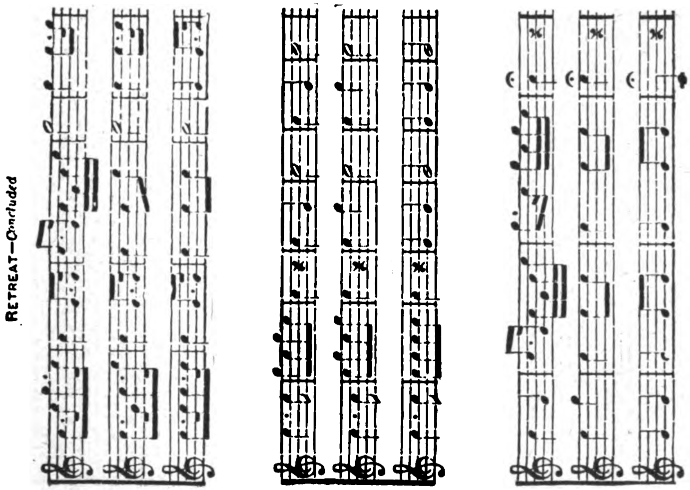
TO THE STANDARD—*Concluded.*

12. FIRE

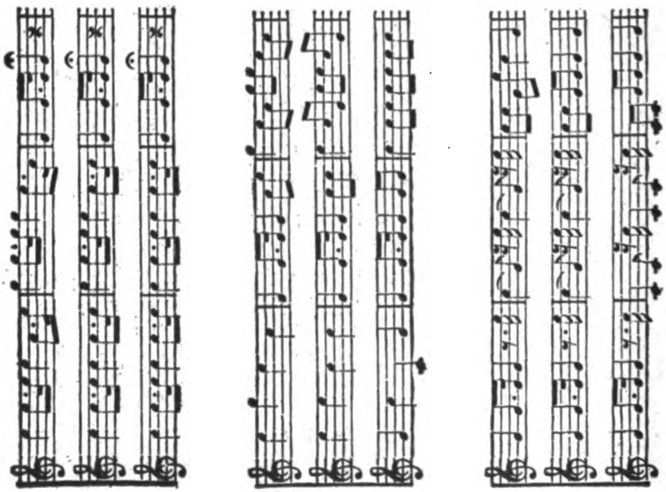


13 TO ARMS

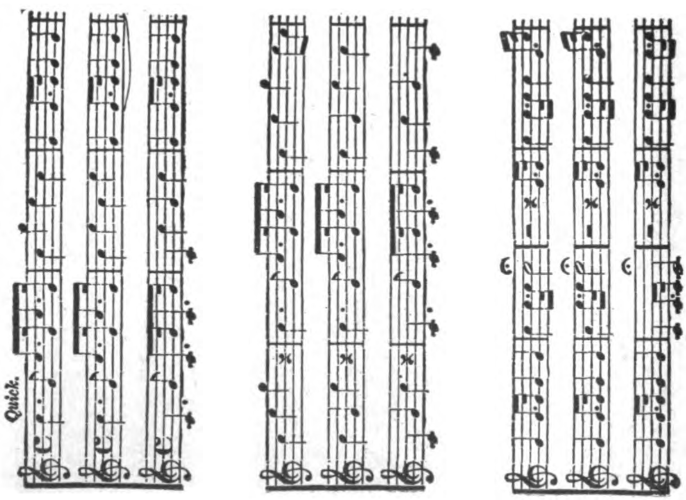

14. To Horse.
Presto.
15. Reveille.
Quick.
End.
D.C.
16. Retreat.
Moderato.

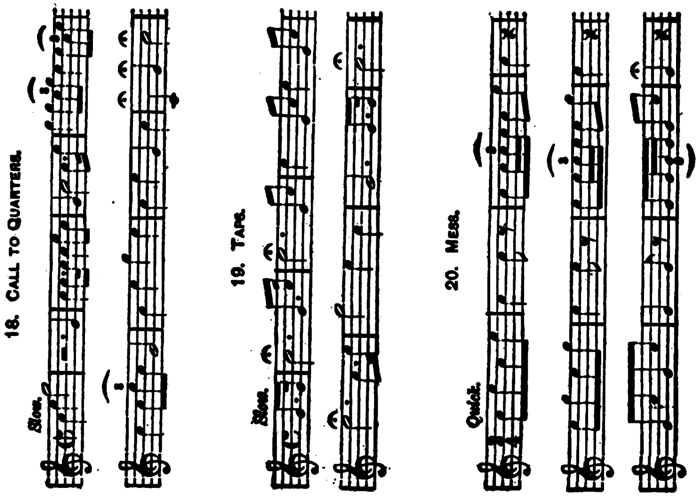

Retreat—Concluded

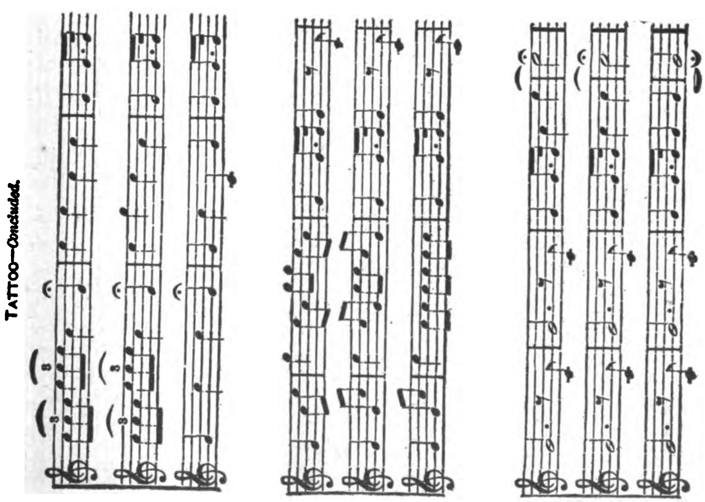
TATTOO—Continued.



17. TATTOO.




18. Call to Quarters.
Slow.
19. Taps.
Slow.
20. Mess.
Quick.


Tattoo—Concluded.


21. SICK.
Quick.
22. CHURCH.
Slow.
23. RECALL.
Moderato.
24. ISSUE.
Allegro.
25. OFFICERS' CALL.
Quick.
26. CAPTAINS' CALL.
Quick.
27. FIRST SERGEANTS' CALL.
Quick.
28. FATIGUE.
Quick.

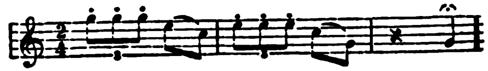
29. SCHOOL.

30. THE GENERAL.

31. ATTENTION.

32. PREPARE TO MOUNT, MOUNT.

33. PREPARE TO DISMOUNT, DISMOUNT.



34. FORM RANK OR POSTS.

35. FORWARD, MARCH.

36. HALT.

37. WALK, MARCH.

Slow.

38. TROT, MARCH.

Quick.

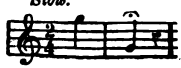
39. GALLOP, MARCH.

40. GUIDE RIGHT.

Slow.

41. GUIDE LEFT.

Slow.



42. GUIDE CENTER.

Slow.

43. BY THE RIGHT FLANK, MARCH.

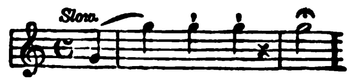
Moderate.

44. BY THE LEFT FLANK, MARCH.

Moderate

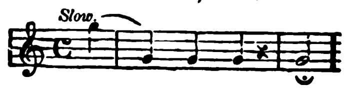
45. RIGHT ABOUT, MARCH

Slow.



46. LEFT ABOUT, MARCH.

Slow.

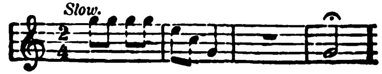


47. COLUMN RIGHT, MARCH.

Slow.

48. COLUMN LEFT, MARCH.

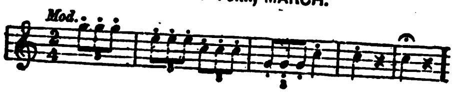
Slow.



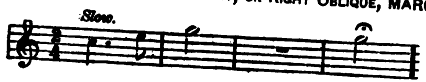
49. PLATOONS.

50. RIGHT TURN, MARCH.

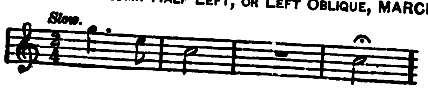
51. LEFT TURN, MARCH.



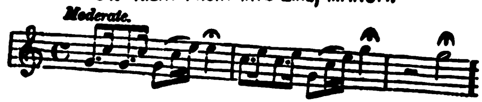
52. SECTIONS COLUMN HALF RIGHT, OR RIGHT OBLIQUE, MARCH



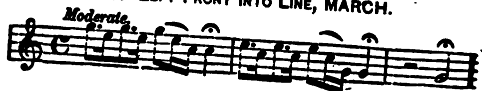
53. SECTIONS COLUMN HALF LEFT, OR LEFT OBLIQUE, MARCH.



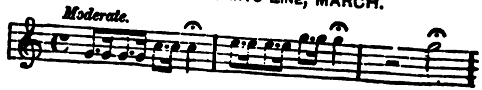
54. RIGHT FRONT INTO LINE, MARCH.



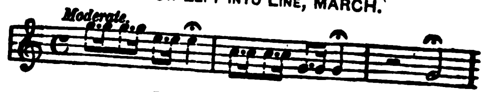
55. LEFT FRONT INTO LINE, MARCH.



56. ON RIGHT INTO LINE, MARCH.

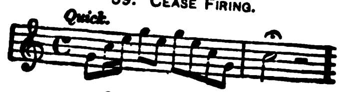


57. ON LEFT INTO LINE, MARCH.

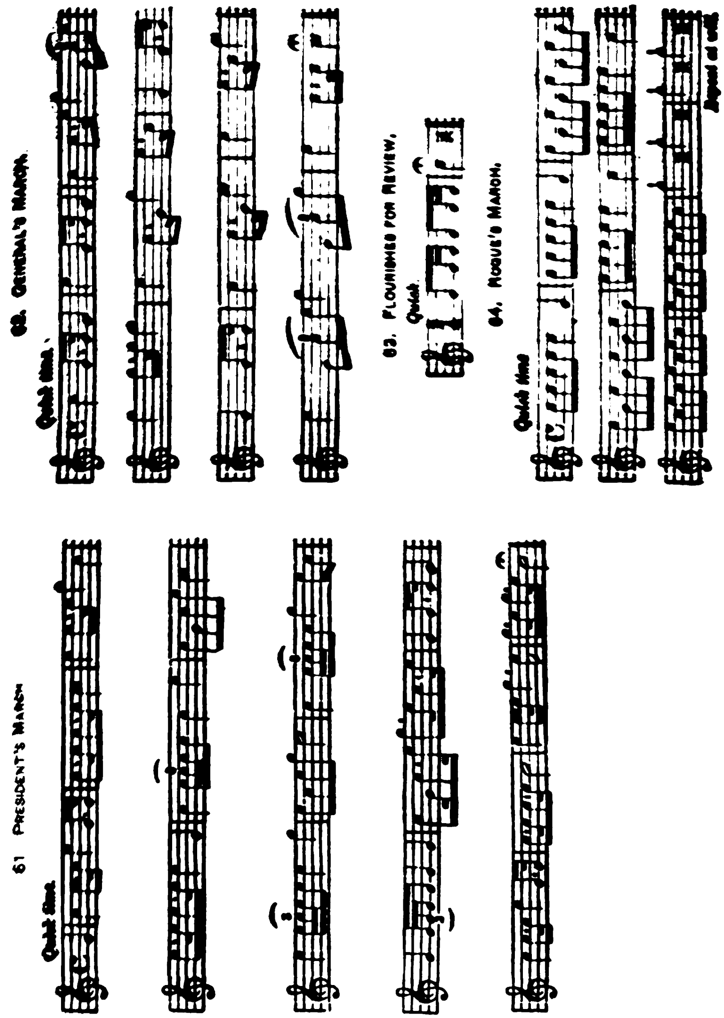


58. COMMENCE FIRING.

59. CEASE FIRING.

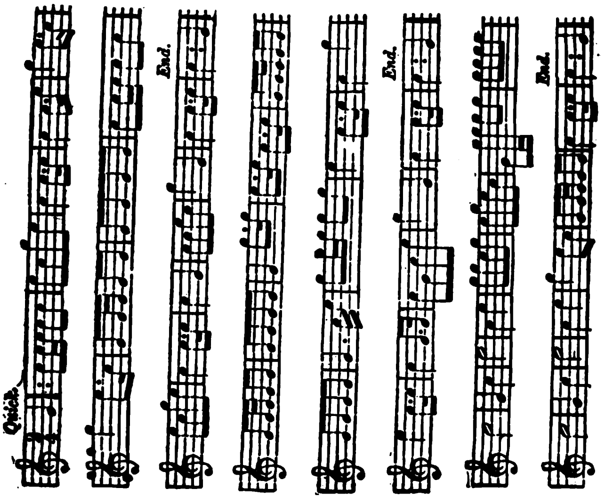


60. ROUTE ORDER.

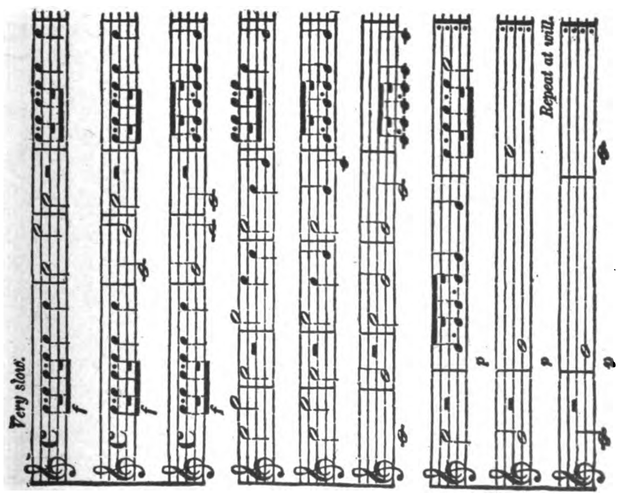


61 President's March
Quick time.
62. General's March.
Quick time.
63. Flourishes for Review.
Quick.
64. Rogue's March.
Quick time
Repeat ad lib.

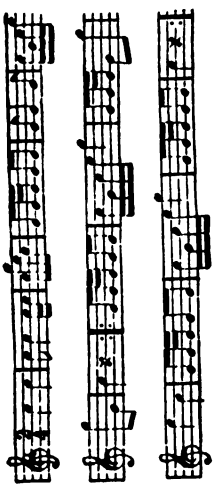
66. Quickstep No. 1.



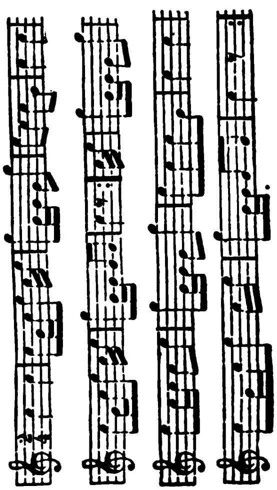
65. Funeral March.



67. Quickstep No. 2.

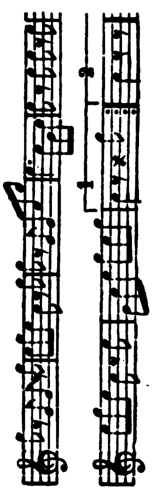


68. Quickstep No. 3.

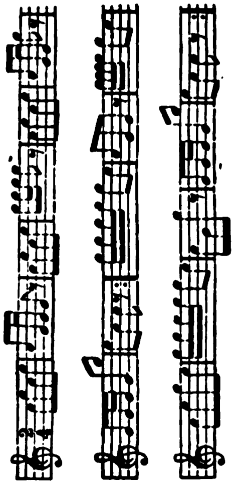


69. Quickstep No. 4.

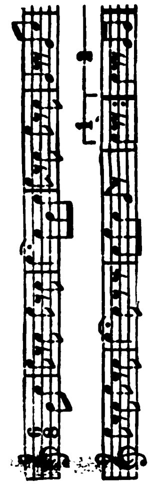
69. Quickstep No. 4—Concluded.



70. Quickstep No. 5.



71. Quickstep No. 6.



SCHOOL OF THE SOLDIER

General Provisions

This instruction has for its object the training of the individual recruit, and afterwards the squad. It must be given with the greatest attention to detail.

The instructor explains briefly each movement, first executing it himself, if practicable. He requires the recruits to take the positions unassisted and does not touch them for the purpose of correcting faults, except when they are unable to correct themselves. He avoids keeping them too long at the same movement, although each should be understood before passing to another; by degrees the desired precision and uniformity is exacted.

In the instruction of the recruit, frequent short rests are given in order that the men may not be unduly fatigued.

The instructor takes advantage of these rests to instruct the recruits in the customs and courtesies of the service, the duties of orderlies, the proper manner of receiving messages from and delivering them to officers, etc., so that when the recruit finally reports for duty he will not only know his prescribed drill thoroughly, but will know how to conduct himself as a trained soldier.

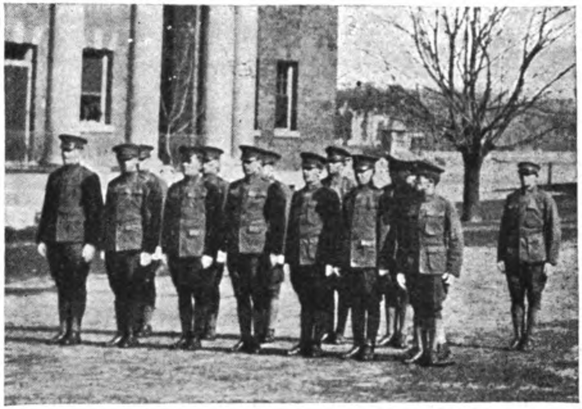
From the beginning, the instructor insists on a smart appearance and requires that clothing be clean and neatly adjusted.

For the individual instruction, a few recruits, usually not exceeding four, are placed in single rank, about 4 inches apart.

They execute the marchings as explained for the squad.

Position of the Soldier, or Attention

Heels on the same line and as near each other as the conformation of the man permits.



RECRUIT INSTRUCTION, ILLUSTRATING THE POSITION OF THE SOLDIER

Feet turned out equally and forming an angle of about 45 degrees.

Knees straight without stiffness.

Hips level and drawn back slightly; body erect and resting equally on hips; chest lifted and arched; shoulders square and falling equally.

Arms and hands hanging naturally, thumb along the seam of the trousers.

Head erect and squarely to the front, chin drawn in so that the axis of the head and neck is vertical; eyes straight to the front.

Weight of the body resting equally upon the heels and balls of the feet.

To Assemble

To teach the recruits to assemble, the instructor first places them in a single rank arranged according to height, the tallest man on the right; intervals of 4 inches are maintained between men, as nearly as practicable. The objects of the interval, it is explained, are to give freedom of movement in marching. Recruits are directed to open out the right elbow slightly until the left elbow of the man on the right is lightly touched; the elbow is then withdrawn. This is repeated several times and the recruits are then instructed to fall out and the man on the right being placed in position, they are instructed that at the command, **FALL IN,** they successively and quickly take their places in rank as before.

The Rests

Being at a halt, the commands are **FALL OUT; REST; AT EASE;** and, **1. Parade, 2. REST.**

At the command *fall out,* the men may leave the ranks, but are required to remain in the immediate vicinity. They resume their former places, at attention, at the command *fall in.*

At the command *rest* each man keeps one foot in place, but is not required to preserve silence or immobility.

At the command *at ease* each man keeps one foot in place and is required to preserve silence but not immobility.

1. Parade, 2. REST. Carry the right foot 6 inches straight to the rear, left knee slightly bent; clasp the hands, without constraint, in front of the center of the body, fingers joined, left hand uppermost, left thumb clasped by the thumb and forefinger of the right hand; preserve silence and steadiness of position.

To resume the attention: **1. Squad, 2. ATTENTION.**

The men take the position of the soldier.

Eyes Right or Left

1. Eyes, 2. RIGHT (LEFT), 3. FRONT.

At the command *right,* turn the head to the right oblique, eyes fixed on the line of eyes of the men in, or supposed to be in, the same rank. At the command *front,* turn the head and eyes to the front.

Facings

To the flank: **1. Right (left), 2. FACE.**

Raise slightly the left heel and right toe; face to the right, turning on the right heel, assisted by a slight pressure on the ball of the left foot; place the left foot by the side of the right. Left face is executed on the left heel in the corresponding manner.

Right (left) half face is executed similarly, facing 45 degrees.

To face in marching and advance, turn on the ball of either foot and step off with the other foot in the new line of direction; to face in marching without gaining ground in the new direction, turn on the ball of either foot and mark time.

To the rear: **1. About, 2. FACE.**

Carry the toe of the right foot about half foot-length to the rear and slightly to the left of the left heel, without changing the position of the left foot; face to the rear, turning to the right on the left heel and right toe; place the right heel by the side of the left.

Salute with the Hand

1. Hand, 2. SALUTE.

Raise the right hand smartly until the tip of the forefinger touches the lower part of the headdress (if uncovered, the forehead) above the right eye, thumb and fingers extended and joined, palm to the left, forearm inclined at about 45 degrees, hand and wrist straight; at the same time look toward the person saluted (*two*). Drop the arm smartly by the side.

For rules governing salutes, see "Military Courtesy."

Steps and Marchings

With the exception of right step, all steps in marching executed from a halt begin with the left foot.

The length of the full stop in quick time is 30 inches, measured from heel to heel, and the cadence is at the rate of 120 steps per minute.

The length of the full step in double time is 36 inches; the cadence is at the rate of 180 steps per minute.

The instructor, when necessary, indicates the cadence of the step by calling *one, two, three, four,* or *left, right,* the instant the left and right foot, respectively, should be planted.

The arms hang naturally, the hands moving about 6 inches to the front and 3 inches to the rear of the seam of the trousers.

All steps and marchings and movements involving march are executed in *quick time* unless the squad be marching in *double time*, or double time be added to the command; in the latter case double time is added to the preparatory command. Example: **1. Squad right, double time, 2. MARCH** (School of the squad).

Quick Time

Being at a halt, to march forward in quick time: **1. Forward, 2. MARCH.**

At the command *march,* move the left foot smartly the right leg, left knee straight.

At the command *march,* move the left foot smartly straight forward 30 inches from the right, sole near the ground, and planted without shock; next, in like manner, advance the right foot and plant it as described; continue to march. The arms swing naturally.

Double Time

Being at a halt, or in marching in quick time, to march in double time: **1. Double time, 2. MARCH.**

If at a halt, at the first command shift the weight of the body to the right leg. At the command *march,* raise the forearms, fingers closed, to a horizontal position along the waist line, take up an easy run with a step at the cadence of double time (180 steps per minute) allowing a natural swinging motion to the arms.

If marching in quick time, at the command *march,* given as either foot strikes the ground, take one step in quick time, and then step off in double time.

To resume the quick time: **1. Quick time, 2. MARCH.**

At the command *march,* given as either foot strikes the ground, advance and plant the other foot in double time; resume the quick time, dropping the hands by the sides.

To Mark Time

Being in march: **1. Mark time, 2. MARCH.** At the command *march,* given as either foot strikes the ground, advance and plant the other foot; bring up the foot in rear and continue the cadence by alternately raising each foot about 2 inches and planting it on a line with the other.

Being at a halt, at the command *march,* raise and plant the feet as described above.

The Half Step

1. Half step, 2. MARCH.

Take steps of 15 inches in quick time, 18 inches in double time.

Forward, half step, halt, and **mark time,** may be executed one from the other in quick or double time.

To resume the full step from half step or mark time: **1. Forward, 2. MARCH.**

Side Step

Being at a halt or mark time: **1. Right (left) step, 2. MARCH.**

Carry and plant the right foot 15 inches to the right having the left foot beside it and continue the movement in the cadence of quick time.

The side step is used for short distances only and is not executed in double time.

Back Step

Being at a halt or mark time: **1. Backward, 2. MARCH.**

Take steps of 15 inches straight to the rear.

The back step is used for short distances only and is not executed in double time.

To Halt

To arrest the march in quick or double time: **1. Squad, 2. HALT.**

At the command *halt*, given as either foot strikes the ground, plant the other foot as in marching; raise and place the first foot by the side of the other. If in double time, drop the hands by the sides.

To March by the Flank

Being in march: **1. By the right (left) flank, 2. MARCH.**

At the command *march*, given as the right foot strikes the ground, advance and plant the left foot, then face to the right in marching and step off in the new direction with the right foot.

To March to the Rear

Being in march: **1. To the rear; 2. MARCH.**

The command *march*, given as the right foot strikes the ground, advance and plant the left foot; turn to the right about on the balls of both feet and immediately step off with the left foot.

If marching in double time, turn to the right about, taking four steps in place, keeping the cadence, and then step off with the left foot.

Change Step

Being in march: **1. Change step, 2. MARCH.**

At the command *march*, given as the right foot strikes the ground, advance and plant the left foot; plant the toe of the right foot near the heel of the left and step off with the left foot.

The change on the right foot is similarly executed, the command march being given as the left foot strikes the ground.

Covering and Marching on Points

The instructor indicates two points and requires that recruits, in succession, place themselves upon the prolongation of a straight line through these points and then to march upon them both in quick and double time.

It is demonstrated to the recruits that they cannot march in a straight line without selecting two points in the desired direction and keeping them covered while advancing.

A distant and conspicuous landmark is next selected as the point of direction. The recruit is required to choose two intermediate points in line with the point of direction and march upon it by covering these points, new points being selected as he advances.

PHYSICAL TRAINING

In the employment of the various forms of physical training it is necessary that well defined methods should be introduced so that the object of the training may be attained in a systematic manner. In planning these methods the following factors must be considered: (a) the condition and physical aptitude of the members, (b) facilities, (c) time, (d) instruction material.

The question of physical aptitude is a very important one and should always determine the nature and extent of the task expected of the members. It is advisable to divide the members into three classes: (a) the recruit class, (b) the intermediate class, (c) the advanced class, planning the work for each progressively.

Time is a decidely important factor and no plan can be made unless those in charge of this work know exactly how much time they have at their disposal. Experience has proven that in citizen-soldier units a 15 minute drill in setting up exercises is sufficient on drill nights.

The proper use of the instruction material is undoubtedly the most important point of an instructor's duty. Every exercise has a function peculiarly its own; it has a certain effect upon a certain part of the body. So far as possible, every lesson should be planned to embrace setting-up exercises that call into action all parts of the body. It is also advisable that a movement requiring a considerable amount of muscular exertion should be followed by one in which this exertion is reduced to a minimum. One portion of the body should not be exercised successively, that is, arm exercises should be followed by a trunk exercise, and that in turn by a leg, shoulder, and neck exercise.

The work laid down here should not be followed blindly; every instructor should select such portions as in his opinion are productive of the best results under the conditions, and if necessary vary them in accordance with changing conditions.

Short and frequent drills should be given in preference to long ones, which are liable to exhaust all concerned, and exhaustion means lack of interest and benefit. All movements should be carefully explained, and, if necessary, illustrated by the instructor.

The lesson should begin with the less violent exercises, gradually working up to those that are more so, then gradually working back to the simple ones, so that the men at the close of the drill will be in as nearly a normal condition as possible. Everything in connection with physical training should be planned so that the men look forward to it with pleasure. Never exercise men to the point of exhaustion. If there is evidence of panting, faintness, fatigue, or pain, the exercise should be stopped at once.

Setting Up Exercises

The commands are of two kinds: the preparatory, indicating the movement to be executed, and the command of execution, causing the execution. The continuation of an exercise is carried out by repeating the command, which usually takes the form of numerals, the numbers depending upon the number of movements that an exercise comprises. Thus, if an exercise consists of two movements, the counts will be 1, 2; or if it consists of eight movements, the counts will be correspondingly increased.

In the continuation of an exercise the preparatory command is explanatory, the command of execution causes the execution and the continuation is caused by a repetition of numerals denoting the number of movements required, or of words describing the movements if words are used.

Each command must indicate, by its tone, how that particular movement is to be executed; thus, if an exercise consists of two movements, one of which is to be energized, the command corresponding to that movement must be emphasized.

Many of the arm exercises are short and snappy; hence the command should be given in a smart tone of voice, and the interval between the commands should be short.

The leg exercises cannot be executed as quickly as those of the arms; therefore, the commands should be slightly drawn out and follow one another in slow succession.

The trunk exercises, owing to the deliberateness of execution should be considerably drawn out and follow one another in slow succession.

All commands should be given in a clear and distinct tone of voice and an effort should be made in this tone to inspire the men with enthusiasm so that they will execute the exercises with willingness, snap and precision.

Blouses should be unbuttoned and the cap removed.

FORMATIONS

The men form in a single or double rank, the tallest man on the right.

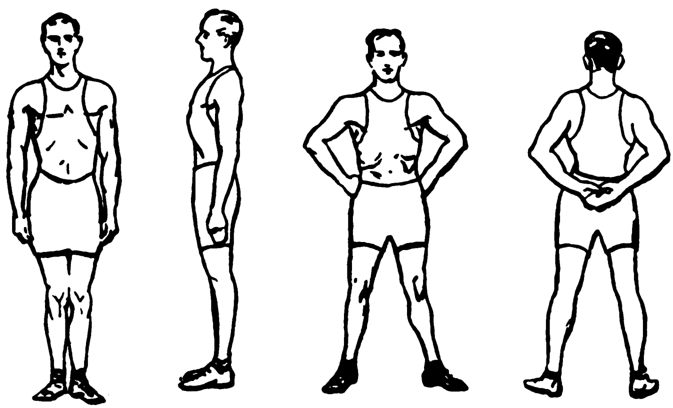
Instructor commands: **1. Count off.**

At this command, all except the right file execute "eyes right" and beginning on the right, the men in each rank count 1, 2, 3, 4; each man turning his head and eyes to the front as he counts.

The instructor then commands: **1. Take distance, 2. MARCH, 3. Squad, 4. HALT.**

At the command "march," number 1 of the first rank moves straight to the front; numbers 2, 3, and 4 of the front and numbers 1, 2, 3, and 4 of the rear rank, in the order named, move straight to the front, each stepping off so as to follow the preceding man at four paces; the command "halt" is given when all have their distances.

In nearly all the arm exercises it is necessary to hold the arms in some fixed position from which the exercises can be most advantageously executed, and to which position the arms are again returned upon completing the exercise. These positions are termed "starting positions"; and though it may not be absolutely necessary to assume one of them before or dur-



STARTING POSITIONS, FROM WHICH EXERCISES ARE EXECUTED ing the employment of any other portion of the body, it is advisable to do so, since they give to the exercise a finished, uniform and graceful appearance.

Intervals having been taken and attention assumed, the instructor commands:

1. Arms forward, 2. RAISE, 3. Arms, 4. DOWN (Fig. 1).

At the command **raise,** raise the arms to the front smartly, extended to their full length, till the hands are in front of and at the height of the shoulders, palms down, fingers extended and joined, thumbs under forefingers. At **Arms, DOWN,** resume position of attention.

1. Arms sideward, 2. RAISE, 3. Arms, 4. DOWN. (Fig. 2).

At the command **raise,** raise the arms laterally, until horizontal, palms down, fingers as in 1.

The arms are brought down smartly without allowing them to touch the body.

1. Arms upward, 2. RAISE, 3. Arms, 4. DOWN (Fig. 3).

At the command, **raise,** raise the arms from the sides, extended to their full length, with the forward movement, until they are vertically overhead, backs of hands turned outward, fingers as in 1.

This position may also be assumed by raising the arms laterally until vertical. The instructor cautions which way he desires it done.

1. Arms backward, 2. CROSS, 3. Arms, 4. DOWN. (Fig. 4).

At the command **cross,** the arms are folded across the back; hands grasping forearms.

1. Arms to thrust, 2. RAISE, 3. Arms, 4. DOWN. (Fig. 5).

At the command **raise,** raise the forearms to the front until horizontal, elbow forced back, upper arms against the chest, hands tightly closed, knuckles down.

1. Hands on hips, 2. PLACE, 3. Arms, 4 DOWN. (Fig. 6).

At the command place, place the hands on the hips, the finger tips in line with trouser seams; fingers extended and joined, thumbs to the rear, elbows pressed back.

1. Hands on shoulders, 2. PLACE, 3. Arms, 4. DOWN. (Fig. 7).

At the command **place,** raise the forearms to the vertical position, palms inward, without moving the upper arms; then raise the elbows upward and outward until the upper arms are horizontal; at the same time bending the wrist and allowing the finger tips to rest lightly on the shoulders.

1. Fingers in rear of head, 2. LACE, 3. Arms, 4. DOWN. (Fig. 8).

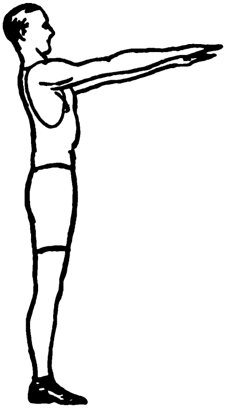


Fig. 1

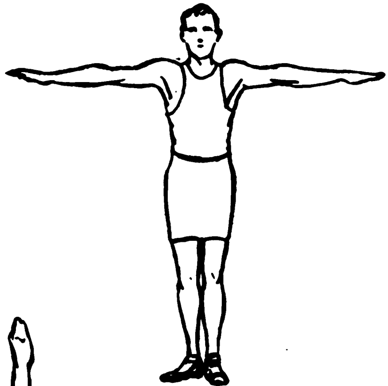


Fig. 2

Fig. 3

Fig. 4

Fig. 5

At the command **lace,** raise the arms and forearms as described in 7, and lace the fingers behind the lower portion of the head, elbows well up and pressed well back.

These positions should be practiced frequently, and instead

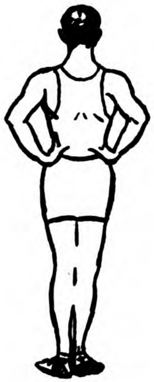


Fig. 6

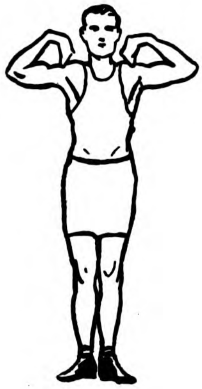


Fig. 7

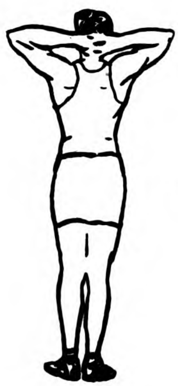


Fig. 8

of recovering the position of attention after each position, the instructor may change directly from one to another by giving the proper commands instead of commanding **Arms, DOWN.**

These changes should, however, be made only after the positions are thoroughly understood and correctly assumed.

RECRUIT INSTRUCTION

First Series

In these lessons only the preparatory command is given here. The command of execution, which is invariably **Exercise,** and the commands of continuance, as well as the command to discontinue, having been already explained, are omitted.

Position of attention, from **at ease** and **rest.**

Starting position, Figs. 1 to 8.

Raise and lower arms to side horizontal.

Two counts; repeat 8 to 10 times, Fig. 2.

The arms rigidly extended are brought to the sides smartly without coming in contact with the thighs. Inhale on first and exhale on second count.

1. Hands on hips, 2. PLACE, 3. QUARTER BEND TRUNK FORWARD.

Two counts; repeat 8 to 10 times, Fig. 9.

The trunk is inclined forward at the waist about 45 deg. and then extended again; the hips are as perpendicular as possible; execute slowly; exhale on first and inhale and raise chest on second count.

1. Arms to thrust, 2. RAISE, 3. RAISE SHOULDERS.

Two counts; repeat 8 to 10 times, Fig. 10.

The shoulders are raised as high as possible without deranging the position of the body or head and lowered back to position; execute briskly; inhale on first and exhale on second count.

1. Hands on hips, 2. PLACE, 3. QUARTER BEND KNEES.

Two counts; repeat 8 to 10 times, Fig. 11.

The knees are flexed until the point of the knee is directly over the toes; whole foot remains on ground; heels closed; head and body erect; execute moderately fast, emphasizing the extension; breathe naturally.

1. Arms backward, 2. CROSS, 3. RISE ON TOES.

Two counts; repeat 8 to 10 times, Fig. 12.

The body is raised smartly until the toes and ankles are extended as much as possible; heels closed; head and trunk erect; in recovering position heels are lowered gently; breathe naturally.

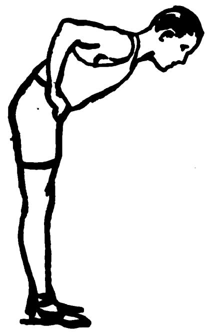


Fig. 9

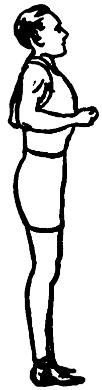


Fig. 10

Fig. 11

Fig. 12

1. Breathing exercise; 2. INHALE, 3. EXHALE.

At **inhale** the arms are stretched forward overhead and the lungs are inflated; at **exhale** the arms are lowered laterally and the lungs deflated; execute slowly; repeat four times.

Second Series

Position of attention, as in first series.
Repeat first lesson.

1. Hands on shoulders, 2. PLACE, 3. EXTEND ARMS FORWARD.

Two counts; repeat 8 to 10 times.
The arms are extended forward forcibly, palms down, and brought back to position smartly, elbows being forced back; exhale on first and inhale on second count.

1. Hands on hips, 2. PLACE, 3. BEND TRUNK BACKWARD.

Two counts; repeat 6 to 8 times, Fig 13.
The trunk is bent backward as far as possible; head and shoulders fixed; knees extended; feet firmly on the ground; hips as nearly perpendicular as possible; in recovering care should be taken not to sway forward; execute slowly; inhale on first and exhale on second count.

1. Arms to thrust, 2. RAISE, 3. MOVE SHOULDERS FORWARD.

Two counts; repeat 8 to 10 times, Fig. 14.
The shoulders are relaxed and moved forward and in as far as possible and then moved backward without jerking; head and trunk erect; execute slowly; exhale on first and inhale on second count.

1. Arms backward, 2. CROSS, 3. HALF BEND KNEES.

Two counts; repeat 8 to 10 times, Fig. 15.
The knees are separated and bent halfway to the ground, point of knee being forced downward; head and trunk erect; execute smartly and emphasize the extension; breathe naturally.

1. Hands on hips, 2. PLACE, 3. HALF BEND TRUNK FORWARD.

Two counts; repeat 8 to 10 times, Fig. 16.
The trunk is inclined forward until it is at right angles to the legs, hips perpendicular; knees extended; head and shoulders fixed; execute moderately slow; exhale on first and inhale and raise chest on second count.

Fig. 13

Fig. 14

Fig. 15

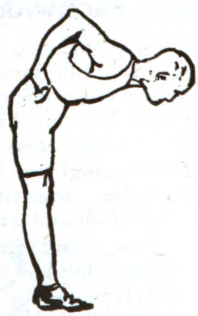


Fig. 16

1. Hands on shoulders, 2. PLACE, 3. STRIKE ARMS SIDEWARD.

The arms, knuckles down, hands closed are flung outward forcibly and brought back to shoulders smartly; execute fast, breathe naturally.

Breathing exercise.

Third Series

Position of attention.
Repeat second lesson.
Raise arms overhead laterally.
Two counts; repeat 8 to 10 times, Fig. 3.

The arms, rigidly extended at the elbows, are raised overhead, palms inward, smartly and brought down the same way; execute moderately fast; inhale on the first and exhale on the second count.

1. Hands on hips, 2. PLACE, 3. BEND TRUNK SIDEWARD, RIGHT OR LEFT.

Two counts; repeat 6 to 8 times, Fig. 17.

The trunk, stretched at the waist, is inclined sideward as far as possible, head and shoulders fixed; knees extended and feet firmly on the ground; execute slowly; inhale on first and exhale on second count.

1. Arms to thrust, 2. RAISE, 3. BEND HEAD FORWARD AND BACKWARD.

Four counts; repeat 6 to 8 times, Fig. 18.

The chin is drawn in and the head bent forward, back muscles of neck being stretched upward; shoulders remain fixed; in recovering the muscles are relaxed; execute slowly; inhale and raise chest on first and exhale on second count. In bending the head backward the muscles of the neck are stretched upward; breathe as before.

Curl shoulders forward.

Two counts; repeat 6 to 8 times, Fig. 19.

The shoulders relaxed are rolled forward as far as possible; arms being rotated forward; they are then rolled backward and the arms are rotated backward; execute slowly; exhale on first and inhale on second count.

1. Hands on hips, 2. PLACE, 3. FULL BEND KNEES.

Two counts; repeat 6 to 8 times, Fig. 20.

The knees are separated and bent as much as possible; point of knees forced forward and downward; heels together; trunk and head erect; execute slowly; breathe naturally.

1. Hands in rear of head, 2. LACE, 3. On toes, 4. RISE. 5. ROCK.

Two counts, repeat 6 to 8 times.

The body is raised on toes and then by short and quick extensions and flexions of the toes it is lowered and raised, knees extended; heels together and free from the ground; breathe naturally.

Breathing exercise as in first lesson.

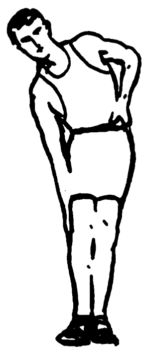


Fig. 17

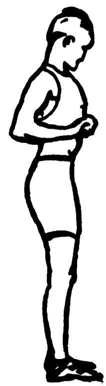


Fig. 18

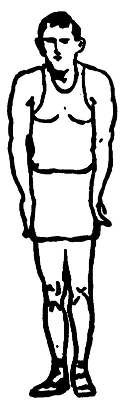


Fig. 19

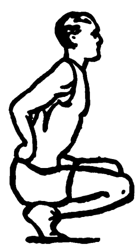


Fig. 20

Fourth Series

Repeat third series.

1. Arms to thrust, 2. RAISE, 3. THRUST ARMS FORWARD.

Two counts; repeat 8 to 10 times, Fig. 21.

The arms, knuckles up, are thrust forward forcibly; in recovering the elbows are forced back; execute moderately fast; exhale on first and inhale on the second count.

1. Hands on shoulders, 2. PLACE, 3. TWIST TRUNK SIDEWARD, RIGHT OR LEFT.

Two counts; repeat 6 to 8 times, Fig. 22.

The trunk is turned to the right or left as far as possible; hips as nearly perpendicular as possible; shoulders square and head erect; knees extended and feet firm; execute slowly; inhale on first and exhale on second count.

1. Arms to thrust, 2. RAISE, 3 TURN HEAD RIGHT, OR LEFT.

Two counts; repeat 6 to 10 times, Fig. 23.

The head, chin square, is turned to the right, or left as far as possible, muscles of the neck being stretched; shoulders remain square; execute slowly; breathe naturally.

1. Hands on hips, 2. PLACE, 3. RAISE KNEE.

Two counts; repeat 10 to 12 times, Fig. 24.

The thigh and knee are flexed until they are at right angles, thigh horizontal; toes depressed; the right knee is raised at **one** and the left at **two;** trunk and head erect; execute in cadence of quick time; breathe naturally.

1. Fingers in rear of head, 2. LACE, 3. FULL BEND TRUNK FORWARD.

Two counts; repeat 6 to 8 times, Fig. 25.

The trunk is bent forward as far as possible; knees extended; feet firm; head and shoulders fixed; execute slowly; exhale on first and inhale on second count.

1. Hands on hips, 2. PLACE, 3. On toes, 4. RAISE, 5. HOP.

Two counts; repeat 12 to 16 times.

The body is raised on toes and the hopping is performed with knees extended; execute fast; breathe naturally

Breathing exercise.

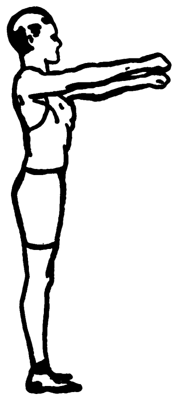


Fig. 21

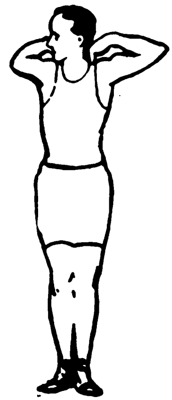


Fig. 22

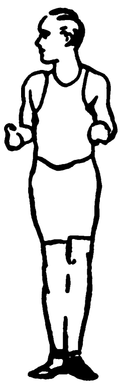


Fig. 23

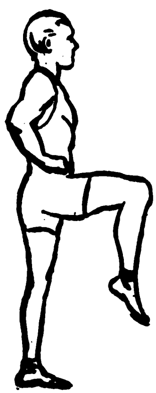


Fig. 24

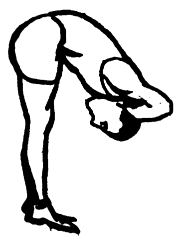


Fig. 25

Fifth Series

Repeat fourth series.

1. Arms forward, 2. RAISE, 3. STRETCH ARMS SIDEWARD.

Two counts; repeat 6 to 8 times, Fig. 26.

From the front horizontal the arms are extended to their fullest extent and then stretched sideward, the arms rotating till the palms are up; the sideward movement is performed slowly; the recovery relaxed and quick; inhale on first and exhale on the second count.

1. Hands on hips, 2. PLACE, 3. BEND TRUNK OBLIQUELY FORWARD, RIGHT OR LEFT.

Two counts; repeat 4 to 8 times, Fig. 27.

The trunk is turned to the right and bent forward to the half-bend position; shoulders remain square, in the plane of the ground; head fixed; knees straight; feet firm; hips as nearly perpendicular as possible; execute slowly; exhale on the first and inhale and raise chest on second count.

1. Arms to thrust, 2. RAISE, 3. EXTEND LEG FORWARD.

Two counts; repeat 8 to 10 times, Fig. 28.

The knee and ankle are extended forward with a snap, the toes just escaping the ground; all extensor muscles contracted; in recovering relax; trunk and head erect; execute briskly; breathe naturally.

1. Hands on shoulders, 2. PLACE, 3. MOVE ELBOWS FORWARD.

Two counts; repeat 8 to 10 times, Fig. 29.

The elbows are brought together horizontally in front and then forced back as far as possible; the forward movement relaxed, the backward a stretch not a jerk; execute moderately fast; exhale on the first and inhale on the second count.

1. Hands on hips, 2. PLACE, 3. BEND TRUNK FORWARD AND BACKWARD.

Two counts, repeat 6 to 8 times.

Bend trunk forward to the half-bend position, Fig. 16, and then backward, Fig. 13; execute slowly; exhale on first and inhale on second count.

1. Arms backward, 2. CROSS, 3. RAISE ON TOES, RIGHT AND LEFT ALTERNATELY.

Four counts; repeat 10 to 12 times, Fig. 30.

The body is extended on the toes of the right foot and then on those of the left; heels closed; trunk and head erect; execute moderately fast; breathe naturally

Breathing exercise.

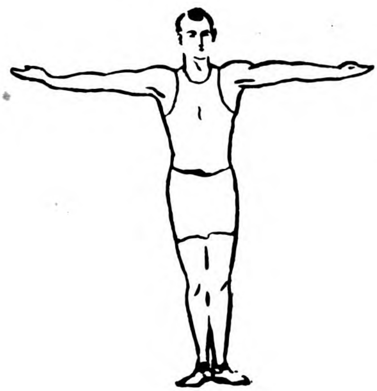


Fig. 26

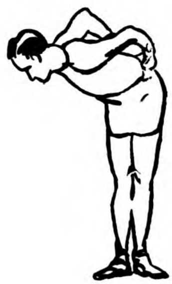


Fig. 27

Fig. 28

Fig. 29

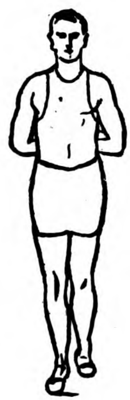


Fig. 30

Sixth Series

Repeat fifth series.

1. Arms forwarded overhead, 2. RAISE, 3. SWING ARMS DOWNWARD AND UPWARD.

Two counts; repeat 8 to 10 times, Fig. 31.

1. Arms sideward overhead, 2. RAISE, 3. Fingers, 4. LACE, 5. BEND TRUNK SIDEWARD, RIGHT AND LEFT.

Two counts; repeat 6 to 8 times, Fig. 32.

The arms are fully extended and the body, stretched at the waist, is bent sideward to the right and left; knees straight; feet firm; head erect; execute slowly; breathe naturally.

1. Knees to squatting position, hands on hips, 2. BEND, 3. ROCK.

Two counts; repeat 6 to 8 times.

The knees are bent as in Fig. 20; extend and bend the knees in quick succession; trunk and head erect; heels closed; execute moderately fast; breathe naturally.

1. Arms to thrust, 2. RAISE, 3. MOVE SHOULDERS FORWARD, UP, BACK AND DOWN.

Four counts; repeat 8 to 10 times.

The shoulders are relaxed and brought forward; in that position they are raised; then they are forced back without lowering them; and then they are dropped back to position; execute slowly; exhale on the first, inhale on the second and third and exhale on the last count.

1. Arms to thrust, 2. RAISE, 3. THRUST ARMS FORWARD; SWING THEM SIDEWARD, FORWARD, AND BACK TO POSITION.

Four counts; repeat 8 to 10 times.

The arms are thrust forward, then relaxed and swung sideward, then forward and finally brought back to position, pressing elbows well to the rear; execute moderately fast; exhale on the first and third and inhale on the second and fourth counts.

1. HOP TO SIDE STRADDLE AND SWING ARMS OVER HEAD LATERALLY AND RECOVER POSITION OF ATTENTION.

Two counts; repeat 8 to 10 times, Fig. 33.

The distance between the legs is about 30 inches; in alighting the toes come in contact with the ground first and knees are bent slightly; trunk and head erect; arms extended; execute moderately fast; breathe naturally.

Breathing exercises.

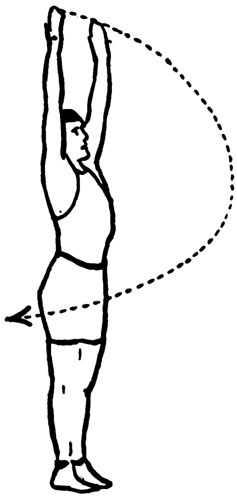


Fig. 31

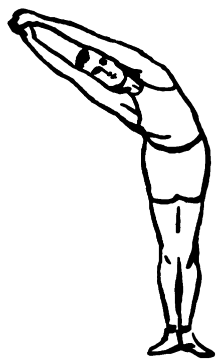


Fig. 32

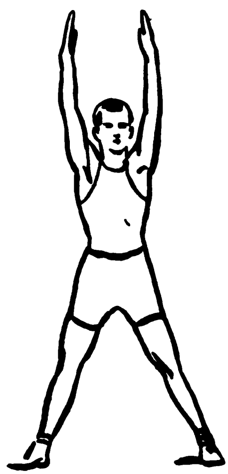


Fig. 33

SCHOOL OF THE SQUAD

THE SQUAD

As soon as the recruits are sufficiently instructed for the purpose, they are formed into squads of convenient size in order to teach them the principles of the alignments, taking intervals, and the marchings.

For this instruction, the recruits are formed in double rank. The files on the right and left of the squad are always complete; if there be an incomplete file, it will be second from the left. The rear-rank men cover their file leaders accurately at 1 yard distance.

In the case of a small number of recruits, they may be formed in single rank. The movements described for the double rank formation apply equally well to the single rank, omitting the explanations for the rear-rank men.

TO FORM THE SQUAD

To form the squad, the instructor designates a recruit as the front-rank man of the right file and indicates to him where the right of the squad is to rest; he then places himself about 3 yards in front of where the center is to be formed, and commands: **FALL IN.**

The men form on the designated recruit, in two ranks facing to the front, as already prescribed.

The rear rank forms with distance of 40 inches.

The instructor then commands: **COUNT OFF.**

At this command, all except the right file execute *eyes right,* and beginning on the right, the men in each rank count *one, two, three, four;* each man turns his head and eyes to the front as he counts.

The squad executes *the rests;* resumes *the attention; marks time;* and executes *the facings,* the *setting-up exercises, the steps,* and *the halt,* and is dismissed by the same commands and means as explained for the recruit.

ALIGNMENTS

The alignments are first taught by requiring the recruits to align themselves upon two files established as a base.

Being at a halt, the instructor causes the first two files on the flank toward which the alignment is to be made to move forward a few paces, and establishes them as a base; he then commands: **1. Right (left), 2. DRESS, 3. FRONT.**

At the command *dress,* all men place the left hand upon the hip (whether dressing to the right or left); each man, except the base file, when on or near the new line executes *eyes right,* and, taking steps of 2 or 3 inches, places himself so that his right arm rests lightly against the arm of the man on his right, and so that his eyes and shoulders are in line with those of the men on his right; the rear rank men cover in file.

The instructor verifies the alignment of both ranks from the right flank and orders up or back such men as may be in rear, or in advance, of the line; only the men designated move.

At the command *front,* given when the ranks are aligned, each man turns his head and eyes to the front and drops his left hand by his side.

In the first drills the basis of the alignment is established on, or parallel to, the front of the squad; afterwards, in oblique directions.

Whenever the position of the base file or files necessitates a considerable movement by the squad, such movement will be executed by marching to the front or oblique, to the flank or backward, as the case may be, without other command.

To preserve the alignment when marching: **GUIDE RIGHT (LEFT).**

The men preserve their intervals from the side of the guide, yielding to pressure from that side and resisting pressure from the opposite direction; they recover intervals, if lost, by gradually opening out or closing in; they recover alignment by slightly lengthening or shortening the step; the rear-rank men cover their file leaders at 40 inches.

In double rank, the front-rank man on the right, or designated flank, conducts the march; when marching faced to the flank, the leading man of the front rank is the guide.

TO TAKE INTERVALS

Being in line at a halt: 1. Take interval, 2. To the right (left), 3. MARCH, 4. Squad, 5. HALT.

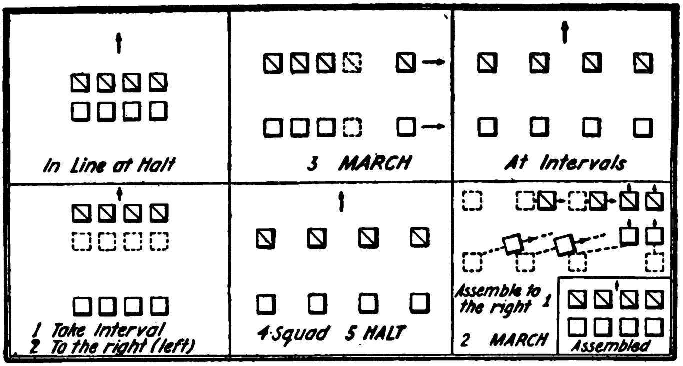


ILLUSTRATION OF THE MOVEMENT, "TAKE INTERVAL" AND "ASSEMBLE"—READ DOWN COLUMNS

At the first command, the rear rank steps back 4 steps and halts; at the command *march,* all face to the right and the leading man of each rank steps off; the other men step off in succession so as to follow the preceding man at 4 paces, rear rank men marching abreast of their file leaders.

At the command *halt,* given when all have their intervals, all halt and face to the front.

To Assemble

1. Assemble, to the right (left), 2. MARCH.

The front-rank man on the right stands fast, the rear-rank man on the right closes to 40 inches. The other men face to the right, close by the shortest line, and face to the front.

Marchings

During the marchings the guide conducts the march, preserving with great care the direction, length, and cadence of the step and selecting points on which to march

To March to the Front

Being at a halt: **1. Forward, 2. MARCH.**

The men step off and march straight to the front.

If in line, the rear-rank men follow their file leaders accurately. The instructor sees that the ranks preserve the alignment and the intervals toward the side of the guide.

The men yield to pressure from that side and resist pressure from the opposite side; by slightly shortening or lengthening the step they gradually recover the alignment, and by slightly opening out or closing in they gradually recover the interval, if lost; while habitually keeping the head to the front, they may occasionally glance toward the side of the guide to assure themselves of the alignment and interval, but the head is turned as little as possible for this purpose.

If in flank column, the men of the leading file step off at full step; the leading rear-rank man marches abreast of his file leader at 26 inches interval. The other files march at the half step, each taking the full step when at 1 yard distance.

Being in march: **1. To the rear, 2. MARCH.**

Executed as explained in preceding chapter, "School of the Soldier," paragraph: **To March to the Rear.**

If at a halt, the squad may be faced about and then moved forward, as explained in the preceding paragraph; or, without facing about, it may be marched a short distance to the rear, by the command: **1. Backward, 2. MARCH.**

Whenever the squad in line is faced about or marched to the rear, all men in the front rank not covered step into the new front rank.

To March by the Flank

Being in line: **1. By the right (left) flank, 2. MARCH.**

At the second command, given as the right foot strikes the ground, advance and plant the left foot, then face to the right in marching and step off in the new direction with the right foot. The rear-rank men cover accurately.

The formation obtained by marching by the flank from line is called a *flank column.*

If at a halt, the squad may be marched by the flank by first facing it in the desired direction and then moving it forward, as explained in "To March to the Front."

When the march by the flank is executed from flank column while at 1 yard distance, the files close in gradually toward the guide until they have the prescribed interval.

Whenever the flank column is halted while marching at 1 yard distance, the leading file halts at the command; the others close to facing distance before halting.

To close up the flank column without halting: **1. Close, 2. MARCH.**

The leading file takes the half step; the other files close to facing distance and take the half step; all the files having closed to facing distance, the column is halted or marched by the flank as previously explained.

To halt the flank column without closing up: **1. In place; 2. HALT.**

To March Obliquely

For the instruction of recruits, the squad being correctly aligned, the instructor causes the squad to face half right or half left, points out to the men their relative positions and explains that these are to be maintained in the oblique march.

1. Right (left) oblique, 2. MARCH.

Each man steps off in a direction 45 degrees to the right of his former front. He preserves his relative position, keeping his shoulders parallel to those of the guide (the man on the right front of the line or column), and so regulates his step as to keep the ranks parallel to their original direction.

If the command *halt* be given while marching obliquely, the men halt faced to the original front.

To resume the original direction: **1. Forward, 2. MARCH, 3. Guide right (or left).**

At *half step* or *mark time,* while obliquing, the oblique march is resumed by the commands: **1. Oblique, 2. MARCH.**

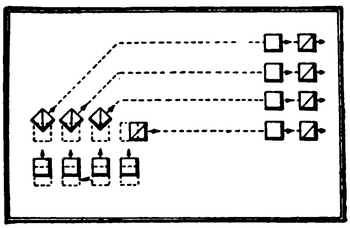


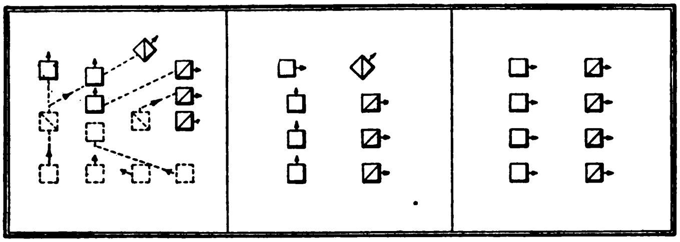
ILLUSTRATION OF SQUAD TURNING
ON MOVING PIVOT

TO CHANGE DIRECTION IN FLANK COLUMN

Turn on Moving Pivot

1. Right (left) turn, 2. MARCH.

The movement is executed by each rank successively and on the same ground. At the second command, the pivot man of the front rank faces to the right in marching and takes the half-step; the other men of the rank oblique to the right until opposite their places in line, then execute a second right oblique and take the half step on arriving abreast of the pivot man.



SQUAD TURNING ON FIXED PIVOT

1.—Squad right (left) 2.—MARCH Forward without command

All glance toward the marching flank while at half step and take the full step without command as the last man arrives on the line.

To Turn on Fixed Pivot

Being in line, to turn and march: **1. Squad right (left), 2. MARCH.**

At the second command the right flank man in the front rank faces to the right in marching and marks time; the other front rank men oblique to the right, place themselves abreast of the pivot, and mark time. In the rear rank the third man from the right, followed in column by the second and first, moves straight to the front until in rear of his front rank man, when all face to the right in marching and mark time; the other member of the rear rank moves straight to the front four paces and places himself abreast of the man on his right. Men on the new line glance toward the marching flank while marking time, and, as the last man arrives on the line, both ranks execute **forward, march,** without command.

INSTRUCTION WITH ARMS

General Provisions

The duties of Signal troops pertain essentially to the service of information. Their sole arm is the pistol, which is furnished as a means of self-defense at such times when the scope of their duty carries them beyond the protection of troops of the line.

Thorough training in the manual of the pistol and careful instruction in dismounted fire action should therefore be given to insure the acquisition of that self-reliance and morale necessary for the performance, unassisted if necessary, of their proper functions.

Both before and after drill or other exercise with the pistol, remove the magazine to see that it is empty and draw back the slide and examine the bore to see that the pistol is not loaded.

Before commencing instruction in the manual, the soldier should be made familiar with the mechanism of the pistol, the names of the principal parts, and the method of cleaning, assembling, and operating it.

When a lanyard is used the snaps are attached to the butt of the pistol and the magazine, the lanyard is passed over the head, and the sliding loop drawn snug against the right armpit. The lanyard should then be of just such length that the arm can be extended without constraint.

For dismounted instruction with the pistol, the men may be with or without intervals.

Except in the act of firing, the automatic pistol, when actually on the person, whether loaded or unloaded, will be carried cocked and locked. At all other times the hammer will be lowered fully down.

Instruction in firing will conform to the regulations prescribed in the Small Arms Firing Manual.

MANUAL OF THE PISTOL

The pistol being in the holster, to raise pistol: **1. Raise, 2. PISTOL.**

Raise: Unbutton the flap of the holster with the right hand and grasp the stock, back of the hand outward.

PISTOL: Draw the pistol from the holster; reverse it, muzzle up, the hand holding the stock with the thumb and last three fingers, forefinger outside the guard, barrel to the rear and inclined to the front at an angle of 30°, hand as high as the neck and 6 inches in front of the point of the right shoulder. This is the position of **raise pistol.**

Being at **raise pistol,** to inspect pistol: **1. Inspection, 2 PISTOL.**

(a) **When a magazine is in the pistol:** Push down the safety lock and lower the right hand to within easy reach of the left, pistol pointed upward and to the right front at an angle of about 30°; grasp the corrugations of the slide with the left thumb and forefinger, thumb to the right; thrust upward with the right hand, thus drawing back the slide until the slide stop is engaged; resume **raise pistol.**

(b) **When no magazine is in the pistol:** Push down the safety lock and lower the pistol to the left hand, rotating the pistol so that the sights move to the left, barrel pointing downward and to the left front, stock pointing upward and to the right front; with the left thumb and forefinger grasp the corrugations of the slide, back of the left hand down; change the grasp of the right hand slightly until the thumb presses against the rounded surface of the slide stop; thrust downward and to the left front with the right hand, thus drawing back the slide, and at the same time press the slide stop with the right thumb against the slide until it engages; resume **raise pistol.**

Inspection pistol is never executed with a loaded pistol or with a loaded magazine in the pistol.

1. Return, 2. PISTOL.

(a) Being at **raise pistol;** lock the pistol, if not locked; lower the pistol to the holster, reversing it, muzzle down, back of the hand to the right; raise the flap of the holster with the right thumb; insert the pistol in the holster and thrust it home; button the flap of the holster with the right hand.

(b) Being at **inspection pistol** (with a magazine in the pistol); lower the pistol to the left hand and grasp the slide as prescribed for inspection pistol without magazine; thrust downward and to the left front with the right hand, thus relieving the pressure on the slide stop, and at the same time disengage the slide stop with the right thumb; release the slide; reverse and lock the pistol; place it in holster as prescribed in (a). If here is no magazine in the pistol, lower it to the bridle hand as in **load;** draw back the slide and release it; lock the pistol and place it in the holster.

When the last shot is fired the slide stop engages automatically. **Return pistol** is then executed as from inspection pistol (b).

Being at raise pistol, to insert a magazine in the pistol: **1. Insert, 2. MAGAZINE,** or **2. LOADED MAGAZINE.**

(a) When a magazine is in the pistol: Lower the pistol into the left hand, rotating it so that the sights move to the left; grasp the slide with the left hand, back of the hand down, barrel pointing downward to the left front, stock pointing upward to the right front; release the magazine catch with the middle finger of the left hand; withdraw the magazine with the right hand; insert the designated magazine and resume **raise pistol.** If there be no empty space in the magazine pocket when the magazine is withdrawn from the pistol, the magazine may be held between the left thumb and the stock of the pistol until the magazine has been taken from the pocket and inserted; the magazine withdrawn from the pistol is then inserted in the magazine pocket.

Whenever the magazine catch is released, the right hand should be so placed as to limit the motion of the magazine and prevent its falling out.

(b) **When no magazine is in the pistol:** Lower the pistol into the left hand and grasp it as before; insert the designated magazine and resume **raise pistol.**

A loaded magazine will never be inserted without specific command.

Being at **raise pistol** with a loaded magazine in the pistol, to load: **LOAD:** Push down the safety lock and lower the pistol to the bridle hand as prescribed for inspection pistol when a magazine is in the pistol; operate the slide; engage the safety lock with the right thumb and raise pistol.

To simulate loading for instruction, first withdraw the empty magazine.

The command load may be given in connection with the insertion of the magazine, for example: **1. Insert, 2. LOADED MAGAZINE; 3. LOAD.**

After inserting magazine, reverse the pistol and load as above prescribed.

Being in any position, to eject the cartridge from the receiver: **UNLOAD.**

Pass the pistol into the left hand as in **insert magazine;** release the magazine catch with the middle finger of the left hand, slightly disengaging the magazine; push down the safety lock with the right thumb; operate the slide to eject the cartridge; engage the magazine; raise and lock the pistol.

Being in any position, to withdraw the magazine from the pistol: **WITHDRAW MAGAZINE.**

Handle the pistol as in **insert magazine;** release the magazine catch; withdraw the magazine and execute **raise pistol.**

Recruits are taught the motions of loading and firing without cartridges, and preferably without a magazine in the pistol, to avoid wear on the magazine lips. Loading and pointing practice should be had at all gaits.

The hammer is always lowered preparatory to placing the pistol in the arm rack or other place of deposit.

Being at **raise pistol,** to lower the hammer:

(a) **Using both hands:** Push down the safety lock; assume the position of **load;** seat the right thumb firmly on the hammer and hold it there; raise the left hand to the right and press the grip safety with the left thumb; insert the forefinger inside the trigger guard; press the trigger and carefully let the hammer down with the right thumb. Resume **raise pistol.**

(b) **Using but one hand:** Raise the right hand until the muzzle of the pistol is well above the head; disengage the safety lock; seat the ball of the right thumb firmly on the hammer; bear down the grip safety by pressure on the hammer; press the trigger and carefully let down the hammer with the right thumb.

To charge the magazine: Hold the magazine in the left hand, open end up, rounded side to the right. Take the cartridge in the right hand, thumb on the rim, bullet end pointing to the right; place the rim on the end of the magazine follower; force down the magazine spring and slip the cartridge to the left of the magazine. The next cartridge is similarly slipped in by placing it on the cartridge just inserted and forcing down the spring.

The magazine may be charged with any number of cartridges from one to seven.

Before dismissing the squad, pistols will be inspected, and if found loaded, will be unloaded and magazines withdrawn to prevent loaded or partially loaded magazines being left in the pistol. Except at target practice, on guard duty, or active service, the pistol is habitually carried unloaded with empty magazine.

To Fire

Being at raise pistol, **to fire:** With the right thumb release the safety lock, if in the locking position; extend the arm, bringing the sights on the target, and press the trigger.

The energy of recoil causes the mechanism of the pistol to eject the empty cartridge case, load, and prepare the pistol for the next shot. Pressure must be entirely relieved from the trigger after each shot in order that the trigger may re-engage the sear. At the firing of the last cartridge, as the slide moves to the rear, it is automatically locked in the open position by the slide stop, thus calling attention to the fact that the magazine is empty.

To reload after firing out a magazine: Remove the magazine, insert a charged one, and release the slide stop with the left hand.

To exercise the squad in collective firing, either actual or simulated: **1. at (such an object), 2. Ready, 3. Squad, 4. FIRE.**

At the command **ready,** the pistols are cocked or the safety latches are released. At the command **fire,** each man aims and fires by steadily increasing the pressure of his grip. It is important that no attempt be made to **pull** the trigger.

THE COMPANY DISMOUNTED

General Provisions

The instruction herein prescribed for the field company dismounted is applicable, with obvious modifications, to the platoon dismounted and the section dismounted. The organization of the various signal companies, and their subdivisions, will be found in the chapters dealing with the several companies.

The lieutenants are assigned as platoon commanders in numerical order beginning with the senior.

Posts of Officers, Non-Commissioned Officers, etc., in Line

The captain: Four yards in front of the center of the company. *Chiefs of platoons*: Two yards in front of the center of their platoons. *Master signal electricians*: In the line of file closers, opposite the center of the company. *First sergeant*: In the front rank, 1 yard from the right of the first section. *Chiefs of sections.* One yard in front of the center of their sections. *Sergeants*: In the front rank on the right of their sections, not covered in the rear rank. *Supply stable, and mess sergeants*: In the line of file closers. *Corporals*: In the front rank of their sections, one on the left of the sergeant, the other on the left of the section. *Guidon and trumpeters*: In the line of file closers, in rear of the first section. Mechanics, cooks, etc., when present, will be assigned to the various sections.

In flank columns the posts are the same as when faced with the company from line.

To Form the Company Dismounted

At the sounding of the assembly, the first sergeant, facing the company, and 6 yards in front of where the center is to be, commands: **1. Fall in, 2. Call rolls, 3 REPORT.**

At the command *fall in,* the sergeants place themselves on the line facing to the front, in their proper order, at sufficient distance apart for the formation of their sections. The men of each section fall in on the left of their sergeants, the chiefs of sections take their posts, facing their sections, and the guidon and the file closers, except the master signal electricians, take their posts. The assembly having ceased, the first sergeant causes the sections to close to the right, if necessary.

At the command *call rolls,* the chief of sections call the rolls and then face to the front.

At the command *report,* the chief of the first section salutes and reports, "First section present," or "First section, Corporal ——— and Private ——— are absent." The first sergeant having received and verified the report, returns the salute with the right hand. The chief of the second section then reports in like manner, and so on. Men who are known to be absent by proper authority are not reported absent by the chiefs of section. After receiving the reports the first sergeant faces about, salutes the captain and reports, "Sir, the company is present or accounted for," or "Sir (so many) non-commissioned officers (or privates) are absent." The first sergeant then takes his post. The captain places himself about 12 yards in front of the center of the company, superintends the formation, and receives the report of the first sergeant, whose salute he returns. The lieutenants and master signal electricians take their posts as soon as the first sergeant has reported. During instruction the officers have the saber drawn or in the scabbard, at the discretion of the captain. When the captain draws saber the lieutenants also will draw sabers.

Alignments

The alignments are executed as prescribed for the squad, the guide being established instead of the base file. In aligning the company, the captain places himself in prolongation of the line, 2 yards from and facing the flank toward which the alignment is made; after commanding **FRONT** he resumes his post.

To Dismiss the Company

Being in line at a halt the captain directs the first sergeant: *Dismiss the company,* and returns the salute of the first sergeant.

The officers and master signal electricians fall out; the first sergeant salutes, steps 3 yards to the front, faces to the left, and commands: **DISMISSED.**

In exceptional cases the company may be dismissed from any formation, either at a halt or marching.

Route Order and at Ease

Marching in flank column: **1. ROUTE ORDER,** or, **1. AT EASE.**

The officers carry their sabers at will or in the scabbard; the men retain their positions in ranks, but are not required to keep step.

If the command be *route order,* the men are permitted to talk; if the command be *at ease,* silence is preserved.

To resume the cadenced step: **1. Company, 2. ATTENTION.**

If halted, while marching at route order, the men remain at rest in ranks; if halted while marching at ease, they remain at ease.

Route order and at ease are not used while marching in double time.

THE SOLDIER MOUNTED

Standard Required

1. The qualifications of a good horseman, in the military service, are as follows:

(a) He should have a strong seat, quite independent of the reins.

(b) He should be able to correctly apply the aids by which a horse is controlled.

(c) He should be capable of covering long distances on horseback with the least possible fatigue to himself and to his horse.

(d) Under proper directions he should be able to train an untrained horse and to improve a badly trained one.

(e) He should have a practical knowledge of the care of horses, both in garrison and in the field; he should understand how to detect and treat the minor ailments to which they are liable; and he should be a good groom.

(f) His attention to the care and adjustment of his equipment should be unremitting.

TO STAND TO HEEL

2. The instructor commands: **STAND TO HEEL**: Each man stands at attention 1 yard in rear of and facing his heel post. At the picket line he is 1 yard in rear of and facing his horse.

TO STAND TO HORSE

3. The instructor commands: **STAND TO HORSE**: Each man places himself, facing to the front, on the left side of his horse, eyes on a line with the front of the horse's head, so that he can see along the front, and takes the position of attention, except that the right hand, back uppermost, grasps both reins, forefinger between them, about 6 inches from the bit. The reins are on the horse's neck.

TO LEAD OUT

4. The men standing to horse, to leave the stable or picket line, the instructor commands: **LEAD OUT.**

Each man, holding his hand well up and firm, leads his horse, without looking at him, to the place designated by the instructor.

The men form in single rank from right to left, and, until further orders, with intervals of 3 yards.

If the horse shows a disposition to resist being led, the man takes the reins from the horse's neck, takes the ends in the left hand, then, with the right hand holding the reins, leads the horse as before. When leading through a low or narrow doorway the horse should be quieted by the voice or caresses, and not allowed to pass through hurriedly. To prevent the horse from rushing ahead the instructor may direct the man to face toward the horse, holding one rein in each hand, close to the bit, and lead him by stepping backward; after passing the doorway the man leads the horse as before.

ALIGNMENTS

5. The men being in line at a halt at stand to horse, the instructor sees that the men on the flank toward which the alignment is to be made are in the desired position and commands: **1. Right (Left), 2. DRESS, 3. FRONT.** Executed as in The Soldier Dismounted, except that the left hand is not placed on the hip, and each man moves his horse forward or backward, as may be necessary, to align him. The instructor may place himself on either flank and give a general alignment by ordering individual men to move their horses backward or forward.

TO MOUNT (WITHOUT SADDLE)

6. 1. Prepare to mount, 2. MOUNT.

At the first command drop the right rein, take two back steps, stepping off with the left foot, at the same time sliding the right hand along the left rein, face to the right. This should place the man behind the left shoulder of the horse. Take both reins in the right hand, aided by the left, the reins coming in on the side of the forefinger, forefinger between the reins, the loose end falling over on the off side; place the right hand behind the withers, holding the reins short enough to feel lightly the horse's mouth; place the left hand near the withers, and grasp a lock of the mane, the lock coming out between the thumb and forefinger.

At the command **mount,** spring lightly from the ground and raise the body, keeping it erect, and supporting the weight on the hands; carry the right leg, knee bent, over the horse's back, the weight still borne on the hands; sit down gently on the horse's back, and take one rein in each hand, the reins bearing equally on the horse's mouth.

POSITION OF THE SOLDIER, MOUNTED (WITHOUT SADDLE)

7. Body balanced on the middle of the horse's back. Head erect and square to the front.

Chin slightly drawn in, but not so much as to produce stiffness.

Body erect, but without stiffness.

Forearms close to the sides, without pressure.

Hands about 6 inches apart, backs straight up and down and outward and held low, so that the little fingers will brush the mane on top of the withers.

The right rein in the right hand and the left rein in the left hand, coming in on the underside of the little finger and coming out over second joint of forefinger, on which the thumb firmly holds the rein; the other fingers closed on the reins, nails toward the body; reins bearing equally on the horse's mouth; bight (end) of reins falling to the front and on the right side of the horse's neck.

Buttocks bearing equally on the middle of the horse's back, the seat being as flat as possible.

Legs stretched by their weight alone; the horse clasped by the entire leg—that is, the flat of the thighs, the inside of the knees, and the calf of the leg.

Feet hanging naturally and turned out at whatever angle the conformation of the man requires in order to grasp the horse as above.

REMARKS ON THE POSITION OF THE SOLDIER MOUNTED

8. **Body erect but without stiffness.**—While the head and shoulders should not droop forward, nor the chest be contracted, nor the back curved to the rear, and any tendency to slouch should be promptly corrected, still no part of the body should be held so straight or erect as to produce stiffness.

Forearms close to the sides without pressure, to prevent their being thrown out when the horse trots; if with pressure, the motion of the body will be communicated to the hand and rein.

Buttocks bearing equally, and seat as flat as possible, so that the body will preserve its steadiness.

Flat of thighs, inside of knees, and the calf of the leg clasping the horse equally to give a firm, steady seat.

The body from the hips up should be movable and should yield to the motion of the horse.

The man should have hold of the horse all the time with the legs, but not grasping him so much as to produce fatigue; his legs from the inside of the thighs and knees and calf should be in constant contact with the horse, but not so much so as to produce fatigue in the man. The arms should be without stiffness at the shoulders to avoid communicating the motion of the body to the reins.

The hands take a gentle feel of the horse's mouth, but otherwise are stationary, except to direct the horse.

During the early lessons the position of the soldier is necessarily one of constraint. He will probably be much fatigued and possibly made sore in tendons and muscles. An effort should be made to teach him to ride without unnecessary fatigue or injuring him physically and without putting him to anything which will tend to destroy his confidence on a horse or his "nerve."

No man can be said to be a good horseman who has not a firm, well-balanced seat and good hands; these are therefore of the utmost importance; they will assist the horse; the want of them will impede the horse's actions and make sore backs.

THE RESTS

9. Being at stand to horse, the commands are: **AT EASE** and **REST,** which are executed as prescribed in The Soldier Dismounted, except that each soldier retains his hold of the reins to keep his horse in place.

Being mounted and at a halt, the commands are: **AT EASE** and **REST;** if marching, **ROUTE ORDER.** At the command **at ease** the soldier may turn his head and make slight changes of position, but preserves silence.

At the command **rest** or **route order,** the soldier may turn his head, may talk, and make slight changes of position, but must not lounge on his horse.

To resume the attention: **1. Squad, 2. ATTENTION.** The soldier, if dismounted, takes the position of stand to horse; if mounted, he takes the position of the soldier mounted.

If the squad be mounted, attention may be resumed by the command: **1. REINS.**

TO DISMOUNT (WITHOUT SADDLE)

10. 1. Prepare to dismount, 2. DISMOUNT.

At the first command pass the right rein into the left hand, then seize both reins with the right hand, in front of the left, forefinger between the reins, and place the right hand on the withers, the reins coming into the hand on the side of the forefinger; let go with the left hand and grasp a lock of the mane in front of the withers, the lock coming out between the thumb and forefinger.

At the command **DISMOUNT,** raise the body on both hands, carry the right leg, knee bent, over the horse's back without touching it; bring the right leg near the left and come lightly to the ground on the balls of the feet, bending the knees a little; face to the left, drop the right rein, step to the front, sliding the right hand along the left rein, and take the position of stand to horse.

TO LENGTHEN OR SHORTEN THE REINS

11. Bring the hands toward each other; grasp the right rein with the thumb and forefinger of the left hand a short distance from the right thumb; relax the grasp of the right hand and allow the rein to slip through to get the proper bearing; then close the right hand and replace the hands. With the left rein the positions of the hands are reversed.

TO TAKE THE REINS IN ONE HAND

12. To relieve the constraint of the arms by changing their position, as well as to prepare the men for the use of the curb bridle, the instructor commands: **1. In left (right) hand, 2. TAKE REINS.**

At the second command bring the left hand opposite the middle of the body; half open and place in it the right rein, holding both reins as explained for the left rein, except that the little finger separates the reins, the right rein coming in about the little finger; close the left hand and drop the right hand behind the thigh.

TO ADJUST THE REINS

13. Seize the bight with the thumb and forefinger of the right hand; partly open the left hand so as to allow the reins to slip through it; raise the right hand until the reins bear equally; close the left hand upon them, letting the bight fall over the forefinger and right rein; drop the right hand.

TO RETAKE THE REINS IN BOTH HANDS

14. The reins being in the left hand: **1. In both hands, 2. TAKE REINS.**

Half open the left hand, seize with the right hand the right rein, and hold them as previously described.

TO DROP AND RETAKE REINS

15. Drop reins: Drop the reins on the horse's neck near the withers and drop the hands behind the thighs.

Take reins: The man retakes the reins and holds them as before dropping them.

TO MOUNT FROM THE RIGHT SIDE

16. Executed as in mounting from the left side, but by inverse means.

17. If the command be **mount** the men execute all that has been prescribed for **prepare to mount** and **mount.**

TO DISMOUNT ON THE RIGHT SIDE

18. 1. To the right, 2. Prepare to dismount, 3. DISMOUNT. Executed as in dismounting from the left side, by inverse means.

19. The men are frequently practiced in mounting and dismounting on the right side.

20. If the command be **DISMOUNT,** the men execute all that has been prescribed for **prepare to dismount** and **DISMOUNT.**

TO DISMISS THE SQUAD

21 The squad being in line at stand to horse: **1. By the right (left, or right and left), 2. FALL OUT.**

The man on the right leads his horse 1 yard to the front and then directly to the stable or picket line. Each of the other men executes in succession the same movement so as to follow the horse next on the right at a distance of 1 yard.

Being in column of files or twos, at the command **FALL OUT,** the leading rider or the rider on the right of each two leads out as prescribed and is followed by the other riders in turn.

The men remove, clean, and put the equipments in place, and care for and secure their horses under the direction of the instructor.

The instructor, having satisfied himself by inspection that the horses and equipments are properly cared for, and that the precautions required for the care of horses on their return from exercise have been observed, orders that the men be fallen in, marched to the company parade, and dismissed.

GAITS OF HORSES

22. The gaits are the walk, trot, canter, and gallop.

The **walk** is at the rate of 4 miles an hour, or 1 mile in 15 minutes, or 117⅓ yards in a minute.

The **maneuvering trot** is at the rate of 8 miles an hour, or 1 mile in 7½ minutes, or 234⅔ yards a minute. For purposes of individual instruction, the rate of the trot may be diminished to the rate of 6 or 6½ miles an hour by the command **SLOW TROT.** At the command **trot out,** the rate is 8 miles an hour.

The **canter** is at the rate of 8 miles an hour and is generally used for individual instruction.

The **maneuvering gallop** is at the rate of 12 miles an hour, or 1 mile in 5 minutes, or 352 yards a minute.

The length of the stride is about 10 feet.

The full or **extended** gallop is at the rate of 16 miles an hour.

To instruct in the maneuvering cadences, stakes are placed on the drill ground, on a convenient line for a long track, 117⅓ yards apart. The men and guides are required to march over the spaces at the rate of one, two, three, or four per minute, according as the gait is the walk, trot, canter, gallop, or full gallop.

Instruction in each gait should be practiced individually and collectively until each man knows whether he has the proper speed or cadence by the rhythm of motion.

Horses may be trained to walk in column under favorable conditions 4½ miles an hour, making 125 steps a minute, the stride being 0.916 yard.

The average walk of a horse is a mile in 16 minutes, 3.75 miles an hour, making 120 steps (110 yards) per minute, the strides being 0.916 yard.

The average trot of a horse is a mile in 8 minutes, 7.5 miles an hour, making 180 steps (220 yards) per minute, the stride being 1.22 yards.

ANALYSIS OF GAITS

The Walk

23. The walk is a gait in which the feet are lifted in succession and put down in the order of their lifting. If the right front foot begins the gait, the other feet are lifted in the following order: Left hind, left front, right hind. The walk should be free, easy, and elastic.

The Trot

24. The trot is a gait at which the horse springs from one diagonally disposed pair of feet to the other; between the beats all the feet are in the air. The right front and the left hind are called the **right diagonal,** the left front and the right hind the **left diagonal.**

The Gallop

25. The gallop is the most rapid of gaits. It must not be used unnecessarily over long distances, particularly on hard roads, where the concussion on the feet is severe, nor when the saddle is packed. However, when the rapidity of the normal trot is not sufficient, the rider, when out alone, should take the gallop in preference to increasing the speed of the trot.

The horse is said to **lead right** when the feet on the right side are more advanced than the corresponding feet on the left side. When the feet are advanced in the inverse order the horse is said to **lead left.**

The gallop is marked by three beats and a period of suspension. If the horse be leading right, the first beat is marked by the left hind foot, the second by the nearly simultaneous placing of the right hind and left front feet, and the third by the placing of the right front foot. The horse then leaps into the air from, and advances, the right front foot. In leading left the beats are right hind, left hind, and right front, left front.

A horse gallops **true** when he leads right in turning to the right, and leads left in turning to the left.

He gallops **false** when he leads left in turning to the right, or conversely. A horse is **united** when he gallops right (left) in front and right (left) behind. He is **disunited** when he gallops right in front and left behind, or conversely.

The gallop should be begun on the circle, because the feet are then favorably placed for taking and maintaining the proper lead. The horses thus start off more calmly and the rider is enabled to regulate the pace by describing a circle of greater or less circumference.

As soon as the horse breaks into the gallop the rider should move in cadence with his horse. The back and legs unite in the rhythm of the gait, the hands accompany gently and **without exaggeration** the movements of the head and neck.

During the gallop the command **at ease** is frequently given. The riders execute the suppling exercises which have been indicated as necessary in each case; they abandon themselves completely to the motion of the horse and thus acquire ease and flexibility. Prolonged periods at the gallop on calm and free-moving horses are most favorable for easily obtaining this result.

The canter is the collected or school gallop.

TO MOUNT (WITH SADDLE)

26. 1. Prepare to mount, 2, MOUNT.

At the first command drop the right rein, taking two back steps, stepping off with the left foot, at the same time sliding the right hand along the left rein; half face to the right; this should place the man about opposite the girth; with the aid of the left hand take both reins in the right, forefinger between the reins, and place the right hand on the pommel, the reins coming into the hand on the side of the forefinger, and held so as to feel lightly the horse's mouth, the bight falling on the right side. Place a third of the left foot in the stirrup, with the assistance of the left hand, if necessary; rest upon the ball of the right foot; grasp a lock of the mane with the left hand, the lock coming out between the thumb and forefinger.

At the command **mount,** spring from the right foot, holding firmly to the mane and keeping the right hand on the pommel; pass the right leg, knee bent, over the croup of the horse without touching him; sit down gently in the saddle; let go the mane, insert the right foot in the stirrup, pass the reins into the left hand and adjust them.

POSITION OF THE SOLDIER, MOUNTED (WITH SADDLE)

27. Same as previously explained (par. 7), with the following exceptions: Buttocks bearing equally and as flat as possible upon the middle of the saddle; reins coming into the left hand on the side of the little finger, and leaving it between thumb and forefinger; little finger between the reins, right rein above it; the other fingers closed, thumb pointing to the right front in the prolongation of the forearm and pressing the reins firmly on second joint of forefinger, the end of the reins falling to the front and outside of the right rein; left forearm close to the body without pressure; the back of the hand nearly vertical; left hand in front of the pommel of the saddle and as close to the top of the horse's withers as possible, without resting upon the pommel; right hand behind the thigh, arm hanging naturally; feet inserted in the stirrups so that the ball of the foot rests on the tread of the stirrup, heel slightly lower than the tread.

STIRRUPS

28. The stirrups should support the feet and the weight of the legs only and be of such length that when the legs are in proper position, the feet out of the stirrups, the treads will be on a level with the lower part of the inner ankle bone.

The length depends somewhat on the formation of the man; a man with a thick, heavy thigh requires a shorter stirrup than a man with a thin, flat one. For long distances at the gallop and trot a shorter stirrup is required than at a walk.

When riding, the stirrups take up, in a measure, the weight of the body in its descent to the saddle, by yielding of the ankles to prevent shock. This action is an easy, quick stiffening of the muscles, which distributes the downward motion between the feet, thighs and seat.

If, after the man has exercised a short time at the slow trot, he has a close seat, his leg in proper position, with his heel down, but does not easily keep his stirrup, then the stirrup requires shortening.

THE DOUBLE BRIDLE

29. The general principles for the use of the reins, already explained for the snaffle bridle, apply to the management of the horse with the double bridle, except that the bridle hand is moved instead of both hands. In all movements of the hand the arm should act freely and without constraint to the body, and as the curb bit is much more severe than the snaffle bit, it must be applied gradually and more gently, particularly in halting and in reining back.

To turn the horse to the right (left): Carry the hand a little forward and to the right (left), so that the left (right) rein bears on his neck.

INSTRUCTION WITH SADDLE, DOUBLE BRIDLE, AND SPURS

30. The instructor causes recruits at first to use the saddle and snaffle bit in executing movements prescribed and does not give them the curb bit and spurs until they have confidence in their seat and are able to ride fairly well.

As a general rule, soon after commencing the use of the saddle in the riding-hall exercises, about one-half the time of each drill may be without saddles, the saddles being removed and conveniently placed in the hall.

A man who can ride bareback can ride with a saddle.

RIDING WITHOUT REINS AND STIRRUPS

31. Riding without reins should be begun with the very first mounted lesson, and thereafter throughout the elementary instruction a portion of each lesson should be devoted to it.

The instructor causes the riders to take the track behind a leader, and to drop their reins as soon as their horses are going quietly and smoothly. For the first few lessons the gait is confined to the walk, then as confidence is established it is pushed to the trot and later to the gallop. At each gait stirrups should be retained until the riders have lost all sign of nervousness, when they should be abandoned and the work continued without reins or stirrups.

When riding without reins the instructor causes the men to fold their arms in front of their bodies, or place their hands on the hips, overhead, to the side, to the front, or to hold them as though they were holding the reins, and at the same time he sees that they do not derange their seats. The movement of the arms in this manner assists in bringing about relaxation and in acquiring balance.

When riding without reins for the first few times, it may be found advantageous with some men to have their horses led by an instructed soldier, who, in this case, may be either mounted or dismounted. Another method is to put the horse on the longe for the first few lessons without reins.

TO DISMOUNT (WITH SADDLE)

32. 1. Prepare to dismount, 2. DISMOUNT.

At the first command seize the reins with the right hand, in front of and near the left, forefinger between the reins, so that they come in on the side of the forefinger; place the right hand on the pommel; let go with the left hand, grasp a lock of the mane, the lock coming out between the thumb and forefinger; take the right foot out of the stirrup; partly disengage the left foot, body erect.

At the command **DISMOUNT,** rise upon the left stirrup, pass the right leg, knee bent, over the croup of the horse without touching him; descend lightly to the ground, remove the left foot from the stirrup and place it by the side of the right, body erect; let go the mane; place the end of the reins on the neck near the pommel of the saddle with the right hand, which then seizes the left rein; face to the left, take two short steps, left foot first, slipping the right hand along the left rein, and take the position of stand to horse.

GATHERING THE HORSE

33. Before the horse is required to execute any movement he should be given a preparatory signal. This signal should be given at the time of the preparatory command or signal. Whatever the movement to be executed, the signal is always the same. Its object is to attract his attention and to prepare him for a movement. This is called **gathering the horse.**

Having a light pressure of the bit against the horse's mouth and a light feel of the lower legs against his sides, the rider, in order to gather him, increases the pressure of the lower legs, with heels well shoved down, and slightly increases the tension of the reins. These pressures are increased intermittently until the elastic movement of the horse under the rider indicates that the former has observed the signal.

If, when at a halt, the horse backs, or when marching decreases the gait, the tension applied to the reins has been too great. If, when at a halt, the horse moves forward, or when marching he increases the pace or gait, the impulse given with the legs has not been met or controlled by the reins.

Each force should exactly balance the other, and the horse, held between the two, should feel responsive to the indications and aids of the rider.

TO MOVE FORWARD

34. Being at a halt: **1. Forward, 2. MARCH.** At the first command the rider gathers the horse; at the second he simultaneously (1) pushes his buttocks to the front, (2) acts with both legs according to the temperament of the horse, (3) eases the reins by slightly relaxing the fingers and giving the wrist, without losing contact. The aids cease to be active as soon as obedience is obtained.

TO HALT

35. Being at the walk: **HALT.** The rider sits well down in the saddle and gathers the horse; he then simultaneously (1) closes the fingers on the reins, bending the wrist, and if necessary, moving the hands in and back with the body; (2) slightly increases the pressure of the legs; (3) imposes the weight of his body against the horse's back by convexing his loins backward.

As soon as the horse slackens the gait ever so little the pressure of the fingers and legs is slightly relaxed to reward him for his obedience. It is then reapplied and again relaxed until the horse has completed the movement desired.

In order to prevent the horse from halting entirely on the forelegs, the rider must increase the pressure of his legs to induce the horse to engage his hind legs farther under the mass. By convexing his loins and imposing his weight against the muscular activity of the horse's back, the rider limits the functionizing of the muscles which control impulsion and thus permits the hind legs to participate in stopping or in reducing the gait. It is faulty to lean back in an exaggerated position, because of the tendency to permit the legs and thighs to go forward and to act with a dead pull of the reins on the horse's mouth; if done abruptly, it is painful to a horse and may cause him to halt in a hard and jolty manner.

In reducing the gait a steady pull against the mouth must be particularly avoided.

THE HALF HALT

36. The **half halt** finds constant application in the training of both horse and rider. It is a brief, energetic action of the hands, which the rider executes with the fingers closed on the reins by twisting the wrist quickly from below upward and from front to rear, without losing contact and without stopping the horse. At the same time the rider momentarily closes his legs and convexes his loins as in the halt. The half halt is used to slow up horses that are too ambitious or to carry to the rear the excess of weight that some badly balanced horses allow to come on the shoulders. It is effected according to need, on one rein, on two together, on the snaffle, or on the curb. The hand should regulate the power of its action by the resistance of weight which it meets.

CHANGES OF GAIT

37. To pass from the halt or the walk to the trot, canter, or gallop, the means prescribed for passing from the halt to the walk are employed and continued until the desired gait is taken.

To pass from a faster to a slower gait, or to a halt, the means prescribed for passing from the walk to the halt are employed and continued until the desired gait is taken or the horse has stopped.

The commands are: **1. Trot, 2. MARCH; 1. Gallop, 2. MARCH; .1 Canter, 2. MARCH; 1. Walk, MARCH;** and **HALT.**

EXTENDING OR REDUCING SPEED AT VARIOUS GAITS

38. To extend or reduce the speed at any gait the rider employs the means prescribed for passing from the halt to the walk or from the walk to the halt to the extent necessary to obtain the desired results.

The horse in extending the walk increases the amplitude of the movement of his head and neck to the same degree as he increases the length of his step; he accelerates the movement of the head as he increases the cadence or tempo of his step.

The rider aids these movements by yielding the hand and giving the horse greater freedom of movement. He maintains contact so that he can exercise gradual restraining influence with the direct rein when he feels the horse is about to spring into the trot.

To reduce the walk the rider makes use of the direct rein and legs as in coming to the halt. The step is shortened and the cadence or tempo decreased.

To extend or reduce the trot, the same means are used. The exercises in extending and reducing the gait afford excellent practice for the rider in the use of the aids and good training for the horse in obeying them, but the soldier out of ranks should use only the regulation gaits.

Changes of speed are executed at the commands: **1. Slow walk (trot or gallop), 2. MARCH;** or, **1. Walk (trot) out, 2. MARCH;** or **Extended gallop, 2. MARCH.** The normal speed is taken at: **1. Walk (trot or gallop), 2. MARCH.**

To increase or decrease the cadence or tempo at any gait the instructor may caution: **Extend (Reduce) the gait.**

INDIVIDUAL MOUNTED DRILL AND INSTRUCTION

39. Wherever formation **in line** is prescribed in these regulations, it will be understood, unless indicated to the contrary, that line **without intervals** is intended.

TO FORM IN LINE WITH INTERVALS

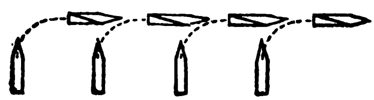
40. To form in line with intervals the instructor designates a trooper to act as the base of the formation, indicates to such trooper the point where the right of the squad is to rest and the direction in which the line is to face, takes position at a convenient distance in front of and facing the point where the center is to rest, and commands: **LEAD INTO LINE WITH INTERVALS.** The base trooper **leads out** and takes position as indicated; the other troopers lead out so as to approach the line **successively directly from the rear** and in single rank form on the line established by the base trooper, in order from right to left. The troopers form at stand to horse with intervals of 3 yards between horses.

BEING IN LINE WITH INTERVALS, TO MARCH BY THE FLANK IN COLUMN OF FILES

41. 1. By the right (left) flank, 2. MARCH.

At the first command gather the horse.

At the command **march,** open the right rein and close both legs, the right leg a little more to the rear than the other; turn to the right by moving the horse over a quarter of a circle whose radius is 2 yards; when the turn is nearly ended diminish the effect of the right rein and leg, using the left rein



and leg to straighten the horse; when the turn is completed, relax both legs and move off at a right angle to the original direction. The effect of the rein is to lead the horse in the desired direction, not to pull him back on that side.

Whenever executing the individual turn at the trot or gallop, the effect if the outer (in this case the left) leg should be increased to sustain the horse.

42. A squad marched by the flank, from line with intervals, is in column of files, with the distance of 4 feet from the head of one horse to the croup of the horse next in front.

Marching in column of files, each soldier should so conduct his horse that the soldier next in front of him shall hide all others in front; all follow in the trace of the conductor or leading file.

Distances, when lost, should be regained gradually.

If the column of files be marched by the flank, the squad will then be in line with intervals of 3 yards between files.

43. For convenience in estimating spaces, each horse with his rider is considered as occupying a space of 3 yards in length and 1 yard in width, but by measurement the horse occupies only about 8 feet in length.

44. To halt the column of files: **1. Squad, 2. HALT,** and **to** resume the march: **1. Forward, 2. MARCH.**

TO CHANGE DIRECTION

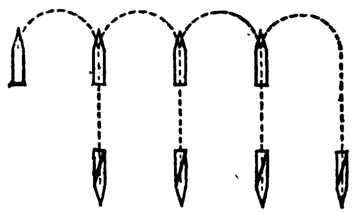
45. At a walk the changes of direction are made on the arc of a circle the radius of which is 2 yards. At fast gaits, where the horse is more or less extended and therefore harder to bend, the radius of the turn must be correspondingly increased.

46. Being in column of files: **1 Column right (left);** or, **1. Column half right (half left), 2. MARCH.**

The leading man turns or half turns to the right at the command of execution and marches in the new direction; the other men move forward and turn successively on the same ground.

THE INDIVIDUAL ABOUT

47. Being in line with intervals, or in column of files: **1. Right (left) about, 2. MARCH.**

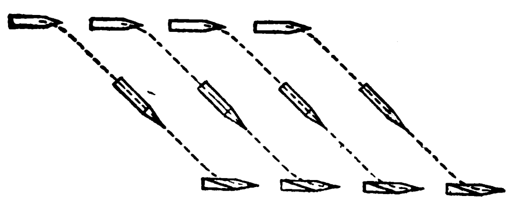


Each man turns his horse on a half circle whose radius is 2 yards, and then moves off in the new direction, to the former rear.

TO OBLIQUE

48. Being in line or in column of files: **1. Right (left) oblique, 2. MARCH.**

Each man turns his horse half right on an eighth of **a** circle, and then moves at an angle of 45° to his former direction.



To resume the original direction: **1. Forward, 2. MARCH.** Each man turns half left and then moves forward.

TO TURN ON THE FOREHAND

49. Being in line or column at the halt: **1. On the forehand, 2. To the right (left),** or, **2. To the right (left) about, 3. MARCH.** The horse is first put up against the bit, or gathered. The rider then takes a slight set of the head toward the side of the turn. The inner right leg is applied behind the girth and when necessary is accompanied by the action of the inner rein. The haunches are swung step by step around the opposing forehand until a turn of 90° or 180°, respectively, is completed. Every step of the haunches is regulated accurately by the outer supporting leg applied behind the girth in such a manner that there is a decided pause between steps, thereby preventing the haunches from rushing. Both during and after the movement the rider's legs and seat should insure that the horse does not back but remains up against the bit. A stepping forward usually indicates a falling out of the outer shoulder and must be counteracted by the outer rein. The inner rein should not act so strongly as to bend the neck, except in case of a green horse that does not understand the leg aids, or with a horse that offers resistance.

The turn on the forehand is not a real schooling lesson, because the haunches are disburdened and the horse thrown on the forehand. For this reason it should not be repeated very often.

As a rule, turns on the forehand are practiced only in the early training of the horse. Their principal purpose is to teach the rider the correct use of the sideward driving inner leg aid, the inner rein, and the outer supporting leg and rein.

As the movement has a great tendency to make the horse reluctant in going up promptly against the bit, the turn should be always immediately followed by a movement to the front at a free walk or at a trot, and it should never be exacted of young horses until the straight-ahead movement has been well confirmed.

TO TURN ON THE HAUNCHES

50. Being in line or column at the halt: **1. On haunches, 2. To the right (left),** or **2. To the right (left) about, 3. MARCH.** The rider puts his horse against the bit, gathers him, and sets the head to the side of the turn. The inner right rein begins and induces the turn, then carried well away from the neck, leads the forehand step by step around the haunches through a turn of 90° or 180°, respectively. The inner right hind foot must be kept in place during the turn. To accomplish this, the outer rein should be reined in, in the direction toward this foot. The outer hind foot must be prevented from falling out by the supporting action of the outer leg. Both of the rider's legs, but especially the inner one, prevent the horse from stepping back during the turn. It is a lesser mistake if the horse steps forward. The rider should place a little more of his weight on the inner buttock.

The instructor must see that the rider's legs and weight are placed as above described and that the tendency to let the legs fly away from the horse's sides be completely overcome.

TO TURN ON THE FOREHAND IN REVERSE

51. Marching on the track to either hand: **1. Reverse, 2. MARCH.** At the command **march** the rider leaves the track by an oblique. Having advanced far enough in this direction to place him from 6 to 15 yards from the track, the instructor adds **NOW,** whereupon the rider moves his horse back to the track over the arc of a half circle whose diameter is the distance thereto and retakes the track in the opposite direction.

Application of the aids.—At the moment the half circle is begun the aids are applied and the horse is bent as if to march on this circle. Immediately thereafter the inside leg is slipped in rear of the girth to the sideward driving position and is applied to drive the haunches outward so that they describe an outer and larger circle than the forehand. The outer leg takes a supporting position behind the girth to prevent the haunches from coming around too fast. The swing of the haunches should be slight as the half circle is begun and should then increase as the track is approached. The lateral drive should be strongest when the forehand has almost reached the track, and the haunches are about 1 yard from it.

With recruits and remounts the turn should be made on a large continuous curve. The horse is therefore changing direction while gaining ground to the front. The diameter of the half circle described by the forehand is never less than 6 yards.

The principal object of this movement is to teach the horse to yield to the inside aids, especially the sideward driving leg. It is therefore of great value to teach the rider the co-ordination and use of these aids and to get control of the haunches of his horse

TO REIN BACK

52. Being in line at the halt: **1. Backward, 2. MARCH, 3. Squad, 4. HALT.**

At the command **backward,** gather the horse.

At the command **march**, keep a firm seat, hold both legs close; carry the weight of the body slightly to the rear, and at the same time rein in gradually until the horse yields to the pressure of the bit and steps to the rear; then immediately yield the hand slightly to allow the horse to regain his balance and relax the legs; continue in the same manner to yield the hand and relax the legs, and rein in and close the legs, giving slight indication to the rear with the weight of the body, so as to keep the horse in continuous motion.

This movement should be frequently practiced to keep the horse light and collected.

If the horse raises his nose and throws his weight on his haunches without stepping back, hold the hands low and play the reins with light, rapid motions of the hands until he yields.

If the horse throws his haunches to the right, close well the right leg. If to the left, close well the left leg. If this be not sufficient to put the horse in proper position, open the rein on the side toward which he throws his haunches, supporting him at the same time with the other rein.

TO FORM IN LINE

53. To form in line, the instructor designates a trooper to act as the base of the formation, indicates to such trooper the point where the right of the squad is to rest and the direction in which the line is to face, takes position at a convenient distance in front of and facing the point where the center of the squad is to rest, and commands: **LEAD INTO LINE.** The base trooper **leads out** and takes position as indicated; the other troopers lead out so as to approach the line **successively directly from the rear** and in single rank form on the line established by the base trooper, in order from right to left. The troopers form at stand to horse, with intervals of 18 inches between horses.

Line having thus been formed, the leader commands: **COUNT FOURS.**

At this command all except the right or base trooper turn the head and eyes to the right. Beginning on the right, troopers count: One, two, three, four; each turning his head and eyes to the front as he counts.

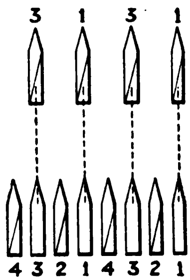
TO MOUNT IN LINE

54. The instructor commands: **1. Prepare to mount, 2. MOUNT, 3. Form, 4. RANK.**

At the first command, the odd numbers, stepping off with the left foot, lead their horses 4 yards straight to the front, regulating by the right; all then prepare to mount.

At the command **mount,** all mount.

At the command **rank,** the even numbers move up in the inter-



vals without jostling or rushing. In forming rank, both mounted and dismounted, the odd numbers hold their horses' heads well up to prevent kicking.

TO DISMOUNT

55. 1. Prepare to dismount, 2 DISMOUNT, 3. Form, 4. RANK.

At the first command, the odd numbers gather their horses and move forward 4 yards, and all prepare to dismount.

At the command **dismount,** all dismount.

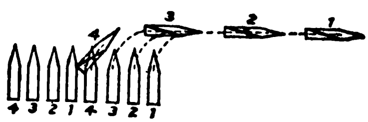
At the command **rank,** the even numbers move up in the intervals.

TO MARCH FROM LINE TO THE FLANK IN COLUMN OF FILES

56. Being at the halt: **1. By file, by the right (left) flank, 2. MARCH.**

At the first command the man on the right gathers his horse.

At the command **march,** he turns to the right and moves forward in the new direction. The second man from the right gathers his horse when the first begins to move, he turns to the right so as to follow the first at the distance of 4 feet from



head to croup. The movement is executed in succession by the other men as explained for the second.

If marching, all halt at the command **march,** except the man on the right. The movement is then executed as before.

TO MARCH FROM LINE TO THE FRONT IN COLUMN OF FILES

57. Being in line at a halt: **1. By file, 2. MARCH.** Executed as explained above for marching to the flank except that the file on the right moves straight to the front, followed in trace by the second and other men.

TO PASS FROM THE FRONT TO THE REAR OF THE COLUMN

58. Being at the walk, to teach the troopers the application of the aids: **1. First man from front to rear, 2. MARCH, 3. NEXT.**

At the first command, the leading man gathers his horse.

At the command **march,** he leaves the column by the right or left about, according as he is marching to the right or left hand, moves parallel to the column, and enters it again by another about.

The men in succession execute the same movement at the command **next,** which is repeated by the instructor until all the men have passed from front to rear.

TO PASS FROM THE REAR TO THE FRONT OF THE COLUMN

59. Being at the walk: **1. Last man from rear to front, 2. Trot, 3. MARCH, 4. NEXT.**

At the command **trot,** the man in rear gathers his horse.

At the command **march,** he leaves the column by an oblique, takes the trot, moves parallel to the column, enters it again at the front by another oblique, and resumes the walk, and so on for the others, each moving out at the command **next.**

Should the man enter the column at too great a distance in front of the leading trooper, he slackens the walk until at the proper distance.

TO MARCH IN CIRCLE

60. Marching to the right, and the conductor being at least 17 yards from a corner: **1. Squad, 2. Circle to the right (left), 3. MARCH.**

At the first command, the conductor gathers his horse.

At the command **march,** he describes a circle between the two tracks; the other men follow, each gathering his horse before entering upon the circle, keeping him there by the inner rein, and closing the leg on that side. If at the fast trot or gallop, the haunches should be sustained by the outside leg.

61. While circling, the squad may change gaits, be halted in column, and put in march, as when marching on the track.

To change hands: **1. Column right (left), 2. MARCH.**

The squad passes over the diameter of the circle and circles in the opposite direction by the commands: **3. Column left (right), MARCH,** the command **march** being given when the conductor is 2 yards from the circumference.

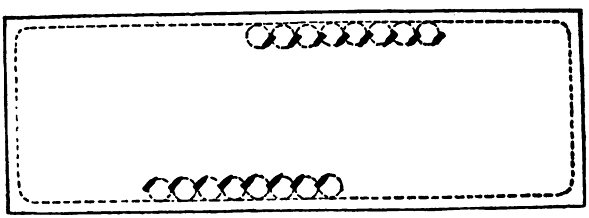
To march again on a straight line, the instructor commands: **1. Forward, 2. MARCH,** when the conductor arrives on the long side of the track.

INDIVIDUAL CIRCLING

62. Marching to the right (left) hand on the long side of the hall: **1. Individual, circle to the right (left), 2. MARCH.**

The men should make one circle only, should complete it at the same time, and take the track to the same hand as when the movement began. The instructor should make the circle larger in the beginning, and as the instruction progresses make it smaller.

When marching on the circle to the right, each man opens the right rein and closes both legs; when marching at the trot or gallop, he closes the left more than the right, to sustain the horse.



If the commands: **1. Squad, 2. HALT,** be given, the men halt their horses facing in the same direction as the conductor.

TO MOVE AT THE SLOW TROT

63. 1. Slow trot, 2. MARCH.

The gait is slow, and the instructor sees that the men feel lightly their horses' mouths **without bearing upon the reins,** and explains that the necessary ease and stability are acquired by sitting well down on the horse, or saddle, and partially relaxing the body, thighs, and legs, the hands feeling lightly the horse's mouth.

He requires the men to preserve their seats by balancing the body; that they avoid the common fault of leaning the body too far or curving the back to the rear; that they sit erect and keep the legs close to the horse.

The movements already taught at the walk are repeated at the trot. In turning by file to the right or left, the instructor sees that the trot is neither slackened nor increased.

TO TROT OUT

64. Being at the slow trot: **1. Trot out, 2. MARCH.**

Gather the horse, then yield the hands and close the legs by degrees until the horse gradually increases the gait to the trot.

The instructor sees that the horses are kept up to the proper gait and pays particular attention to the position of the men; if their seats become too much deranged, he brings the squad to the slow trot or to the walk; this is especially important in the earlier instruction of recruits.

65. To resume a moderate trot: **1. Slow trot, 2. MARCH.**

Rein in by degrees until the horse moderates the gait, closing the legs to prevent his taking the walk.

The greater part of the work without saddles or stirrups should be given at the slow trot, as it is unnecessarily fatiguing and difficult to sit at a fast trot without the saddle or stirrups.

66. In riding at a slow trot, those undergoing instruction will "sit tight in the saddle," i. e., maintain contact therewith with the buttocks. In riding at the regulation trot it is prescribed that posting or rising to the trot, as hereinafter explained, be employed.

POSTING

67. Posting, or rising to the trot, greatly diminishes the concussion produced by the rider's weight on the back and joints of the horse. It also makes breathing easier and facilitates the impulsion from the engagement of the hind feet. It is also less fatiguing to the rider than sitting down to the trot.

Posting is habitually employed by the rider, and should be learned during this period of the instruction.

It is executed as follows: The horse moving at a trot, the rider inclines the upper part of his body forward, then supporting himself on the stirrups while maintaining the grip of the knees, he rises under the impulsion of the horse, maintaining his position detached from the saddle while the succeeding impulse is produced, again sits down in the saddle, shoving his buttocks forward in doing so, and continues in this way, always avoiding every other impulse.

At the beginning the mechanism of posting is made easier to the rider by causing him to stroke the horse's neck or to grasp a lock of the mane or the pommel with either hand, thus determining the forward inclination of the body.

Its proper execution requires that the seat shall be raised moderately; that contact with the saddle shall be resumed gently and without shock; that the full support of the stirrup is obtained, while keeping the lower leg steady; that the ankle joint shall be supple; and that the heel shall be kept lower than the toe. Above all, the rider must be supple in the loins and convex them backward.

CHANGING THE DIAGONAL IN POSTING

68. In posting the rider is said to post on the right diagonal when after rising he sits down in the saddle at the instant the right fore foot comes to the ground.

It is important to instruct the rider to post for a time on one diagonal and then change to the other, so that the horse's legs will each perform the same amount of work and the chance of injury from the equipment will be reduced.

In the riding school the rider should always ride on the inside hind foot, because this foot, in response to the inner leg aid, is the only one that can properly place itself under the mass of the horse and support the weight during the change of direction in the corners; hence to insure automatically that the posting is done as much on one diagonal as on the other the riders may be required to post on the left diagonal when riding to the right hand on the track and on the right diagonal when riding to the left.

The instructor occasionally requires each rider to inform him on which diagonal he is posting.

To teach the rider to change, the diagonal, the instructor directs him to diminish the weight borne on the stirrups and to retain his seat in the saddle for two successive beats of the horse's feet instead of one, and then to rise as before.

The rider will then find himself posting on the diagonal opposite to the one on which he was posting before.

TO GALLOP

69. 1. To 3 yards take distance, 2. TROT, 3. MARCH.

The leading man takes the trot; each of the other men in succession takes the trot when the one in front of him has gained the distance of 3 yards.

This precaution is taken to prevent the horses running upon each other and causing confusion.

1. Gallop; or, **canter, 2. MARCH.**

At the command **gallop**, gather the horse.

At the command **march,** close both legs and rein in with a firm, light hand (this is to bring the haunches under), then carry the bridle hand to the left and press the left leg with vigor; these actions throw the weight on the near hind leg and allow the off fore and hind feet to lead; as soon as the horse rises, give the hand and relax the left leg; reining in slightly and closing the legs with light pressure will keep the horse at the gait and up to the hand; a dead pull should be avoided; if the horse leans on the hand, yield the hand and play the reins a little, then close the legs and rein in a little abruptly; as soon as the horse obeys, yield the hand.

For recruits the gait at first is restricted to the canter.

To keep the horse true the rider must accommodate himself to all the horse's motions, sustaining him slightly with the outside leg, particularly in changing direction at the corners. When a horse gallops false or disunited, his rider is ordered to leave the column, come to the trot, and pass to the rear of the column, taking care not to interfere with the other men; arriving at the rear he resumes the gallop, the instructor explaining how to keep the horse true. The gallop to each hand will be kept up only once or twice around the riding school, the horses being brought to the trot before changing hands.

In turning corners at a fast gait there is danger that the horse will fall down. If his haunches swing out, he will change so as to gallop disunited, and the danger of his falling will be increased. To prevent this the man should keep the outside leg closed strongly and not lean in, but maintain a vertical position.

The instructor will not at first dwell upon the mechanism of the gait, but allow each rider to accommodate himself to the motion of the horse without losing his seat.

The men must keep their horses steady; when able to manage them properly at the gallop the distance of 4 feet from head to croup is gradually resumed.

In order to make it easier for each man to start his horse true, the instructor will find it advantageous to march the squad in line with intervals across the hall at the trot, and, upon approaching the track, command: **1. By the right flank, 2. Gallop;** or, **2. Canter, 3. MARCH.**

Or, give the command **gallop** or **canter** when the squad is circling at the trot.

When the men have been sufficiently exercised at the gallop on straight lines and in circling, they are exercised at the gallop in marching by the flank and circling by man, the instructor taking care that the turns are not made too short; that the men keep their horses true, and that they do not derange their positions.

TO PASS FROM THE CANTER TO THE GALLOP, AND THE REVERSE

70. Being at the canter: **1. Gallop, 2, MARCH.**

Give the hand and close the legs by degrees until the horse increases his gait to the gallop; when the proper cadence is attained, the instructor pays particular attention to the positions of the men; if their seats become too much deranged, he brings the squad to the canter or to the trot.

To resume the canter: **1. Canter, 2. MARCH.**

Rein in by degrees until the horse moderates the cadence, closing the legs to prevent his taking the trot.

TO PASS FROM THE GALLOP OR CANTER TO THE TROT

71. 1. Trot, 2. MARCH.

At the command **trot,** gather the horse.

At the command **march,** rein by degrees and hold the legs close; as soon as the horse trots replace the hand gradually and relax the legs.

JUMPING

72. For this exercise the height of the bar should at first be 1 foot, and the width of the ditch 2 feet. As the men and horses become used to jumping, the height of the bar and the width of the ditch are gradually increased, the bar to 3 feet and the ditch to 5 feet; this exercise should generally be practiced near the end of each drill.

A horse that hurries or rushes will become an uncertain and unsafe jumper. If impatient in going up to the bar, he should be halted, reined back, halted and tried again until he takes it coolly.

73. Horses are taught to jump the ditch and the bar. They are equipped with the snaffle bit and are led by a steady horse that is accustomed to jumping.

This instruction is also given on the longe.

The horses are taken in the open field and practiced at jumping shallow ditches, fallen logs, very low fences, etc. If the horse refuses to take the jump, the instructor may give aid with the whip, but in such a way as not to terrify him. If the horse be timid, it is advisable to place the bar on the ground until he passes over it without alarm. Great discretion must be used in applying the whip, and the horses will not be required to jump repeatedly over the same thing or at the same place.

74. The instructor forms the squad in line, about 30 yards from the obstacle, and commands: **1. First file from the right (left), 2. MARCH, 3. NEXT.**

The man on the right moves to the front at the walk; he takes the trot when he has passed over about one-third the distance, and then the gallop.

After making the jump, he takes the trot, then the walk, and takes his place in the rank, which is re-formed about 30 yards beyond, and on the right or left of the obstacle, and facing it.

The other men move out successively from the right at the command **NEXT.**

75. In the riding hall the men are formed in two squads, in line, facing each other at opposite ends of the hall; two bars are placed across the track, one on each of the long sides of the hall, about midway.

1. First file from the right (left), 2. MARCH, 3. NEXT.

The man on the right of each squad moves out at the walk and marches diagonally across the hall; on passing each other both take the trot and when abreast of the flank of the opposite squad they take the track at the gallop or canter, the horse leading with the right foot; after jumping both bars, each man takes the trot, then the walk, passes around the left flank of the opposite squad, marches at the walk diagonally across the hall, and forms on the left of his squad.

76. The other men move out successively from the right or left of each squad at the command **NEXT.**

This rule is general for individual exercises.

77. In making the flying jump, the horse must not be hurried nor allowed to rush, but be held steady and straight for the bar or other obstacle. The rider should sit down snugly in the middle of his saddle, the horse firmly inclosed between the legs, the hands held low and steady, and the body not forward, and thus ride steadily and smoothly at the obstacle. The muscles of the back and shoulders should not be contracted. The waist should be supple, so as to adopt in its motion the movement of the horse.

TO JUMP THE DITCH

78. Ride straight for the ditch at a steady, animated gait, with the legs closed firmly; the instant the horse springs, give the hand, and as he grounds sustain him with a light, steady pressure.

79. The instructor must observe that the rider does not thrust his weight into the stirrups nor throw out his elbows, nor check his horse too abruptly. If the hand is held so that the back of the hand is nearly vertical with the ground, there will be little tendency to turn out the elbows. If the horse is checked with a sudden violence after making the jump, he takes it as a punishment, and may thereafter try to avoid the obstacle.

Beginners are apt to try to sustain themselves by the reins; to prevent this the instructor may find it necessary to allow them to place the bridle hand on the horse's neck until they have gained confidence. If necessary the bar should be lowered to the height at which the rider can easily keep his seat.

The rider will be practiced jumping obstacles without stirrups and without saddles.

ELEMENTARY COLLECTIVE MOUNTED INSTRUCTION

ALIGNMENTS

80. Being in line, mounted: **1. Right (left), 2. DRESS, 3. FRONT.**

At the command **dress** all the men move up slowly on the basis of the alignment established by the instructor, each casts his eyes to the right so as to see the buttons on the breast of the second man from him, sits squarely on his horse, keeps his horse straight in ranks, and touches lightly with his stirrup the stirrup of the man on his right. At the command **front,** given with the last man is aligned, all cast their eyes to the front. All movements in ranks must then cease.

In dressing the first two or three men are accurately aligned as quickly as possible, in order to afford a base for the rest of the squad.

This rule is general.

TO MARCH IN LINE

81. Being in line at the halt: **1. Forward, 2. MARCH.** The squad moves off promptly, the guide marching straight to the front at the regular gait.

The instructor observes in marching in line that the squad marches straight to the front at the regular gait; that the men keep their horses straight in the rank; that they maintain the interval of about 6 inches from knee to knee or light touch with stirrup toward the side of the guide; that they yield to pressure from that side and resist pressure from the opposite direction; that if too much closed toward the guide they carry the bridle hand from that side, and close the leg on the side of the guide; that if the interval be too great they carry the hand toward the guide, and also close the leg on the opposite side, and, while habitually keeping the **head to the front,** they occasionally **glance** toward the guide. If in advance, they rein in **gradually.** If in rear, they **gradually** increase the gait until the alignment is regained.

82. Marching in line, to effect a slight change of direction: **INCLINE TO THE RIGHT (LEFT).**

The guide turns his horse slightly to the right and marches in the new direction. The other men gradually conform to the movements of the guide, increasing or diminishing the gait according as the change is toward or opposite the side of the guide.

TO HALT

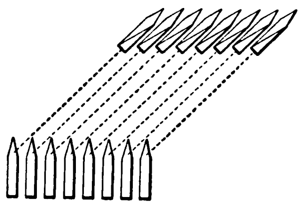
83. Whenever the squad is in motion, it is halted by the commands: **1. Squad, 2. HALT. This rule is general,** the command **section, platoon, company,** being substituted for **squad.**

TO MARCH BACKWARD

84. 1. Backward, 2. MARCH.

All the men rein back, dressing on the guide.

This movement is used for short distances only.



TO OBLIQUE

85. 1. Right (left) oblique, 2. MARCH.

At the command **march** each man executes a turn of 45° to the right, his right knee in rear of the left knee of the man on his right. The squad moves in the new direction, regulating by the right, in a line parallel to the original front.

To resume the original direction: **1. Forward, 2. MARCH.**

Each man turns 45° to the left and marches straight to the front, regulating on the guide.

TO TURN AND ADVANCE

86. Being in line at the halt or at the walk, the instructor commands: **1. Right (left) turn, 2. MARCH.** The man on the right turns his horse 90° to the right, on an arc with a radius of 2 yards, and moves forward in the new direction without increasing the speed. Each of the other men turns his horse to the right aproximating an oblique, and, moving at the trot by the shortest line, places himself on the new line, when he takes the gait and direction of the pivot man. During the turn the guide is, without command, on the pivot flank. The guide is announced when all men have arrived on the line. If marching at a trot, the pivot man continues at the trot. All others move at the gallop. If marching at the gallop, the pivot takes the canter; all other men continue the gallop, each taking the canter on arriving in line; as soon as all the men have arrived on the line all resume the gallop.

BEING IN LINE AND HAVING COUNTED FOURS, TO FORM COLUMN OF FOURS TO THE FRONT

87. 1. Right (left) by fours, 2. MARCH. The right four moves straight to the front, the other fours oblique to the right, so as to follow the preceding four at the proper distance of 4 feet from head to croup.

If marching, rule 2, paragraph **133,** applies for gaits.

BEING IN LINE AND HAVING COUNTED FOURS, TO FORM COLUMN OF FOURS TO THE FLANK

88. 1. Fours right (left), 2. MARCH.

Each four executes **RIGHT TURN,** as explained in paragraph **86,** and all march off in the new direction.

TO CHANGE DIRECTION

89. Being in columns of fours: **1. Column right, 2. MARCH.** The leading four executes right turn, the other fours move forward and turn on the same ground as the first. **Column half right** is similarly executed, except that the leading four makes a half turn.

BEING IN COLUMN OF FOURS, TO MOVE TO THE REAR

90. 1. Right about, 2. MARCH. The leading four turns to right about, the pivot trooper marching on a circle whose radius is 2 yards, the others conforming. The other fours move forward, and, following the first, turn on the same ground.

BEING IN COLUMN OF FOURS, TO FORM LINE TO THE FRONT

91. 1. Left (Right) front into line, 2. MARCH. The leading four moves straight to the front, each of the rear fours obliques to the left until the preceding four is uncovered, when it moves straight to the front until it arrives on the line.

Rule 1, paragraph **133,** applies for gaits.

BEING IN COLUMN OF FOURS, TO FORM COLUMN OF TWOS TO THE FRONT

92. Being at a halt: **1. By twos, 2. MARCH.**

The right two, Nos. 1 and 2 of the leading four, moves straight to the front, the left two, Nos. 3 and 4 of the leading four, keep their horses' heads straight until their horses' heads are passed by the croups of the horses of the right two, when they oblique to the right and follow the leading two, at a distance of 4 feet. Each of the other fours form in the same manner as soon as the left two in the preceding four commences to oblique. Nos. 3 and 4 always follow in rear of Nos. 1 and 2, no matter on which side the guide may be.

If marching, Rule 2, paragraph **133,** applies for gaits.

BEING IN COLUMN OF FOURS, TO FORM COLUMN OF FILES

93. 1. By file, 2. MARCH.

The movement is executed according to the principles of the preceding paragraph. No. 1 of the leading four moves forward and is followed successively by Nos. 2, 3, and 4, who preserve a distance of 4 feet from head to croup. When No. 4 commences to oblique, No. 1 of the succeeding four marches forward or takes the increased gait.

Column of files from column of twos is formed in similar manner, No. 1 leading the column.

BEING IN COLUMN OF TWOS, TO FORM COLUMN OF FOURS

94. Being at the halt: **1. Form fours, 2. MARCH.** Nos. 1 and 2 of the leading four move straight to the front. The instructor commands **halt** when the leading two have moved 3 yards. Nos. 3 and 4 of the leading four oblique to the left until uncovered, then march to the front and halt when abreast of Nos. 1 and 2. The other twos march forward and form fours successively as explained for the first four. Nos. 3 and 4 of each four commence the oblique to the left when Nos. 1 and 2 are at 3 yards from their position.

If marching, rule 1, paragraph **133,** governs the gaits.

BEING IN COLUMN OF FILES, TO FORM COLUMN OF FOURS OR TWOS

95. 1. Form fours, 2. MARCH.

The movement is executed on the same principles as in forming fours from column of twos, No. 1 of each four being the base, and Nos. 2, 3, and 4 obliquing to the left and forming on the left of No. 1.

96. 1. Form twos, 2 MARCH. The movement is executed on the same principles as in forming fours, Nos. 1 and 3 being the base men, No. 2 forming on the left of No. 1, and No. 4 on the left of No. 3.

MOVEMENTS IN COLUMN OF TWOS

97. The column of twos changes direction, halts, and advances by the same commands and means as a column of fours.

BEING IN COLUMN OF FOURS, TO DISMOUNT

98. Being at the halt or marching: **1. Prepare to dismount, 2. DISMOUNT.**

At the first command, Nos. 1 and 2 open to the right and front, Nos. 3 and 4 to the left and front, and all halt. Each four opens only so far as to allow sufficient room for each man to dismount without interference from the others. Nos. 1 and 4 open a little more than 2 and 3.

The column of twos dismounts by the same commands and means. In mounting from column of twos or fours the horses are opened out as in the preceding paragraph at the preparatory command for mounting. At the commands **Forward, March,** either before or after mounting, the column moves forward, the files closing toward the center.

MANUAL OF THE PISTOL

99. The instruction under this head will conform to what has already been described in The Soldier Dismounted.

FIELD SIGNAL TROOPS

OBJECT AND COMPOSITION

Field signal troops comprise those Signal Corps units permanently assigned to divisions, army corps, and armies for the purposes of establishing and maintaining **tactical** lines of information and for transmitting over these lines such information as is incident to operations in the field.

The basis of organization for field signal troops is the field battalion, which is composed of a headquarters and a supply detachment, a wire company, a radio company, and an outpost company.

One field battalion is assigned to each division, one to each army corps, and such number as necessary to each army.

Field signal troops assigned to a division are used only in the presence of an enemy, real or assumed. Their use in the handling of routine and administrative matters or for the convenience of the personnel of the division is unauthorized except in so far as these are related to existing tactical situations.

Field signal troops assigned to army corps and armies are intended to furnish a reserve for the field battalions in advance, to supplement the work of the latter when necessary or desirable, and for use with separate brigades and expeditionary forces. In emergency, these troops may assist telegraph troops in establishing and maintaining the necessary strategical lines of information.

The normal use of field signal troops is to establish, maintain, and operate tactical lines of information within the division and such is the use which will be dealt with hereinafter. Field signal troops assigned to army corps and armies normally constitute a reserve and, except for the use of wagon radio sets for communicating with divisions, their active employment otherwise is to be regarded as exceptional.

THE WIRE COMPANY

FUNCTION AND EMPLOYMENT

100. The wire company is the field signal organization used by the commander of a division for establishing and maintaining those tactical lines of information which radiate from division headquarters, and which serve, in general, to connect these headquarters with the major subordinate units. Normally the wire company is used to connect division headquarters with the headquarters of the various brigades within the division, with the divisional artillery, and, in some cases, with the divisional trains. Opportunity for its use in maintaining communication with the divisional cavalry will occur so rarely that its employment in this manner is prohibited except in emergency.

ORGANIZATION

101. The wire company is organized into the necessary headquarters and company staff and two platoons of two wire sections each.

For drill the company is formed as above. In the field or on the march the company instrument wagon and the two reserve wire carts form a third platoon under command of the supply sergeant.

102. The organization, in detail, is as follows:

1 captain.
2 first lieutenants.
1 master signal electrician.
1 first sergeant (sergeant, first class).
1 supply sergeant (sergeant).
1 stable sergeant (sergeant).
1 mess sergeant (sergeant).
1 horseshoer.
1 clerk (corporal).
2 cooks.
1 farrier (corporal).
1 saddler (corporal).
1 mechanic (corporal).
1 assistant mechanic (private first class.
3 drivers (private, first class).
1 guidon (private, first class).
2 buglers (privates, first class).
4 wire sections.

DUTIES OF INDIVIDUALS

The captain commands the company and is responsible for its training and efficiency.

The lieutenants command platoons, and will be assigned to such other duties as the captain may deem necessary.

The master signal electrician is responsible to the captain for the condition of the technical equipment of the company. To this end he will make frequent and regular inspections of same and, when parts of the technical equipment are found or reported unserviceable, will make or supervise the necessary adjustments or repairs. Under the direction of the captain, he will order such precautionary and corrective measures as he may deem advisable concerning the care and repair of technical equipment. Master signal electricians also act as substitute chiefs of platoons.

The first sergeant is the assistant of the captain, and is responsible to him for the general good order, police, and discipline of the company. In action he remains with the captain and under his immediate orders.

The supply sergeant is responsible to the captain for the care and preservation of the material not issued to the sections.

The stable sergeant is responsible to the captain for the general care of the public animals assigned to the company, the good order and police of the stables and picket lines, and the conduct of the stable personnel, when on duty.

The mess sergeant is responsible to the captain for the efficient and economical handling of the ration, for the conduct of the kitchen personnel when on duty and for the cleanliness of the company kitchen and surroundings.

The mechanics, under the orders of the supply sergeant, are responsible for the repair of the material pertaining to the company

Chiefs of sections command the sections and will be held responsible to the captain for the condition of their equipment and the training and efficiency of their sections. They will make, or cause to be made, such minor adjustments or repairs to technical equipment as can be effected by the personnel of the section, promptly reporting more serious deficiencies to the master signal electrician.

The drivers are directly responsible to their chiefs of sections for their animals, harness, and equipment. They will report at once to their chief of section any injury to animals or matériel.

Drivers of combat vehicles not assigned to sections are likewise responsible to the supply sergeant.

The operators are responsible for the serviceable condition of their instruments and will report at once to their chiefs of sections any need of repairs.

The linemen are responsible for maintaining the section lines intact. They will carry the necessary equipment, and will report to the chief or section at once if their matériel is not in their possession or is unserviceable.

Messengers are responsible for the delivery of all messages, no matter what the conditions.

THE SECTION

COMPOSITION

103. The wire section is normally composed of 13 mounted men and a wire cart and its driver.

The organization, in detail, is as follows:

1 section chief (sergeant, first class).
1 driver (private, first class).
3 station squads, each consisting of:

1 lineman 1 messenger 1 horse holder 1 operator Total, 14.	assigned by section chief from sergeant, corporal, private, first class, or private according to qualifications.

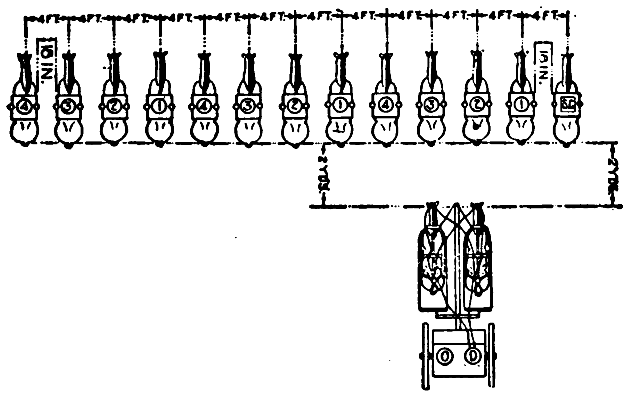
FORMATION

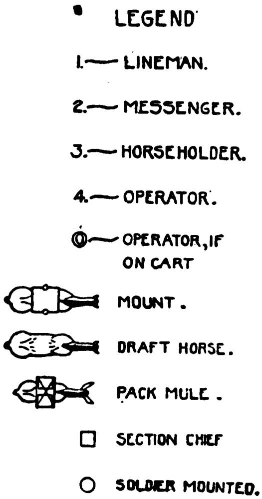
104. The mounted men of the section are formed in column of fours, as prescribed in The Soldier Mounted, the cart horses 2 yards in rear of the mounted men, and in such a position that the pole of the cart is in prolongation of the interval between the numbers 2 and 3 in the mounted ranks.

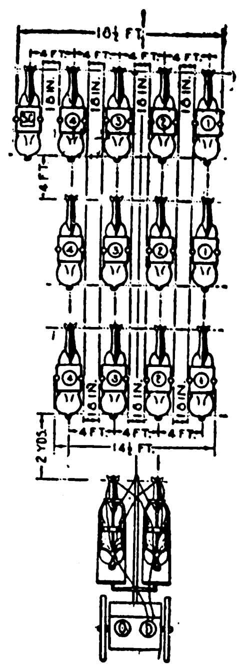
POSTS AND DUTIES OF INDIVIDUALS

105. The chief of section is on the left of the leading four, two or file, except that when the section is acting alone he may go where his services are most needed.

Each four constitutes a **station squad** and includes the personnel necessary to establish and operate one buzzer station. Each four is formed from right to left as follows: No. 1, the lineman; No. 2, the messenger; No. 3, the horse holder; No. 4, the operator.







THE WIRE SECTION
ABOVE—SECTION IN LINE
TO THE RIGHT—SECTION IN COLUMN

Where practicable, noncommissioned officers, except the chief of section, should be assigned to duty as operators.

DRILL OF THE SECTION

The Guide

106. The guide of the section is the chief of section. In the absence of the chief of section the left man of the leading rank is the guide.

To March to the Front

107. 1. Forward, 2. MARCH.

Executed as prescribed in paragraph **81,** substituting "section" for "squad." The cart maintains its position 2 yards in rear of the mounted men.

To Halt

108. 1. Section, 2. HALT.

Executed by all individuals stopping simultaneously.

To Change Direction

109. 1. Column right (left), 2. MARCH.

The section remaining in column of fours, the fours successively execute **RIGHT TURN** as prescribed in paragraph **86.** The cart maintains its position 2 yards in rear of the mounted men.

To March to the Rear

110. Right (left) about, 2. MARCH.

The section, remaining in column of fours, moves to the right and rear, the right man in the leading rank marching over half a circle whose radius is 2 yards. The cart maintains its position 2 yards in rear of the mounted men.

To March Obliquely

111. 1. Column half right (left), 2. MARCH.

Executed as prescribed for changing direction except that fours successively make a half turn to the right.

To make a slight change of direction: **INCLINE TO THE RIGHT (LEFT).**

Executed as in paragraph **82.**

To Form the Mounted Men of the Section Into Line

112. 1. Left front into line, 2. MARCH.

The chief of section places himself on the right of the leading four.

Executed by the mounted men as prescribed in paragraph **295.**

The cart closes up to 2 yards in rear of the right four.

This movement will always be executed to the left.

Rule 1, paragraph **133,** governs the gaits, substituting "four" for "section."

To Re-form the Section in the Normal Formation

113. 1. Right by fours, 2. MARCH.

The right four moves straight to the front; the other fours successively oblique to the right front when disengaged so as to follow the leading four at the proper distance.

The chief of section takes post on the left of the leading four.

The cart follows the rear four at 2 yards distance.

Rule 2, paragraph **133,** governs the gaits, substituting "four" for "section."

To Form the Mounted Men in Column of Twos or Files

114. 1. By twos (files), 2. MARCH.

Executed by the mounted men as indicated in paragraphs **92** and **93.**

The cart follows the column of twos or files at 2 yards distance.

Rule 1, paragraph **133,** governs the gaits, substituting "two" or "file" for "section."

To Re-form the Mounted Men in Column of Fours

115. 1. Form fours, 2. MARCH.

Executed by the mounted men as indicated in paragraphs **94** and **95.**

The cart follows the rear four at 2 yards distance.

Rule 1, paragraph **133,** governs the gaits, substituting "two" or "file" for "section."

To Open Station

116. To open station and move to the front from a halt: **OPEN STATION.** At this command the linemen of the first and second fours, the messenger of the first four, and the chief of section turn out of the column, to the right, the horse holder and operator of the first four turn out of the column to the left. The two linemen, remaining mounted, prepare to follow the reel cart and lay out the wire, the lineman of the second four starting off in front.

The remaining men of the first four all move to the rear of the cart and dismount, except the horse holder, to whom the horses are turned over. The messenger unties the wire from the cart and pulls off enough slack and holds it or makes it fast to some convenient anchor. The operator prepares his buzzer, connectors, and ground rod, and opens the station in the location indicated.

When it becomes necessary for the lineman of the second four to stop for the purpose of making a tie, or for other reasons, he is passed or "leap frogged" by the lineman of the first four. This practice obtains whenever two linemen are working together, linemen using the "leap frog" method to the best advantage.

Laying the Wire.

117. When the end of the wire has been removed from the cart the chief of section, or, in his absence, the senior present, at a signal from messenger, commands: **DRIVE ON,** at which command the cart, preceded by the men of the second and third fours, except the lineman of the second four, moves out over the indicated route, at first slowly, in order not to break the wire. The two linemen follow the cart attending the wire until the second station is opened, when the lineman of the first four returns back over the line to his station. His place is taken on the line work by the lineman of the second four, who is replaced by the lineman of the third four.

The manipulation of the machinery of the wire cart for handling the wire will be a part of the duty of the cart driver, unless an operator be placed on the cart, in which case the latter may handle the clutch. The reel must always be stopped before a march to the rear is taken up.

118. The chief of section rides near the cart, or wherever necessary in order to properly supervise the laying of the line. He will also designate a scout to precede the section from 100 to 200 yards and select a route in the immediate front for the cart to follow. The driver will conform to the signals of the scout. If the section is in march, it is halted before giving the command for opening station. As each station is established the operator will call up the initial station.

To Close Station

119. 1. CLOSE STATION. At this command the lineman of the distant station immediately starts back over the line, laying out the wire in a convenient place for recovery. The operator of the distant station calls up all stations on his line, send G. B., and signs his station call, cuts out his buzzer, and mounts. The horse holder now mounts and prepares to attend the loop, using the spare pike which is lashed to the pole of the wire cart. The messenger takes the hand guard from the cart and feeds the wire upon the reel.

Recovering the Wire

120. 1. REEL UP.

At this command the wire cart moves off back over the line, reeling up the wire. As the loop approaches the cart the man attending it will call out **clutch,** when the driver will throw out the clutch in order to allow the loop to drop back.

121. Intermediate stations are closed by the command **close station,** and when the cart approaches the members of these stations take charge of the work of recovering the line back to the next station.

Members of the section not engaged in laying out or recovering the line ride in front of the cart. **This rule is general.**

As the cart approaches the end of the line an increased gait will be taken to gain sufficient momentum to reel up the slack. When all the wire is on the reel the section is re-formed in its proper place.

THE WIRE PLATOON

COMPOSITION

122. The wire platoon is composed of two wire sections and is commanded by a lieutenant.

FORMATION

123. The habitual formations of the platoon are the **order in section column** and the **order in line.**

The **order in section column** is that in which the sections of the platoon follow each other in the order, or the reverse order, of their numbers from front to rear. The distance between sections is 2 yards.

The **order in line** is that in which the sections of the platoon are formed abreast of each other in the order, or the reverse order, of their numbers from right to left. The interval between the sections is that which would result from the sections moving from the order in section column by the flank. This interval is approximately 16 yards.

POSTS AND DUTIES OF INDIVIDUALS

124. In the order in section column the post of the lieutenant is 4 yards opposite the center of the platoon, on the left when the first section of the platoon is leading and on the right when the column is reversed. In the order in line his post is midway between the two sections and in line with the leading fours of the platoon. When acting as an instructor he goes where his presence is necessary.

The lieutenant commands the platoon. The posts and duties of enlisted men in the platoon are prescribed in Section II above.

DRILL OF THE PLATOON

125. The platoon is drilled in accordance with the principles and by the methods and means prescribed for the section and the company.

The captain may assign to platoons, for purposes of drill and instruction, such members of the company staff as he may deem advisable.

THE COMPANY

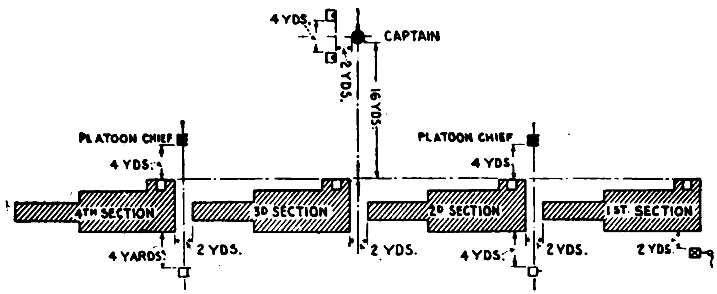
FORMATION OF THE COMPANY

126. The habitual formations are: **The order in section column, the order in line,** and **the order in platoon column.**

127. The order in section column is that in which the sections of the company follow each other in the order, or the reverse order, of their numbers, from front to rear. The distance between the mounted men and carts in a section, between sections and between platoons is 2 yards.

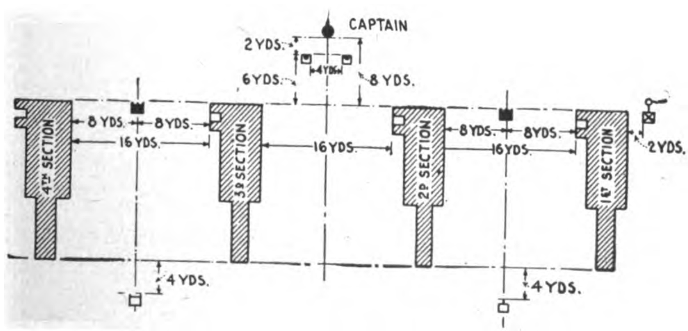
The order in line is that in which the sections of the company are formed abreast of each other in the order, or the reverse order, of their numbers from right to left. The interval between the sections and between platoons is that which would result from the sections moving from the order in section column by the flank.

The order in platoon column is that in which the platoons of the company, each in the order in line, follow each other in the order, or the reverse order, of their numbers from front to rear. The distance between the platoons is that which would result from wheeling the platoons from the order in line to the order in platoon column.



COMPANY IN COLUMN

LEGEND
- CAPTAIN
- FIRST LIEUTENANT
- M.S.E.
- FIRST SERGEANT
- SECTION CHIEF
- BUGLER
- GUIDON



COMPANY IN LINE

POSTS OF INDIVIDUALS

128. In the order in line:

Captain, 8 yards in front of the center of the company.

Chiefs of platoons, as in the wire platoon in the order in line.

Master signal electrician, 4 yards in rear of the center of the second platoon. The master signal electrician and first sergeant establish the line of file closers.

First sergeants, 4 yards in rear of the center of the first platoon.

Chiefs of sections, as prescribed in The Section.

Guidon, abreast of the front rank of the company and 2 yards from the flank toward which the guide has been announced.

Buglers, in line, 2 yards in rear of the captain.

Other members of the company staff when present mounted, posted in the line of file closers in order of rank from position of the first sergeant to that of the master signal electrician. They conform to the movements of the above noncommissioned officers.

129. In order in section column:

Captain, opposite the center of the column and 16 yards from the flank; on the left when the first section leads and on the right when the column is reversed.

Chiefs of platoons, 4 yards from the center of their respective platoons and on the same side as the captain.

Master signal electrician, 4 yards from the center of the second platoon and on the flank opposite the captain.

First sergeant, 4 yards from the center of the first platoon and on the flank opposite the captain.

Chiefs of sections, as prescribed in The Section.

Guidon, abreast of and 2 yards to the right of the leading section

Buglers, as in the order in line.

130. In the order in platoon column:

Captain, except at ceremonies, 16 yards from the center of the company and on the side of the guide. At ceremonies as in the order in line.

Chief of platoons, master signal electrician, first sergeant, chiefs of sections, guidon and buglers, as in the order in line.

DRILL OF THE COMPANY

The Guide

131. Chiefs of sections supervise the gait and direction of march of their sections. In section column, the guide of the leading section is the guide of the company.

The guide of the company or platoon in line is the guide of the right or left section.

During an oblique march the guide of the company is, without indication, the guide of the leading section on the side to which the oblique is made.

The guidon always posts himself as prescribed in paragraphs **128-130.** Should the guide be changed, he hastens to his new post, except that he does not change post during an oblique movement. With this exception, the guide is always toward the guidon.

Gaits

132. In changes of formation, the section which establishes the new direction and rate of march will be termed the directing section.

133. The following rules govern the gaits during changes of formation:

Rule No. 1.—When a change of formation requires certain sections to gain ground so as to reach specified positions abreast of the directing section, an increased gait may or may not be announced for the movement. If an increased gait is announced, the directing section maintains its gait; the other sections move at the gait announced until they have reached their new position, when they take the gait of the directing section.

If an increased gait is not announced, the directing section reduces its gait one degree; the others maintain their gait until they reach their new positions, when they take the gait of the directing section. If the movement is executed from a halt or while marching at a walk, and an increase of gait is not ordered, the directing section advances toward the front of the new formation and halts at command.

Rule No. 2.—When a change of formation requires the directing section to gain ground in order to precede the other sections, an increased gait may or may not be announced for the movement. If an increased gait is announced, the directing section takes the increased gait at once, the other sections take it up so as to follow the movement in their proper order.

If an increased gait is not announced, the directing section maintains its gait, the others reduce the gait one degree, and take the gait of the directing section in time to follow the movement in their proper order. If the movement is executed from a halt or while marching at a walk and an increase of gait is not ordered, the directing section moves at a walk, the others remain halted or halt and take up the gait of the directing section as before explained.

Reducing gait one degree is to be understood as passing from the gallop to the trot, from the trot to the walk, or from the walk to the halt. Increasing the gait one degree is the reverse.

To Form the Company Mounted

134. The company is formed dismounted and marched to the stables by the first sergeant where he commands **BY SECTION FALL OUT.** The drivers then harness their teams and the men saddle their horses, under the direction of the chief of section. The latter then causes the wire cart of his section to be hitched up, verifies and makes an inspection of his section, causes it to mount, and reports the result to his chief of platoon. The chiefs of platoons then make an inspection of their platoons, after which the company is formed under the direction of the senior chief of platoon and brought to rest. On the arrival of the company commander the company is brought to **attention** by the senior chief of platoon. The captain then commands **REPORT.** The chiefs of platoons then report in the order of rank, **(SUCH) PLATOON IN ORDER, SIR,** or reports the deficiencies shown by the verifications and inspections. The first sergeant then reports to the captain as prescribed in regulations governing the company dismounted.

The master signal electricians, other members of the company staff, if present, and the guidon, take their posts when the company is formed. The buglers report to the captain at such time and place as he may direct. The chiefs of platoons join their platoons at the stable or picket line and superintend the formation of their platoons.

To Dismiss the Company

135. The captain commands: **Dismiss the company.**

The chief of platoons and the master signal electrician fall out. The company is returned to the stables or picket line by the first sergeant, who then commands: **By section, FALL OUT.** The chiefs of sections supervise the placing of the transportation under shelter or in park; the horses in the stable or on the picket line; and see that horse equipment and harness has been properly put away, and that all equipment has been properly disposed.

To Align the Company

136. The company being at a halt.

If the section on the side toward which the alignment is to be made is not in proper position, the captain establishes it in the position desired, and commands: **1. Right (left), 2. DRESS, 3. FRONT.** At the command **dress** the other sections move forward or backward, the chiefs of sections aligning themselves; the men and drivers turn their heads to the right and dress on their corresponding elements in the section on their right. The captain places himself on the right of the leading element of the right section, facing to the left. He quickly establishes the leading element of the next section to arrive on the line, and superintends the alignment of the other sections as they arrive on the line. The captain then commands **FRONT,** and takes his post.

To March to the Front

137. 1. Forward, 2. MARCH.

Executed simultaneously by all the sections moving straight to the front, taking care to maintain their proper relative positions in the formation.

To Halt

138. 1. Company, 2. HALT.

Executed by all sections stopping simultaneously, but not suddenly.

To March by the Flank

139. 1. By the right (left) flank, 2. MARCH.

Executed simultaneously by all the sections executing column right, as prescribed in paragraph **109.**

140. If the company is in line, with closed intervals, the following modifications apply: The movement is successive; the section on the indicated flank begins the movement by executing column right; the others take it up in turn so as to follow, at the proper distance, in the track of the sections which preceded them. If executed while marching, all the sections, except the one on the indicated flank, halt and then resume the march so as to follow at the proper distance in the column.

To March to the Rear

141. 1. Right (left) about, 2. MARCH.

Executed simultaneously by all sections as prescribed in paragraph **110**, taking care to quickly track the section preceding them in the new formation, if the company was in column at the command, or to promptly take up the announced guide if it was in line.

142. If the company is in line with closed intervals, the following modifications apply: The captain first commands: **1. Right sections forward, 2. MARCH.** The right section of each platoon moves forward so as to clear the left section. If the captain orders an increased gait for the maneuver, the right sections take the gait indicated; if an increased gait is not ordered, the left sections reduce the gait one degree, or, if halted, they remain halted. As soon as the right sections are clear of the left sections the captain gives the command for the about, which is executed by all the sections at the gait of the right sections. On the completion of the about the sections in rear increase the gait so as to move up to their positions in line.

To March Obliquely

143. 1. Sections, 2 Column half right (left), 3. MARCH.

All the sections execute column half right simultaneously, as prescribed in paragraph **111.** The sections move on parallel lines. The guide of each section takes care to align himself on the guide of the section toward which the movement is made. To resume the original direction, the command will be: **1. Sections, 2. Column half left (right), 3. MARCH.**

To Change Direction

144. Being in section column: 1. Column right (left), 2. MARCH.

The leading section executes column right, as explained in paragraph **109**; the sections in rear follow the leading section and turn on the same ground.

Column half right (half left) is similarly executed, except that the turn is only 45°.

145. Being in line: **1. Right (left) turn, 2. MARCH, 3. Company, 4. HALT.** The pivot section executes column right. The other sections increase the gait one degree, preserving their intervals from the pivot section and take the gait of the latter on arriving abreast of it.

Company right half (left half) turn is similarly executed, except that the pivot section executes column half right.

If the company is marching at a gallop, the pivot section will take the canter at the command **march;** the other sections will take the canter when abreast of the directing section. When all of the sections are in line, the captain commands: **1. Gallop, 2. MARCH.**

To Close or Extend Intervals in Line

146. 1. On (such) section, 2. Close (extend) intervals, 3. MARCH.

The normal closed interval is 8 yards. If the captain wishes any other interval than the normal closed or normal interval to be taken, he announces the interval before giving the second command; for example: **1. On first section, 2. To 20 yards, 3. Extend intervals, 4. MARCH.**

The indicated section moves straight to the front, the other sections incline toward or away from the indicated section and move to the front when at the proper interval. Paragraph **133** governs the gait.

To Form Section Column to the Front from Line

147. 1. Right (left) by section, 2. MARCH.

The right section moves straight to the front. The other sections, in turn, move by the right flank, and follow in the column at 2 yards distance. Rule 2, paragraph **133** governs the gait.

To Form Line to the Front from Section Column

148. To the front: **1. Right (left) front into line, 2. MARCH.**

The leading section moves straight to the front. Each section in rear executes column half right until opposite its place in line, when it executes column half left, moves to the front, and takes its place on the line. Rule No. 1, paragraph **133,** governs the gait.

To Form Line to the Right (Left) from Section Column

149. On the right (left): **1. On right (left) into line, 2. MARCH.**

The leading section executes **column right** and moves straight to the front in the new direction; the other sections move forward beyond the preceding sections, and successively execute **column right** when opposite their positions in line with proper intervals, and then move forward until abreast of the leading section. When an increased gait is ordered all of the sections will take it, but the leading section will resume the original gait when it has turned out of column. If moving at a trot or gallop and no increased gait is ordered the leading section, after completing the turn, will decrease its gait one degree. As here modified, Rule No. 1, paragraph **133,** for gaits applies.

150. To form on right (left) into line at closed intervals the captain commands: **At closed intervals** before giving the prescribed commands for forming line; the company is then formed with 8 yards instead of the normal intervals.

151. To the right (left): **1. Right (left) into line, 2. MARCH.**

The leading section executes **column right** and moves straight to the front in the new direction; the other sections move forward and successively executes **column right** when they are in rear of their places in line to the right (left) of the leading section at closed intervals. They then move forward until abreast of the leading section. Rule No. 1, paragraph **133,** governs the gaits.

152. To form line at intervals other than normal or closed intervals the captain commands: **At — yards interval,** before giving the prescribed commands for forming line; the company is then formed with the indicated intervals between sections.

To Form the Mounted Men of the Sections in Line

153. This will always be done to the left.

1. Sections, 2. Left front into line, 3. MARCH.

This will be executed by the sections as prescribed in paragraph **112.**

To Re-form the Sections in the Normal Formation

154. 1. Sections, 2. Right by fours, 3. MARCH.

To Form Platoon Column to the Front From Section Column

155. 1. Platoons, 2. Right (left) front into line, 3. MARCH.

The leading section of each platoon moves straight to the front. The rear section executes column half right and then column half left, when by so doing it will have its normal interval from the leading section.

Rule No. 1, paragraph **133,** governs the gaits.

To Form Platoon Column to the Flank From Section Column

156. 1. Column of platoons, first platoon by the right (left) flank, 2. MARCH.

At the first command the chief of the leading platoon commands: **1. By the right flank.** At the command **MARCH** each section in the leading platoon executes **column right** as before described.

At the first command the chief of the rear platoon cautions

CONTINUE THE MARCH. When it arrives in rear of the leading platoon, the chief of platoon commands: **By the right (left) flank,** adding **MARCH** in time to follow the leading platoon in trace.

To Form Section Column to the Front From Platoon Column

157. 1. Right (left) by section, 2. MARCH.

The right sections of the platoons move straight to the front.

The left sections execute column half right and then column half left, and follow in the rear of the leading sections.

Rule No. 2 governs the gaits.

Being in Line, to Form Platoon Column, to the Right (or Left)

158. 1. Platoons, 2. Right (left) turn, 3. MARCH, 4. Company, 5. HALT.

The right section of each platoon executes column right. The other sections increase the gait one degree, preserving their interval from the right section, and take the gait of the latter on arriving abreast of it.

Being in Platoon Column, to Form Line to the Right (Left)

159. 1. Platoons, 2. Right (left), 3. MARCH, 4. Company, 5. HALT.

Executed as prescribed in the preceding paragraph.

Route Order and at Ease

160. Marching in any formation: **1. ROUTE ORDER, or 1. AT EASE.** Executed as prescribed in the Soldier Mounted.

The section column is the habitual column of route. The mounted men of the sections may, when conditions require it, be formed in column of twos instead of column of fours. Being in march, route order or at ease are executed according to the principles already prescribed. Sabers are returned if drawn. To resume attention the captain commands: **Company, ATTENTION.**

The captain marches 8 yards in front of the leading element, followed at 2 yards distance by the trumpeters and guidon. the latter on the right; the chiefs of platoons usually march near the rear of their platoons, but they and the chiefs of sections may go wherever their presence is necessary; the file closers march where the captain directs.

To avoid dust, the captain may direct the officers and file closers to march on the windward side.

EMPLOYMENT IN THE FIELD

GENERAL

161. The main equipment of each of the four wire sections is a two-horse reel cart carrying 5 miles of Signal Corps field wire and the buzzers and other apparatus for establishing the necessary stations. Wire can be laid out and recovered at fast gaits and stations established or discontinued in a few seconds.

Buzzer wire carriers, each with a quarter mile of buzzer wire, can be used in emergency or where it is impracticable to lay the field wire. Each section carries 1½ miles of buzzer wire and 4 buzzer wire carriers.

162. Whenever practicable, a reserve of equipment will be kept on hand to provide for a sudden move of the headquarters or other station. For this reason the company commander must take every opportunity to reel up wire no longer used. This can often be done as the action progresses or after a move of headquarters.

163. When a wire line is discontinued, every effort will be made to recover the wire, and wire or matériel will not be abandoned unless its recovery has become impracticable.

164. When lines are laid within the zone of fire or observation of the enemy, the men laying the lines will take advantage of cover to conceal their position and movements. Sections should not be placed in positions exposed to the enemy, nor, on the other hand, in places where it will be difficult for those for whose use the line is established to find them readily.

ON THE MARCH

165. The position of the wire company in the column is not important unless resistance is expected. In the latter case, the company should be where sections and platoons may proceed promptly from division headquarters and lay lines to the brigades and other units as soon as they deploy. To be in a position to meet this requirement, the company should be at or near the head of the main body.

166. In case it is desired for tactical reasons to maintain communication between different parts of a division on the march, this service should be rendered by means of the radio sets rather than by the use of wire lines. The use of the latter on the march is more exhausting to the Signal Corps personnel and uses wire which may be urgently needed for combat lines at any moment when contact with the enemy is possible.

IN BATTLE

167. When resistance is encountered and the division is deploying opportunity for the most useful and important application of the wire company is presented. The division commander or a representative will indicate by formal field order or otherwise the wire lines it is desired to establish. As soon as possible, the captain designates an initial point for the beginning of wire laying and assigns sections and platoons to suitable tasks.

168. The strictest economy of wire and other matériel should be observed in planning for and laying the lines to the end that same be not uselessly expended and found exhausted at a critical stage. As large a reserve as possible of wire and equipment should be assembled at a central point with which to effect replacements and meet unexpected demands. It is advantageous and most usual to play wire from a point near division headquarters outward. A principal advantage lies in the fact that the reel cart is thus placed at the end where changes of position are most frequent.

IN CAMP

169. When the division goes into bivouac or camp the wire company establishes such tactical lines of information as may be indicated. These will usually be wire lines on the ground and will connect division headquarters with brigades and important outposts and observation points.

RESERVE WIRE CARTS

170. The two extra wire carts in the company carry 10 miles of field wire each, which constitutes a reserve supply for issue to subordinate units when necessary. The captain regulates the issue and use of this reserve matériel in the most judicious manner for supplementing and replacing the equipment pertaining to subordinate units. The reserve wire carts and the company instrument wagon constitute a part of the company combat train and should march in rear of the company.

RECONNAISSANCE

171. A most important preparatory measure for units of a wire company to take before actually laying indicated ground lines of information is to provide for as complete a reconnaissance as time will permit of the route to be followed in laying the wire. Such reconnaissance will be accomplished by suitable reconnoitering or scouting parties detailed from the personnel of the sections or by such detachments from the company staff as the captain may direct.

172. These scouting parties will examine carefully the general route to be followed in laying the wire with a view to selecting the particular route (a) which best utilizes the existing matériel and artificial cover along the route; (b) which offers the least difficult terrain to traverse; and (c) due regard being had for the above, that route which is the shortest and which involves the laying of the least possible amount of wire.

173. It is incumbent on the scouting party in front to **mark the route** so that uncertainty may not arise as to the direction to be followed. A marker is made to understand clearly:

(a) The route to be followed.

(b) The particular unit or units to be guided.

(c) The message, if any, to be delivered.

(d) Other directions to be carried out or the route he is to follow in order to rejoin his party.

174. The marker indicates the correct route, acting as guide if necessary over terrain where the route is difficult to follow, and as soon as his mission is fulfilled hastens to replace the next marker or to rejoin his detachment or detail.

By the establishment of well-understood conventions, or by the use of suitable signs, the number of markers may be reduced. Thus, it should be understood that a main traveled road is not, without indication, to be left for one that is noticeably less traveled, and that a straight road is not, without indication, to be left for one which deviates from it. By marking arrows on trees and buildings, or by other suitable signs, uncertainties of a minor nature may be removed. In important cases, however, a marker should always be left at places where a reasonable doubt may arise.

When the head of the column for which the route is being marked comes within view of a marker the latter **signals** the former, and the former acknowledges with a **countersignal.** Both signal and countersignal should be distinctive and should have been previously agreed upon. The same signal and countersignal are used throughout the detail.

175. The men designated for the foregoing are selected for special aptitude from the personnel of the sections and the company staff and are carefully instructed in the duties they are to perform.

It will be found advantageous to have those men of a section designated for scout duty grouped in the station squad which is last to establish its station.

Additional men are designated from time to time to receive the instruction so that substitutes may be available. Alert, cool-headed, and intelligent men should be selected for this duty; they should be good horsemen and have good eyesight and hearing.

Each scout should be provided with a good field glass, a compass, a watch, a whistle, a field message book, and a pencil.

176. The training of a scout should have for its object:

1. To develop his powers of observation.
2. To teach him what to look for and how to recognize it.
3. To teach him how to report intelligently and concisely.

The scout's powers of observation and description are developed first of all by simple exercises. Thus he may be required to look at a given section of terrain and describe what he sees in it.

The scout is made to appreciate the lay of the land as indicated primarily by its drainage, and secondarily by other natural features, and by the works of man. A good eye for country is thus to be acquired; the scout learns to appreciate the configuration of a terrain which may be only partially visible to him, and thus to deduce the most favorable routes for traversing it and the most probable positions for hostile occupation.

The scout must also be taught to distinguish troops of the different arms, to recognize their formations, and to familiarize himself with their usual methods of action.

The scout must be trained (a) to use field glasses; (b) to read maps; (c) to make reports, both verbal and written; (d) to make route sketches.

THE RADIO COMPANY

General

FUNCTION AND EMPLOYMENT

177. The radio company is used by the commander of a division for maintaining communication with adjacent columns, with the divisional cavalry, and in other instances when distance, the character of service, and the nature of the terrain prevent the laying of wire lines. The radio company usually serves to connect division headquarters with the divisional trains and, pending the construction of semi-permanent lines, with the radio station at Army corps headquarters in rear. These radio facilities may also be used to intercept messages sent by the enemy or to interfere with the operation of his radio stations.

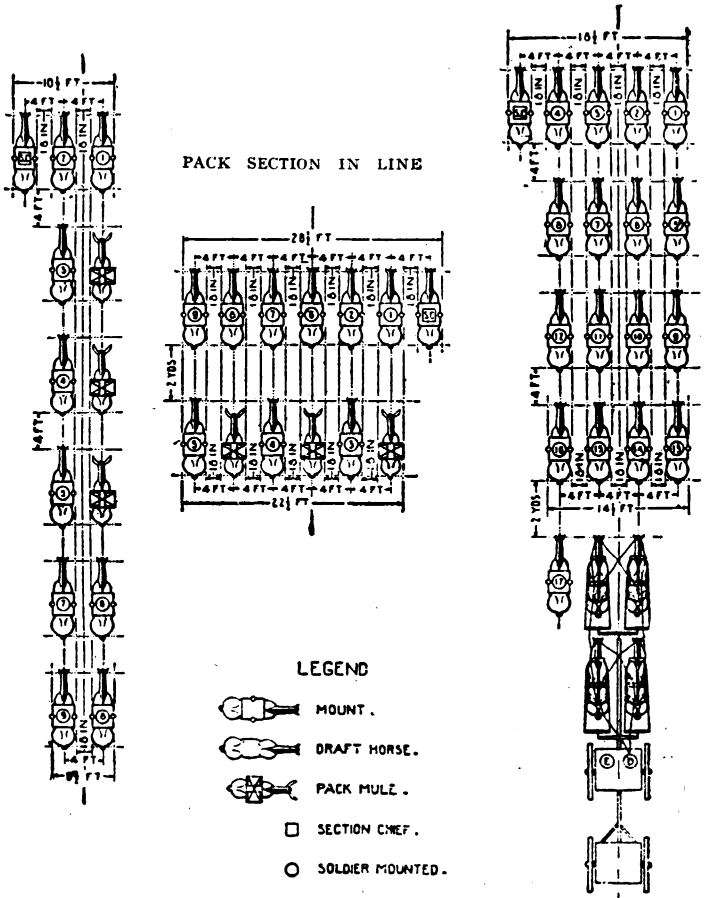
ORGANIZATION

178. The radio company is organized into the necessary headquarters and company staff, two platoons of two pack radio sections each, and one wagon radio section.

For drill the company is formed, as above, the wagon radio section forming a provisional platoon on the left of the company. In the field or on the march the company instrument wagon forms a fourth platoon under command of the supply sergeant.

179. The organization, in detail, is as follows:

1 captain.
2 first lieutenants.
1 master signal electrician.
1 first sergeant (sergeant, first class).
1 supply sergeant (sergeant)
1 stable sergeant (sergeant).
1 mess sergeant (sergeant).
1 horseshoer.
1 clerk (corporal).
1 farrier (corporal).
1 saddler (corporal).
1 mechanic (corporal).
2 cooks.
1 driver (private, first class).
2 buglers (private, first class, one acting as guidon).
4 radio sections, pack.
1 radio section, wheel.



PACK SECTION WAGON SECTION

RADIO SECTION.

DUTIES OF INDIVIDUALS

180. The duties of individuals in the various grades are identical with those of the same grades in the wire company.

The Pack Radio Section

COMPOSITION

181. The pack radio section is normally composed of 10 mounted men and 3 pack mules, designated the "generator" mule, the "chest" mule, and the "kit" mule. If a fourth pack mule be present with the section it will be designated the "supply" mule.

The organization, in detail, is as follows:

1 section chief (sergeant, first class).
2 operators (1 sergeant, 1 corporal).
1 messenger (private, first class).
4 antenna and counterpoise men (1 corporal, 3 privates, first class).
2 horseholders (1 private, first class, 1 private).
Total, 10.

FORMATION

182. The section is formed in column of twos as prescribed in "The Soldier Mounted." Each mule is led by one of the men and, with its driver, forms a two.

POSTS AND DUTIES OF INDIVIDUALS

183. The chief of section is on the left of the leading two except that when the section is acting alone he may go where his services are most needed.

The other men are numbered from 1 to 9, Nos. 1 and 2, the operators, form the leading two, No. 1, the sergeant operator, on the right. These are followed by Nos. 3 and 4, horseholders, and No. 5, the messenger, leading, respectively, the kit, generator, and chest mules. Mule drivers march on the left of their led mules. The mules are followed by Nos. 6, 7, 8, and 9, antenna and counterpoise men, in column of twos with Nos. 6 and 8 on the right. It is the duty of No. 6 to observe the packs and keep up any lagging mules. The antenna squad corporal is No. 9. If a supply mule be present it is led by No. 6, and the duty of observing packs and keeping up lagging mules devolves upon No. 8.

It is the duty of all men so far as they may be able in addition to leading their own mules, to urge forward the mule immediately in front.

DRILL OF THE SECTION

The Guide

184. The guide of the section is the chief of section. In the absence of the chief of section, the left man of the leading rank is the guide.

The Marchings

185. The pack section executes the **march to the front,** the halt, the **changes of direction,** the **march to the rear,** and the **oblique march,** as prescribed for the wire section, substituting "twos" for "fours" wherever found and omitting reference to the carts.

To Form to the Front in Two Lines

186. 1. Left front into line, 2. MARCH.

This will be executed by forming in two lines, with 2 yards distance, the first line being composed of the men not leading mules, the second being composed of the pack mules and their drivers. Each line is formed in a manner similar to that described in paragraph **91.** Mule drivers wait until the mounted men in rear pass them before forming front into line. The chief of section takes his place on the right of the leading rank.

This movement will always be executed to the left.

Rule 1, paragraph **133,** governs the gaits, substituting "two" for "section."

To Re-form the Section in Normal Formation

187. 1. Right by twos, 2. MARCH.

The right two moves straight to the front, the other twos successively oblique to the right front, when disengaged, so as to follow in their proper places in column. The chief of section resumes his post on the left of the leading two.

Rule 2, paragraph **133,** governs the gaits, substituting "two" for "section."

To Form in Column of Files

188. 1. By file, 2. MARCH.

Executed as indicated in paragraph **93.** Each mule driver precedes his mule.

Rule 2, paragraph **133,** governs the gaits, substituting "two" for "section."

To Re-form in Column of Twos

189. 1. Form twos, 2. MARCH.

Executed according to the principles indicated in paragraph **95.**

Rule 1, paragraph **133,** governs the gaits, substituting "file" for "section."

To Open Station

190. Being in normal formation: **1. Open station, 2. DISMOUNT.**

At the command **OPEN STATION,** Nos. 3 and 4 stand fast; No. 1 executes individual right about, chief of section and No. 2 left about; No. 6, moving along right flank of column, comes in alongside No. 1; No. 8 comes in alongside No. 6; No. 7, moving along left flank of column, comes in alongside the chief of section; No. 9 comes in alongside No. 7; No. 5 leads his mule left front into line on No. 4. At the command **DISMOUNT,** all pass reins over horses' heads and dismount. Chief of section, Nos. 1, 2, 6, 7, 8, and 9 turn their horses over to No. 3, and proceed to unpack the generator and chest mules. Nos. 4 and 5, holding their mules in place, move their horses out of the way. No. 1 working on right side and No. 2 on left side, with No. 8 assisting, unpack generator mule. No. 6 working on right side and No. 7 on left side, No. 9 assisting, unpack chest mule. The equipment will be placed on ground 1 yard in rear of mules, iron ferrules of mast pointing to rear. Nos. 4 and 5, after seeing that all loose straps and cinchas are crossed over mules, lead off their horses and mules and turn them over to No. 3. No. 4 moves up on the right and No. 5 on the left of No. 3. As soon as the mules are unpacked Nos. 6 and 7 open antenna bag and distribute antenna reels, the chief of section places top insulator into top joints of mast, and distributes pins to Nos. 1, 2, 6, and 7, who secure antenna, snap their antenna into insulator, and reel out their antenna wires. No. 1 goes to right and No. 2 to left of horses, their antenna wires forming an angle of 90 degrees, No. 6 opposite No. 2 and No. 7 opposite No. 1, and then face mast and watch the chief of section for signals. The chief of section and No. 4 then raise the mast hand over hand; No. 5, assisted later by No. 4, connects up chest and generator, antenna, and counterpoise leads. As soon as bottom joint is in place and mast vertical, chief commands **tie in,** when the antenna men secure their antenna cords to pins and return to mast; Nos. 8 and 9 reel out the counterpoise directly under the antenna wires. In their absence this will be done by Nos. 6 and 7. The chief of section details the necessary operators, messengers, men to turn generator, guards to protect antenna and over animals.

Each man, having a permanent assignment of duty, soon learns to do his part quickly, and after the men have become proficient in handling the equipment the entire operation of unpacking and opening station may be effected by the command **open station.**

To Close Station

191. At the command **CLOSE STATION,** the chief of section and No. 4 immediately start lowering the mast; Nos. 1, 2, 6, and 7 move rapidly to their respective antenna cords, face the mast, and watch for signals. They place their antenna pins in leggings and, when the mast is down, reel up without waiting for command. The chief of section unsnaps all antenna wires from top insulator, throws them clear, and then reels up antenna lead. No. 5 closes and secures chest for packing, while No. 4 attends to generator, after which they secure their respective horses and mules and spot the latter for packing. Nos. 8 and 9 reel up the counterpoise and place it in bottom of bag. In their absence this will be done by Nos. 6 and 7. The chief of section packs away antenna reels and secures pins. Nos. 1 and 2, No. 8 assisting, pack generator mule. Nos. 6 and 7, No. 9 assisting, pack chest mule. Men, when they find themselves no longer of assistance in packing mules, will promptly secure their horses, mount up, and form column. No. 3 being the base. The section forms in column, facing in the same direction as when **open station** was given.

THE WAGON RADIO SECTION

COMPOSITION

192. The wagon radio section is normally composed of 20 men, and one wagon radio set drawn by four horses. All men are individually mounted except the driver and the engineer, who ride on the wagon.

The organization in detail is as follows:

1 section chief (sergeant, first class).
3 operators (1 sergeant, 2 corporals).
3 mast men (1 sergeant, 2 privates, first class).
1 engineer (corporal).
8 antenna, counterpoise and guy men (1 corporal, 7 privates, first class).
1 messenger (private, first class).
1 driver (private, first class).
2 horseholders (privates).
Total, 20.

FORMATION

193. The mounted men of the section, less the chief of section and one horseholder, are formed in column of fours as prescribed in "The Soldier Mounted." The wagon is posted so that the lead horses are 2 yards in rear of the column of fours and in such a position that the pole of the wagon is in prolongation of the interval between the numbers 2 and 3 in the mounted ranks.

POSTS AND DUTIES OF INDIVIDUALS

194. The chief of section is on the left of the leading four, two, or file, except that when the section is acting alone he may go where his services are most needed. Beginning with No. 1 on the right of the leading four and going to the left, thence beginning at the right and going to the left of each succeeding four, the remaining mounted men of the section are numbered consecutively from 1 to 17 for the purpose of describing their duties. Nos. 1, 2, and 3 are operators; No. 1 being the senior operator; No. 4 is the messenger; Nos. 5, 6, and 7 are the mast men; No. 5 being the senior and in charge of the mast detail; No. 8 is a horseholder; Nos. 9, 10, 11, and 12 are the antenna men; No. 9 being the senior and in charge of the antenna and counterpoise detail; Nos. 13, 14, 15, and 16 are the counterpoise and guy men; No. 17 is the remaining horseholder and marches on the left of the leaders except that on the march he may ride in rear of the wagon.

THE WAGON RADIO SET

195. The wagon radio set is carried on a pintle-type wagon. It consists of the necessary technical radio apparatus, an engine, a dynamo, a jointed mast, antenna and guy ropes, and the counterpoise. The technical radio apparatus is attached to the front, and the engine and dynamo to the rear element, and electrically connected with the instruments by cable. On the rear vehicle are also carried the mast, consisting of 10 sections 8 feet in length; the antenna, which has nine cords, one of which is the connecting cord; two sets of guy ropes, four to each set; and the rubber insulated wire counterpoise, consisting of eight branches.

DRILL OF THE SECTION

Maneuver

196. The section is maneuvered by the methods and means prescribed for the wire section, where applicable.

To Open Station

197. The chief of section indicates the location of the station and commands: 1. **OPEN STATION.**

At this command the driver halts and unhitches his team. The chief of section moves the mounted men a sufficient distance to be out of the way of the antenna and guy ropes when the mast is raised and dismounts them. The horses are turned over to the horseholders (Nos. 8 and 17) and the remaining men proceed to unpack the wagon, each man assisting in unpacking and making ready that part of the equipment which it is his duty to handle in establishing the station.

Nos. 1 and 2 place the counterpoise in position; Nos. 3 and 4 take position on top of the front element of the wagon prepared to raise the mast; Nos. 5, 6, and 7 unpack the sections of the mast and place them on the ground convenient to the point at which the mast is to be raised; Nos. 9, 10, 11, and 12 unpack the antenna and pins or stakes and pay out the antenna under direction of the chief of section; Nos. 13, 14, 15, and 16 unpack and pay out the two sets of guy ropes under direction of the chief of section.

As soon as the top joint of the mast is unloaded, No. 7 places the top insulator, with antenna attached, in top of the joint and raises it vertically to Nos. 3 and 4. He then places the remaining joints successively in place and assists Nos. 3 and 4, who raise the mast vertically. The five smaller joints form the upper part of the mast. No. 7 also places the guy rings in place at the top of the fourth and seventh section.

No. 9 should be in front of the wagon, with Nos. 10, 11, and 12 in sequence to his left, in a circle around the mast. This will bring No. 11 opposite No. 9, and No. 12 opposite No. 10. Each man holds two adjacent antenna cords, carries necessary pins in his leggings and a hammer in his belt. Nos. 13, 14, 15, and 16, the guy men, each with an upper and lower guy rope, a hammer, and necessary pins take position, in a corresponding manner, in a smaller circle around the mast, No. 13 being between No. 9 and the mast. This will bring No. 15 opposite No. 13, and No. 16 opposite No. 14. As the mast is being raised the antenna and guy men, standing facing it, will keep it vertical by proper handling of the antenna and guys, under direction of Nos. 5 and 6. No. 5 will direct 9, 11, 13, and 15, and No. 6 will direct 10, 12, 14, and 16. When it is desired that an antenna or guy be pulled out, the command **out** will be used, as No. — **OUT.** When it should be slacked off, the command **in** will be used. The guy ropes which each guy man holds are referred to, respectively, as **upper** and **lower.**

When the mast is up to the required height the chief of section commands **TIE IN.** At this command the guy men, with the assistance of Nos. 6 and 7, if necessary, drive pins in the ground and secure their guys. Antenna men, with the assistance of Nos. 6 and 7 or guymen, if necessary drive a pin in the ground and secure the proper antenna cord. They then secure the remaining cord in a similar manner midway between those first placed. In doing this all move to the right from the antenna cord first secured.

As soon as the command **tie in** is given, No. 5 makes the proper connection for the antenna and counterpoise, while No. 6 supervises the tying in and sees that cords and ropes are kept taut.

198. As soon as the driver unhitches his team, the engineer will see that there is sufficient gasoline in the tank, oil in the cups, water in the proper receptacles (if the engine is water cooled), and connect the dynamo to the instrument by means of the cable and generally make ready to start the engine and dynamo.

When the mast is up the chief of section details the operators, messengers, and guards for the antenna and guys, and makes such disposition of the remaining men as the situation demands. If the station is to be maintained open any length of time, he also directs that the picket line be established or the horses otherwise disposed of.

The driver takes care of his team.

To Close Station

199. At the command **close station,** the operator removes the antenna and counterpoise connections, the guy men take up the pins and hold the guys, each antenna man first takes up the pin and frees the end of the antenna cord which he last secured and turns it loose, then proceeds to his other antenna cord, pulls up the pin, and holds the cord while the mast is being lowered. The mast is lowered by the same men in the same positions as when being raised. Nos. 5 and 6 direct the antenna and guy men. The counterpoise men recover the counterpoise; the engineer shuts off all valves, the driver brings his team close to wagon, and when the mast is down hitches it to the wagon. All men assist in packing the equipment which they unpacked. When all the apparatus has been securely packed the chief of section commands **stand to horse,** when all men proceed to their horses and obey this command. The men are then mounted and the section formed by the appropriate commands.

200. In opening and closing station, all men who have finished the duty herein assigned to them may be directed by the chief of section to perform such other duties as may be necessary.

The Radio Platoon

201. The radio platoon is composed of two radio pack sections commanded by a lieutenant.

The matter contained in "The Wire Platoon" is applicable to the radio platoon, except that the interval between sections in the order in line is approximately 22 yards.

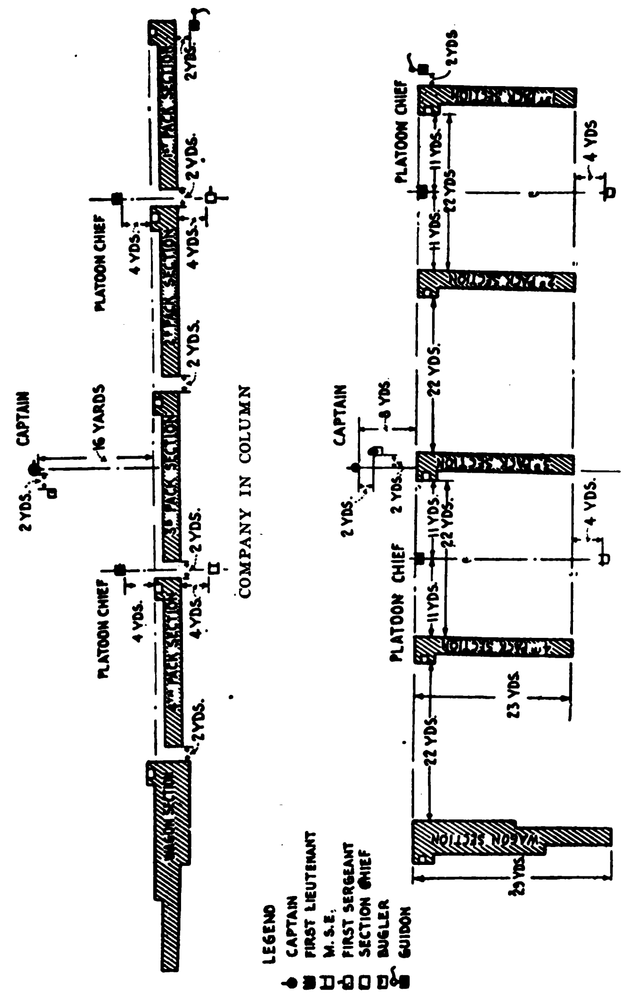
THE COMPANY

FORMATION OF THE COMPANY AND POSTS OF INDIVIDUALS

202. The company is formed and individuals therein are posted as prescribed for the wire company.

DRILL OF THE COMPANY

203. The same movements in maneuver executed by the wire company are prescribed for the radio company, and, in so far as not entirely impracticable, the same commands, methods, and means are employed in maneuvering the latter as obtain in maneuvering the former. Wherever "The Section" is referred to in the maneuver drill prescribed for the wire company it will be understood that for the purposes of this section reference to "The Pack Radio Section" or "The Wagon Radio Section," as pertinent, is intended.



COMPANY IN LINE

THE RADIO COMPANY

Employment in the Field

GENERAL

204. The main equipment of each pack radio section is one pack radio set actuated by a hand generator, and that of the wagon radio section is one wagon radio set actuated by an engine-driven dynamo. Component parts of these sets are as indicated from time to time in War Department orders. The company instrument wagon carries a spare pack radio set. The pack radio set has a range of 20 to 30 miles, depending on conditions. The set can be unpacked, the mast erected, station opened, and messages started in 2½ minutes. The wagon radio set has a range of 150 to 250 miles, depending on conditions. The set can be unpacked, the mast erected, station opened, and messages started in 10 minutes.

ASSIGNMENT OF SECTIONS TO DUTY

205. In general, the wagon set remains with headquarters. The pack sets can be so disposed that the division commander can send to and receive messages from the divisional cavalry and other important units with which radio communication is desired.

The field battalion at army corps headquarters can, if desired, make use of the large and more powerful motor truck radio sets available there for keeping in touch with the advancing organizations.

SELECTION OF STATION SITES

206. The selection of station sites involves on the part of those charged with that duty a suitable reconnaissance of the terrain, according to the principles laid down in "The Wire Company," a knowledge of the possibilities and limitations of the station to be erected and a consideration of the tactical needs and probable developments. The locality for the station will be selected with as much care as the time available and conditions will permit.

High open ground as far from near-by hills as practicable is to be preferred, due regard being had for cover and security of the station. The nearer the station is placed to the commanding officer or to the headquarters of the command with which the section is serving, the better.

If not impracticable the site selected should permit the full spread of antenna and guy ropes. The greater the spread of the antenna wires, the farther they are from the ground and the greater the capacity.

INSTRUCTIONS FOR THOSE IN CHARGE OF FIELD RADIO STATIONS

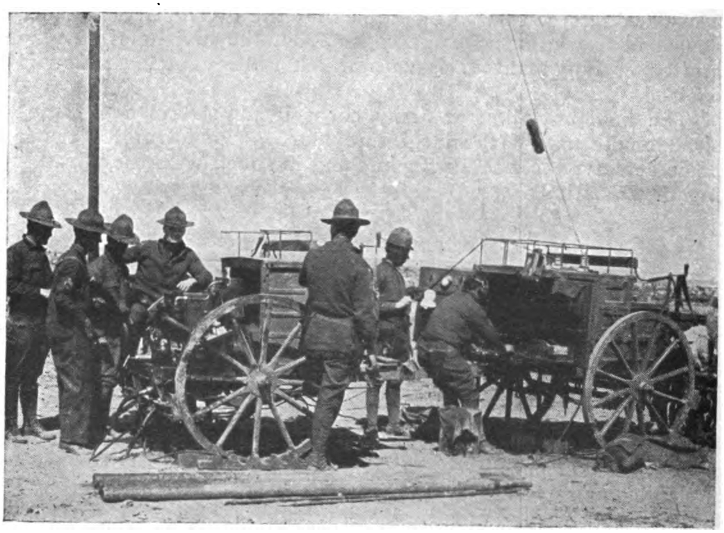
207. Be sure you know the organization which you are serving and the commander to whom you report and are responsible.

Familiarize yourself promptly with the call letters and locations of all stations with which you are in communication; likewise, with the location of your own troops and the names of commanders.

Arrange for the subsistence of the men and the foraging of the animals.

Constant attention to instruments and minor repairs made immediately will avoid serious breakdowns.

In receiving, attention to the insulation of the set and the mast from the ground is very important.



AN ILLUSTRATION OF THE "OPEN STATION" OF A WAGON WIRELESS STATION TAKEN UNDER SERVICE CONDITIONS

THE OUTPOST COMPANY

General Provisions

FUNCTION AND EMPLOYMENT

208. The general function of the outpost company is to extend the lines of information in the division forward of the brigade. Specifically, its normal function is to furnish telephone communication between the infantry brigade commander and his regimental commanders in combat. In addition, it may be called upon to supplement the work of the other companies of the field battalion wherever the same may be necessary or desirable.

209. Conditions of employment will probably cause the frequent dispersion of the fractions of the company among the divisional units for long periods of time. For this reason the personnel should be inculcated with the highest possible degree of discipline and should have unquestioned ability to maintain itself in the field.

ORGANIZATION

210. The outpost company is organized into a company headquarters and three platoons.

The organization, in detail, is as follows:

- 1 captain.
- 4 first lieutenants.
- 1 master signal electrician.
- 1 first sergeant (sergeant, first class).
- 1 mess and supply sergeant (sergeant).
- 1 stable noncommissioned officer and farrier (corporal).
- 1 clerk (corporal).
- 1 horseshoer.
- 2 cooks.
- 1 saddler (corporal).
- 1 driver (private, first class.)
- 2 buglers (1 as guidon, privates, first class).
- 3 platoons (21 men each).

DUTIES OF INDIVIDUALS

211. The duties of officers and men in the various grades are identical with those of similar grades in wire and radio companies.

The captain, lieutenants, master signal electricians, first sergeant, buglers, assistant platoon chiefs, the chiefs of headquarters sections, and 1 lineman in each platoon are individually mounted.

The Platoon

TACTICAL EMPLOYMENT

212. In the outpost company the platoon is the working unit. It is specifically designed, as to personnel and matériel, to furnish practical telephonic communication within the infantry brigade. In the normal case it connects the higher brigade units in combat; in other cases it furnishes such lines of information as may be ordered by the brigade commander.

While operating, the platoon is habitually detached from its company and attached to some other unit, normally the infantry brigade. Under such conditions it receives all orders from and follows any directions given by the commander of the unit to which assigned.

Communication furnished by outpost platoons is not intended to supplant other authorized methods. It is intended to be supplemental and additional thereto.

COMPOSITION

213. The platoon is composed of 21 enlisted men, commanded by a first lieutenant.

It consists, in detail of the following:

1 platoon chief (first lieutenant).
1 assistant platoon chief (sergeant, first class, or sergeant).
1 headquarters section (4 enlisted men).
1 switchboard section (4 enlisted men).
3 telephone sections (4 enlisted men each).
Total, 1 officer and 21 enlisted men.

The combat transportation of the platoon consists of 3 pack mules.

214. The platoon chief, assistant platoon chief, chief of headquarters section, and one lineman belonging to the headquarters section are individually mounted. The three pack mules of the platoon are habitually attached one to each of the three telephone sections, a lineman being detailed to act as driver.

DUTIES OF INDIVIDUALS

215. On detachment of the platoon from its company and its assignment with a tactical unit of line troops, the duties of the platoon chief assimilate those of a company commander. To be readily able to meet this condition platoon chiefs should constantly exercise administration, supervision, and control over their commands. Platoon unity of action is paramount in all outpost company training.

The assistant platoon chief is not attached to a section. He assists the platoon chief in the performance of his duties and is always prepared to take command of this unit if circumstances render such action necessary.

The duties of the several noncommissioned officers and enlisted men belonging to sections are described under the paragraph relating thereto.

NUMERICAL DESIGNATION OF MEMBERS

216. The men of the outpost platoon, except the platoon chief and assistant platoon chief, are numbered from 1 to 20 for the purpose of prescribing their positions and duties in the various drills and formations.

*1. Sergeant, section chief. 2. Private, first class, telephone operator. 3. Private, first class, telephone operator. *4. Private, first class, lineman.	Headquarters section.
5. Corporal, section chief. 6. Private, first class, switchboard operator. 7. Private, first class, switchboard operator. 8. Private, lineman.	Switchboard section.
9. Corporal, section chief. 10. Private, first class, telephone operator. 11. Private, first class, lineman. †12. Private, lineman.	First telephone section.
13. Corporal, section chief. 14. Private, first class, telephone operator 15. Private, first class, lineman. †16. Private, lineman.	2nd telephone section.

* Mounted. † Mule Driver.

17. Corporal, section chief. 18. Private, first class, telephone operator. 19. Private, first class, lineman. †20. Private, lineman.	3rd telephone section.

FORMATIONS AND POSTS OF INDIVIDUALS

217. The habitual formations of the platoon are: **In column** and **in line.**

218. The formation **in column** is that in which the sections in double rank follow each other in the order, headquarters section, switchboard section, telephone sections in numerical order, from front to rear. The mounted men and mule drivers march in column of pairs at the rear.

219. The formation **in line** is that in which the sections are abreast of each other from right to left in the order, headquarters section, switchboard section, telephone sections in numerical order, the dismounted men of the sections being formed in double rank, the mule drivers and mounted men forming a third rank 2 yards in rear.

220. The platoon is habitually formed and maneuvered in column; the formation in line is had preliminary to technical operations and for inspection.

221. For the purpose of enlarging the front of the column and economizing road space, the length of the column may be reduced by closing the dismounted men to column of fours.

Conversely to permit the passage of obstacles and the traversing of difficult terrain, the front of the column can be contracted by forming both mounted and dismounted men in column of files.

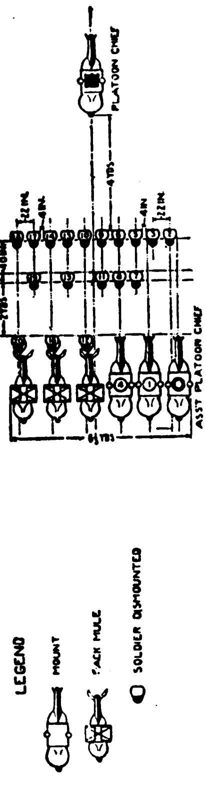
MANEUVER

GENERAL RULES

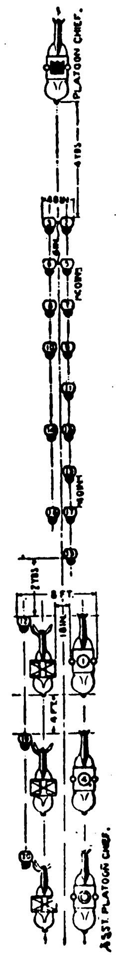
222. On account of the small size of the outpost platoon, the movements prescribed for its maneuver are as simple in character and as limited in number as is possible to accomplish efficient handling.

223. Whenever possible, and in all cases where not otherwise prescribed, the maneuver of the dismounted men will be in accordance with the principles laid down under "Dismounted Instruction"; that of the mounted men and mule drivers in accordance with the principles of "Mounted Instruction."

†Mule driver.



PLATOON IN LINE



PLATOON IN COLUMN

THE OUTPOST PLATOON

224. Wherever the term **section is** used, it is intended to mean **dismounted section,** or that part of the section included in the dismounted rank. Where the term **mounted man** is used, it is intended to include both men actually **mounted** and **mule drivers.**

To Form the Platoon

225. The mounted men are marched to the stables by the assistant platoon chief, who superintends the harnessing and the saddling. The dismounted men are marched to the storerooms by the senior dismounted noncommissioned officer under whose direction the equipment is procured. The chief of each telephone section then superintends the packing.

The assistant platoon chief then forms the platoon in column, verifies, and makes an inspection of it. He causes the mounted men to mount, reports the result of his inspection to the platoon chief, and takes his post.

To Dismiss the Platoon

226. The platoon chief commands: **DISMISS THE PLATOON.**

The platoon is marched to the storerooms by the assistant platoon chief. The chief of each telephone section superintends the unpacking. The mounted men are then marched to the stables by the assistant platoon chief, who superintends the unpacking, unsaddling, the disposal of horse and pack equipment, and the placing of the animals in the stable or on the picket line. The senior dismounted noncommissioned officer is charged with the proper disposal of the platoon technical equipment.

To March to the Front

227. Being at a halt: **1. Forward, 2. MARCH.** Executed by the dismounted rank in accordance with principles laid down in School of the Soldier.

Executed by the mounted rank in accordance with principles laid down in paragraph **81.**

The guide of the platoon is its left leading file unless otherwise announced.

228. The platoon in any formation may be marched in double time, the dismounted ranks conforming to the principles enunciated in explanations of quick time and double time, the mounted rank putting their animals into a slow trot. On account of the confusion likely to ensue from executing this movement in a mixed command, the same should only be employed where circumstances render rapidity of movement imperative.

To Halt

229. Being in march, to arrest a movement: **1. Platoon, 2. HALT.**

Executed by dismounted rank in accordance with "School of the Soldier;" by the mounted rank as prescribed in paragraph **35.**

To March to the Rear

230. 1. Right (Left) about, 2. MARCH.

At the second command the leading section changes direction to the right in accordance with principles laid down in paragraph **89,** moves two paces forward in the new direction and again changes direction to the right. The succeeding sections each in turn conform to the movements of the first, executing identical movements on the same ground. The mounted men follow in column, each pair executing two changes of direction at the proper time as prescribed in paragraph **89.**

To March Obliquely

231. 1. Right (Left) oblique, 2. MARCH.

Executed simultaneously by the sections in accordance with the principles of the Squad. Executed by the mounted men as prescribed in paragraph **85.**

To resume the original direction: **1. Forward, 2. MARCH.**

Executed as explained in preceding paragraphs.

To Change Direction

232. Being in column: **1. Column right (left), 2. MARCH.**

Executed by each section successively according to principles of the Squad.

The mounted men follow in column, each pair executing the change of direction at proper time as prescribed in paragraph **89.**

Half changes of direction are executed in accordance with the same principles substituting the command: **Column half right (left).**

To Form Column to the Front from Line

233. Being in line: **1. Right by section, 2. MARCH.**

The right section moves straight to the front; the other sections execute section right, column left, and follow the leading section.

The mounted men move out at the proper time to take their places in column by the shortest practicable route.

This movement is only executed from the right.

To Form Line to the Front from Column

234. Being in column: **1. Left front into line, 2. MARCH, 3. Platoon, 4. HALT, 5. FRONT.**

At the second command the leading section moves straight to the front, each of the succeeding sections oblique to the left, and when opposite its place in line resumes original direction of march. The sections halt on arrival on the line and dress to the right without command.

The mounted men move to their places in line by the shortest practicable route.

The fifth command is given after the completion of the alignment of both dismounted and mounted ranks.

This movement is only executed toward the left.

The Double Column

235. Being in column: **1. Double column, 2. MARCH.**

At the second command the two leading sections stand fast if at a halt or halt if in march. The third and fifth sections oblique to the left and halt abreast of the second and fourth, respectively. The fourth section closes to normal distance on the second.

The mounted men close to normal distance on the sections and halt.

This movement is only used in route marches to economize road space and no other movements, except those connected with conduct of the march, are contemplated until the column formation is again resumed.

236. Being in double column, to form column: **1. Column, 2. MARCH.**

At the second command the two leading sections take up the march if at a halt; if marching they continue the march. All the other sections and mounted men stand fast or halt as the case may be. The third and fifth sections oblique to the right in time to follow the second and fourth respectively. The fourth section moves forward to follow the third.

The mounted rank takes up the march in time to follow in rear of the dismounted rank at the proper distance.

The Single Column

237. Being in column: **1. Single column, 2. MARCH.**

At the second command all stand fast or halt if in march, except the right man of the leading section. The left leading man obliques to the right in time to follow the leader at the shortest practicable distance. The single column is formed successively by the other sections in accordance with similar principles, each section following its predecessor as closely as possible.

The mounted rank forms column files in the most convenient manner so as to follow at normal distances in rear. The order of this column is mule drivers in order of sections in column and mounted men in same order as in column.

The single column is only used to pass obstacles or to traverse terrain where other formations are unsuitable. No maneuvers of the platoon except those directly connected with the conduct of the march are contemplated in this formation.

238. Being in single column, to form column: **1. Column, 2. MARCH.**

At the second command the leading man stands fast or halts if in march. The several sections are formed successively in column by the proper men obliquing to the left; the sections successively close to normal distances on the leading section and halt.

In the mounted rank, the mule drivers close to normal distance and halt; the mounted men oblique to the right and halt in their proper positions abreast of the drivers.

To Align the Platoon

239. The platoon being in line at a halt: If the section on the side toward which the alignment is to be made is not in proper position, the platoon chief establishes it in the position desired, and commands: **1. Right (left), 2. Dress, 3. FRONT.** Executed by the dismounted rank according to the principles laid down in the School of the Squad.

Executed by the mounted rank in accordance with principles laid down in paragraphs **5** and **80,** the mounted man on the side toward which the alignment is prescribed establishing himself accurately in his position 2 yards in rear of the dismounted rank.

The platoon chief aligns each rank separately, commencing with the dismounted rank, taking position for this purpose in prolongation of the line, 2 yards from and facing the flank toward which the alignment is made. After commanding **FRONT,** he resumes his post.

240. The alignment of the platoon in column is conducted on similar principles. In this case the platoon chief, in addition to aligning the several ranks, sees that the men column cover accurately in file.

To Open and Close Ranks

241. Being in line at a halt: **1. Open ranks, 2. MARCH, 3. FRONT.**

Executed by the dismounted rank in accordance with the principles of dismounted company instruction, so far as applicable.

The mounted men rein back the animals so as to be 2 yards in rear of dismounted rank in its new position.

The platoon chief aligns the three ranks successively from the front, taking similar positions to those prescribed for dressing the platoon.

The command **FRONT** is given by the platoon chief after having aligned the ranks and taken position facing to the left 4 yards in front of the dismounted rank directly in front of the right file. The platoon chief then turns his horse to the front.

242. Being in open ranks: **1. Close ranks, 2. MARCH.**

Executed by the dismounted rank in accordance with principles of dismounted regulations.

The mounted rank closes to normal distance.

The platoon chief takes his prescribed post in line.

Route Order and At Ease

243. Marching in any formation: **1. ROUTE ORDER,** or **1. AT EASE.**

Executed as prescribed in paragraph **9.**

In route marches the platoon chief habitually marches on the leeward side of his platoon opposite the leading mounted man of the platoon.

TECHNICAL OPERATION

The technical operation of the outpost platoon occurs, in general, while it is a detached unit. Possible cases may arise where the platoon will operate in conjunction with other signal units, but they will be of such rarity as to be regarded as highly exceptional. It may be stated, therefore, as a guiding principle that the outpost platoon functions as a unit in a limited, but nevertheless distinct, sphere of operations.

As before stated, the composition of the platoon is based upon furnishing efficient telephonic communication within the infantry brigade in combat. The term combat applies to all phases of the same, whether it be offensive or defensive, active or passive. It can hardly be doubted that the character of the organization and of its equipment is such as will readily lend itself to the supply of lines of information in many other situations besides that for which it was primarily designed. In fact, in practically all cases where troops in active operations are not in constant motion the outpost platoon can and should be utilized to advantage.

Ordinarily the platoon should be detached from its company and directed to report to the unit, usually an infantry brigade, to which it is assigned for information service, as soon as conditions pointing to early probable use obtain. As soon as practicable after reporting for service, the platoon commander should thoroughly acquaint himself with the local situation. He should keep in constant touch with developments and be prepared at a moment's notice to lay any or all section lines in accordance with a prepared scheme and one best suited to the terrain to be covered.

On receiving an order to lay certain lines of information, a position for the switchboard will be first selected. This position should generally be in rear of the center of the chain of outlying stations. If at all practicable, the combat transportation and the platoon personnel should be conducted intact to the switchboard station before commencing work. Whether this procedure can be followed or not depends entirely on local conditions and the decision at what point the platoon is to begin operations should be decided by its commander forthwith.

There are no specific commands for the technical handling of the platoon. On arrival at the point where wire laying is to commence the platoon chief gives such directions to the various section chiefs as are necessary for each to work rapidly and intelligently in conformity with the general plan. The technical equipment of the headquarters and switchboard sections is unpacked and turned over to the personnel of these sections. The switchboard section establishes the board at the designated location and the headquarters section at once connects it with general headquarters. At the same time the three telephone sections, or as many as may be designated, proceed to lay wire to connect their several assigned stations to the board and thus effect intercommunication throughout the system.

All stations, including the switchboard station, should be selected so as to be secure from the view and fire of the enemy. On the other hand, the telephone sections should be located as close and constantly keep as close as possible to the commander of unit for whose use they are installed. The fact that the telephone is an instrument for the commander's personal use should never be lost sight of. It will be frequently difficult to reconcile the two above conditions, but the same should be done whenever possible.

The laying of the lines should always be done with a view to successful maintenance. They should be as short and direct as is possible consistent with security from hostile view and fire. They should avoid, if practicable, crossing or traversing routes of probable use by line troops. If this be impracticable, arrangements should be made for their protection at these points. When the lines are in service the operators will be constantly "on" their instruments, and trouble of any kind should be detected almost coincident with its occurrence. Immediate effort should be made by all concerned to effect its early removal.

Cases will no doubt arise where the use of the switchboard will be unnecessary or inadvisable. These cases should be readily apparent to the platoon chief, and necessary orders should be given to lay independent lines.

The telephone stations keep intimate contact with their unit commanders at all times. The general procedure in operating the line will be to have the telephone operator send a call for the individual wanted to come to the telephone. The matter of time makes short distances imperative. All communications over outpost lines should be by personal conversation of the officers concerned. Any other method of transmitting information over telephone lines is unnecessarily slow, generally inaccurate, and frequently dangerous.

The personnel of the station sections should be intimately acquainted with the several unit commanders and their staffs. This is necessary in finding their proper locations when initially laying the line, and especially so, if, as will frequently be the case, the exact location of the unit to be connected is in doubt. Unless this personal element obtains valuable time may often be lost by failures to find the proper headquarters, in taking erroneous routes, and causing wire to be recovered and relaid.

When a change in the system is necessary, the platoon chief will give directions how the same shall be effected. Minor changes can usually be made by lengthening or shortening one or more lines in use. In extended changes it will probably be best to recover all wire, assembling the platoon at the switchboard, and project an entirely new system in accordance with the new plan.

The improvised expedients possible with the outpost platoon are innumerable. In no branch of signal work will the resourceful officer find a larger field than in this work; in no branch will practical experience be of more value.

Uninterrupted communication between the units, despite all conditions, is the goal to be striven for, and the subaltern who attains it will have found that he has solved a problem more difficult than those which usually confront far higher commanders.

The Sections

TYPES OF SECTIONS

The outpost platoon is composed of five sections, namely, one headquarters section, one switchboard section, and three telephone sections.

The headquarters section does not derive its name from the fact that it is the headquarters of the platoon, for such is by no means the case. It is so termed because its normal station is at the brigade or other unit headquarters to which the platoon is attached.

The switchboard section derives its name from the character of duty it is designed to perform. The operation and maintenance of the switchboard is its primary function. In addition, it performs such duties of line maintenance as may be necessary.

The telephone sections are so called because they are normally designed to operate the telephone stations at the several subsidiary units. In addition, they install and maintain the lines necessary between their variously assigned stations and the switchboard.

THE HEADQUARTERS SECTION

The personnel consists of one sergeant, chief of section (mounted), one private, first class, lineman (mounted), and two privates, first class, telephone operators.

The technical equipment includes one telephone, one breast reel, and one half-mile outpost wire, together with certain miscellaneous articles necessary for the installation and maintenance of the line and the operation of one telephone station.

The mounts of the section constitute a properly located reserve calculated to afford rapid assistance to any of the other sections wherever occasion should require it.

The specific duties of the various individuals of the section are generally described by the character of their titles. In general all perform any duties necessary to rapid and efficient transmission of information. This includes any necessary messenger service in connection with the operation of the line, provided the same can not be promptly performed by other troops.

The small amount of wire assigned to this section presupposes that the length of line between unit headquarters and the switchboard will be very short. It is not expected that it will ordinarily exceed a few hundred yards. For this reason, the headquarters and switchboard sections will frequently be able to perform their combined duties as a single group, thus permitting a large platoon reserve for the support of other sections of the line, if same should be required.

THE SWITCHBOARD SECTION

The personnel consists of one corporal, chief of section, two privates (first class), switchboard operators, and one private (lineman).

The technical equipment includes one field switchboard and such miscellaneous articles as are necessary for the operation of the switchboard station and the maintenance lines contiguous thereto.

There are no mounts or pack animals attached to this section, and it is not expected to lay wire. On account of its position, one having direct access to all lines, it will be peculiarly susceptible to the early location of line trouble in the system, and prompt attention should be given in every instance toward removing it.

The specific duties of individuals are, as with the headquarters section, generally described by the character of their titles. In general the duties of the entire section are embraced under two heads, namely, the operation of the switchboard and the prompt removal of trouble occurring on any radiating line. Duties will be performed by various members of the section in such a way as to best accomplish these ends.

The location of the switchboard is of primary importance in the installation and operation of the line. This will be always done, if at all practicable, by the platoon chief. He takes into consideration the tactical situation, the features of the terrain, and the present, and probable future, positions of headquarters and the various subordinate units to be connected. The possession of a good map and a position affording a clear view of the surrounding country are indispensable requisites to the intelligent selection of this position.

THE TELEPHONE SECTIONS

These sections are designed to furnish lines and telephone stations for three subordinate unit headquarters by connecting same to general headquarters through the switchboard. The personnel, matériel, and transportation of the telephone sections are identical.

The personnel of a telephone section consists of one corporal, chief of section; one private, first class, telephone operator; one private, first class, lineman; and one private, lineman. The latter, in addition to his other duties, acts as packer and mule driver.

The matériel of the section consists of one telephone, one breast reel, and 2 miles of outpost wire, together with certain miscellaneous articles necessary for the installation and maintenance of the line, and the operation of one telephone station.

The platoon combat transportation, the three pack mules, is habitually attached to the three telephone sections. These animals will transport the entire technical equipment of the platoon until the commencement of active operations. At this time matériel belonging to the headquarters and switchboard sections will be removed from the packs and transferred to the personnel of these sections. Thereafter one pack animal will accompany each telephone section to its assigned station and remain with it throughout action, unless good reasons exist for the contrary.

As with the other sections, the character of duty performed by the individuals of the telephone section is indicated by their titles. In general the duties performed by the members of the section are similar to those prescribed for members of the headquarters section.

Each telephone section is expected to install and maintain a line from the switchboard to a certain designated subordinate unit headquarters, and to operate a telephone station thereat. To effect this connection the wire furnished is expected in all ordinary cases to be ample for this purpose. The section will follow with its line all movements of the headquarters to which attached, keeping intimate connection therewith and utilizing its own wire as far as possible. Where necessary and practicable, improvised lines will be employed. Frequent reports will be made by chiefs of sections to the platoon chief as to location of the section station, amount of unused wire on hand, anticipated movements, and the practicability of employing existing lines for purposes of communication.

So far as is practicable, after a section station is once opened, the lines of the telephone sections will be kept in constant communication with switchboard. In changing the location of the station timely arrangements should be made for extending the line and the telephone removed therefrom only for the shortest time compatible with removal to the new site.

THE COMPANY

FORMATION OF THE COMPANY

244. The habitual formations are: The **order in line,** the **order in section column.**

245. The **order in line** is that in which the platoons, each in column of sections, are formed abreast of each other in their numerical order or the reverse order from right to left. The interval between the platoons is 27 yards.

246. The **order in section column** is that in which the platoons, each in column of sections, follow each other in their numerical order or the reverse order, from front to rear. This distance between the platoons is 4 yards.

POSTS OF INDIVIDUALS

247. The captain in the order in line is 8 yards in front of the company opposite its center. In the order in section column, he is opposite its center and 16 yards from the flank. In column the captain is on the left when the first platoon leads and on the right when the column is reversed.

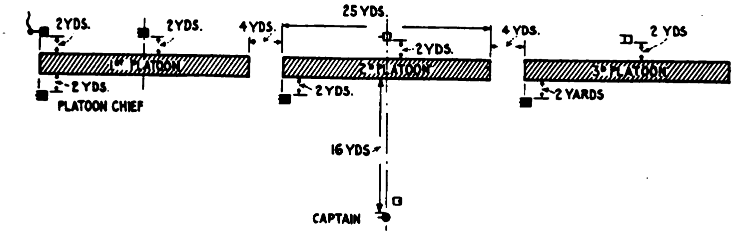
The platoon chiefs in both formations are posted 4 yards to the left and abreast of the leading file of their platoons.

The first lieutenant not commanding a platoon, the first sergeant, and master signal electrician occupy similar positions in both formations with reference to the first, second, and third platoons, respectively. Each is posted on the right flank of the respective platoon, opposite the center and 2 yards therefrom.

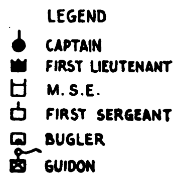
The guidon in line is abreast of the leading rank of the company and 2 yards from the flank toward which the guide has been announced; in section column abreast of and 2 yards to the right of the leading rank of the leading section.

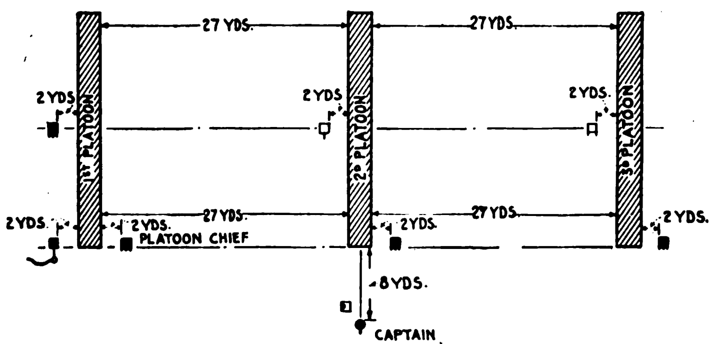
The buglers, or bugler not acting as guidon, follow 2 yards in rear of the captain.

The dismounted men attached to company headquarters do not take part in company maneuvers, except when assigned to duty in platoons. Otherwise they are present only with field



COMPANY IN COLUMN





COMPANY IN LINE

THE OUTPOST COMPANY

and combat transportation, taking such posts with it as are assigned them by the captain.

MANEUVER

General Rules

248. The rules for the maneuver of the platoon apply to the company.

249. The guide of the company in line is the guide of the platoon on the side of the guide. In section column it is the guide of the leading platoon.

250. During an oblique march the guide of the company is, without indication, the guide of the platoon on the side to which the oblique is made.

251. The guidon conducts himself as prescribed for maneuver of wire or radio companies.

252. In all maneuvers resulting in a formation in line the company is either halted at the completion of the formation, or the guide is announced if the march is to be continued.

253. Platoon chiefs repeat such preparatory commands as are to be immediately executed by their platoons. They give only such commands of execution as are necessary to cause their platoons to function properly in company maneuver.

To Form the Company

254. The company is formed dismounted by the first sergeant after which he commands: **By platoon, FALL OUT.** The procedure outlined in paragraph **225** is followed by each platoon. Each platoon is then minutely inspected by its assistant chief.

The first sergeant forms the company in line and takes his post.

Each platoon chief, having received the report of his assistant platoon chief, makes a general inspection of his platoon and commands: **REST.**

Upon the approach of the captain the platoon chiefs call their platoons to attention, and as soon as the captain takes his place in front report in succession from right to left: **(SUCH) PLATOON IN ORDER, SIR**; or if anything is missing or out of order they so report.

As soon as the platoon chiefs have reported, the first sergeant reports to the captain as prescribed in forming the company dismounted.

The lieutenant not assigned as platoon chief and the master signal electrician take their posts on the approach of the captain.

To Dismiss the Company

255. The captain commands: **DISMISS THE COMPANY.**

The lieutenants and master signal electrician fall out. The first sergeant takes charge of the company and commands: **By platoon, FALL OUT.** The platoons are then dismissed as prescribed in paragraph **226.**

To Align the Company

256. The company being in line at a halt.

If the platoon on the side toward which the alignment is to be made is not in proper position, the captain establishes it in the position desired and commands: **1. Right (left), 2. DRESS, 3. FRONT.**

At the command **DRESS,** the other platoons move forward or backward, the leading dismounted rank aligning itself toward the right: both dismounted and mounted men turn their heads to the right and dress on the corresponding elements in the platoon on their right.

The captain aligns the leading dismounted and mounted ranks of all the platoons, taking position for this purpose in prolongation of the line, 2 yards from and facing the flank toward which the alignment is made. After commanding **FRONT,** he resumes his post.

To March to the Front

257. Being at a halt: 1. Forward, 2. MARCH.

Executed simultaneously by all the platoons as prescribed in paragraph **227.** All the platoons move straight to the front, taking care to maintain their proper relative positions in the formation.

258. The principles of paragraph **228** relative to movements in double time in the platoon apply to the company.

To Halt

259. Being in march: **1. Company, 2. HALT.**

Executed by each platoon as prescribed in paragraph **229** all platoons stopping simultaneously but not suddenly.

To March to the Flank

260. 1. By the right (left) flank, 2. MARCH.

Executed simultaneously by each platoon making a change of direction as prescribed in paragraph **232.**

To March to the Rear

261. 1. Right (left) about, 2. MARCH.

Executed simultaneously by each platoon as prescribed in paragraph **230.**

To March Obliquely

262. 1. Right (left) oblique, 2. MARCH.

Executed by each platoon as prescribed in paragraph **231.**

To Change Direction

263. Being in column: **1. Column right (left), 2. MARCH.**

Executed successively by the platoons in accordance with paragraph **232,** each platoon chief giving the command for his platoon to change direction on the same ground as the one preceding it.

264. Being in line: **1. Company right (left), 2. MARCH, 3. Company, 4. HALT.**

The right platoon changes direction to the right, the other platoons are conducted by the shortest line to their places abreast of the first.

The fourth command is given when the right platoon has advanced the desired distance in the new direction; that platoon halts; the others halt successively on arriving on the line.

To Close or Extend Intervals

265. On (such) platoon, 2. To (so many yards), 3. Close (extend) intervals, 4. MARCH, 5. Company, 6. HALT.

The indicated platoon moves straight to the front, the other platoons oblique toward or away from the indicated platoon, and move to the front when at proper interval.

The sixth command is given when the directing platoon has advanced sufficient distance to permit the proper execution of the movement by the other platoons; it halts; the other platoons halt successively on arrival in line.

To Form Column from Line

TO THE FRONT

266. Being in line: **1. Right (left), by platoon, 2. MARCH. ..**

The right platoon moves straight to the front if marching; if at a halt it takes up the march. The other platoons, in turn, execute column right and follow in column at 4 yards distance.

TO THE FLANK

267. Executed as prescribed in paragraph **260.**

To Form Line from Column

TO THE FRONT

268. 1. Right (left) front into line, 2. MARCH, 3. Company, 4. HALT.

The leading platoon moves straight to the front. Each platoon in rear executes column half right. When opposite its place in line it executes column half left, and moves to its place in line.

The fourth command is given when the directing platoon has advanced the desired distance; it halts; the other platoons halt successively on arrival at their places in line.

TO THE FLANK

269. On right (left) into line, 2. MARCH, 3. Company, 4. HALT.

The leading platoon executes column right and moves straight to the front in the new direction. The platoons in rear continue to march straight to the front; each passes beyond the platoon directly preceding it, and when opposite the right of its place executes column right and proceeds to its place in line.

The fourth command is given when the directing platoon has advanced the desired distance in the new direction; it halts; the other platoons halt on arrival successively at their proper places in line.

270. 1. Right (left) into line, 2. MARCH, 3. Company, 4. HALT.

The leading platoon executes column right and moves straight to the front in the new direction. The platoons in rear continue to march straight to the front until each is at the right of its place in line, at the prescribed interval from the preceding platoon; each then executes column right and proceeds to its place in line.

The fourth command is given when the directing platoon has advanced the desired distance in the new direction; it halts; the other platoons halt successively on arrival at their places in line.

This movement is intended to be used to form line with contracted intervals and therefore the interval between platoons desired should be interpolated in the preparatory command.

The Double Column

271. Formed simultaneously by each platoon as prescribed in paragraphs **235** and **236**.

The platoon chiefs of the rear platoons close their platoons on the preceding element as soon as the double column is formed.

The Single Column

272. This movement is not usually executed by the company. If desired, however, it can be executed as prescribed in paragraphs **237** and **238**.

To Form the Platoons in Line

273. Being in line of column: **1. Platoons, 2. Left front into line, 3. MARCH, 4. Company, 5. HALT, 6. FRONT.**

Executed at the third command simultaneously by each platoon as prescribed in paragraph **234**.

The lieutenant not commanding a platoon, the first sergeant, and the master signal electrician take post 4 yards in rear of the center of the respective platoons.

The sixth command is given after the completion of the alignment of the dismounted and mounted ranks of the company.

This movement is only executed to the left.

To Form Line or Column

274. 1. Platoons, 2. Right by sections, 3. MARCH.

Executed simultaneously by each platoon as prescribed in paragraph **233**.

This movement is only executed from the right.

To Open and Close Ranks

275. Being in line, or in column, with platoons in line at a halt: **1. Open ranks, 2. MARCH, 3. FRONT.**

Executed by each platoon simultaneously as prescribed in paragraph **241**. The file closers conform.

The captain aligns the ranks of the company successively from front to rear from similar positions to those described for dressing.

The command **FRONT** is given by the captain after having aligned all the ranks and taken position facing to the left 4 yards in front of the dismounted rank of the right or leading platoon, and directly in front of its right file. The captain then turns his horse to the front.

276. Being at open ranks: **1. Close ranks, 2. MARCH.**

Executed simultaneously by each platoon as prescribed in paragraph **242.**

Route Order and at Ease

277. Executed as prescribed for dismounted and in paragraph **9.**

In route marches, the captain marches 8 yards in front of the leading element, followed at 2 yards by the bugler and guidon, the latter on the right. Platoon chiefs march as prescribed in paragraph **243.** File closers march where the captain directs. The company instrument wagon marches in rear of the column.

Employment in the Field

The employment of the outpost company in the field includes the functioning of its several platoons in performing such duties as may be directed by the field battalion commander.

The detachment of any element or elements of the company when necessity for the same arises, occurs at the direction of the battalion and by the order of the company commander. The company, at all times, acts as administrative headquarters for all of its units whether attached or detached. This matter will be attended with some difficulty if the units be widely scattered as may frequently happen. The procedure is inevitable, however, from the fact that the company functions wholly in the dispersion of its elements.

Besides the conduct of administration, the company headquarters will furnish such assistance to the working units as may be necessary for the efficient performance of their duties at all times and under all circumstances.

Detached signal units usually mess with line troops with whom they are assigned for duty. Where this method is for any reason impracticable, necessary arrangements for separate subsistence must be made by the company, if necessary, assisted by the battalion commander.

Company headquarters assists the several detached platoons by furnishing such reserve personnel and matériel as may be practicable.

The limited quota of company headquarters will necessarily restrict the number of reserve personnel which at any time can be spared for detachment therefrom.

Some reserve personnel, however, can and should be supplied by it, if called upon. Moreover, if all the working units are not detached at the same time, provision can be made to temporarily re-enforce active units from those inactive. As the platoon and the several sections therein are made large enough to furnish their own reserves, depletion beyond the safety limit should be discovered in ample time to requisition and secure the needed reserve personnel from the nearest point at which they are readily obtainable. Furthermore, the temporary presence of one or more of the specially skilled members of the headquarters staff, such as the horseshoer or saddler, will not infrequently be of incalculable benefit if promptly supplied to detached units when needed. Close touch should, therefore, be had at all times with the working units looking to the supply of this character of aid if the same should be required.

A reasonable amount of reserve matériel is carried upon the company instrument wagon. This matériel includes not only a reserve supply of all matériel used by the outpost platoon, but in addition, extra tools and certain special articles, the need for which, while infrequent, is at times imperative. The need for any of this matériel should be readily and quickly apparent at company headquarters through unfailing channels of contact with its working units, and no delay should be permitted in proper supply.

The technical operation of the working units is described under the platoon. The general function of the company is the support, maintenance, and, when necessary, the co-ordination of the work of these units when employed in the service of information.

THE FIELD BATTALION

Organization of the Battalion

278. The headquarters of a field battalion consists of the following:

One battalion commander (major).

One battalion adjutant and supply officer (first lieutenant).

One sergeant major, assistant to the adjutant (sergeant, first class).

One clerk (sergeant).

One color sergeant (sergeant).

Four orderlies (privates, first class).

One driver, for shop wagon (private, first class).

The supply detachment of a field battalion consists of the following:

One battalion supply sergeant (sergeant, first class).

Five drivers, for field train wagons (privates, first class).

POSTS OF INDIVIDUALS

279. At ceremonies the major is 30 yards in front of his battalion, opposite the center. On other occasions he places himself where he can most readily observe and direct his battalion. The commissioned staff is posted 2 yards in rear of the major; the noncommissioned staff and the orderlies, similarly formed, 2 yards in rear of the commissioned staff. The supply detachment is with the field train.

FORMATION OF THE BATTALION

280. The normal formations of the battalion are the **order in line** and the **order in section column.**

281. In the **order in line** the companies of the battalion, each in the order in line are formed abreast of each other in the order, from right to left, outpost company, wire company, and radio company. The interval between companies is 30 yards. If the battalion be formed with closed intervals, the interval between companies is 15 yards.

282. In the **order in section column** the companies of the battalion, each in the order in section column, follow each other in the order given in the preceding paragraph. The distances between companies are such as would result from the companies moving simultaneously by the flank from the **order in line.**

TO FORM THE BATTALION

283. To form the battalion in line, the adjutant causes adjutant's call to be sounded; the adjutant and sergeant major proceed to the selected ground and post themselves facing each other a few yards outside the points where the right and left of the right company of the battalion are to rest.

The companies approach the line from the rear and are posted in succession from right to left by their captains, so that the front rank will be on the line established by the adjutant and sergeant major. After halting his company, each captain aligns it toward the right.

When the company that arrives first on the line has been established, the sergeant major joins the battalion noncommissioned staff.

The line being formed, the major and his staff take post, facing the center of the battalion. The adjutant then moves at a trot or gallop by the shortest line to a point midway between the major and the center of the battalion, halts, facing the major, salutes and reports: **Sir, the battalion is formed.**

The major returns the salute.

The adjutant then takes his post with the battalion staff.

284. The battalion may also be assembled in any other convenient formation. In such cases, as soon as the last company has taken its place the adjutant joins the major and reports to him that the battalion is formed.

285. Officers draw and return saber with the major. At ceremonies, sabers are habitually drawn; at other times, they are drawn or kept in the scabbard at the discretion of the major.

TO ALIGN THE BATTALION

286. To effect a general alignment the major causes one of the flank companies to be established in the desired position, and commands: **1. Right (left), 2. DRESS.**

Each captain in turn, commencing with the company first posted, aligns his company toward the flank designated, and commands **front** when the alignment is complete.

The captain of the company first established superintends the alignment from the flank of his company nearest the point of rest. The captains of the other companies superintend the alignment from the flank of their companies farthest from the point of rest.

TO DISMISS THE BATTALION

287. The major commands: Dismiss your companies, or sends appropriate instructions to the captains. Each captain marches his company to its park and dismisses it.

MANEUVERS OF THE BATTALION

288. Formal maneuvers of the battalion are of limited application.

For passing from one formation to another, and for the simple evolutions requisite for ceremonies and the ordinary incidents of service, the battalion is maneuvered in accordance with the principles heretofore prescribed for the separate companies and by similar commands. In the case of simultaneous movements, such as marching to the front, to the flank, to the rear, or obliquely, the command or signal of execution of the major is immediately repeated by the captains and simultaneously executed by the companies. In the case of successive movements, the captains maneuver their companies so as to cause them to assume their proper positions by the shortest route and in conformity with the principles of the rules of gaits.

289. The commands of the major are transmitted by orderlies or given by arm, saber, or trumpet signals, or by word of mouth. The captains habitually repeat the commands of the major, or give such commands as may be necessary to insure the execution of the movement. Their commands are given by arm or saber signal, or by word of mouth. The whistle, and not the trumpet, is habitually used to attract attention to the signals of the captain during the evolutions of the battalion.

EMPLOYMENT OF THE BATTALION

290. The field battalion is a technical and an administrative unit. The headquarters and supply detachment concerns itself principally with matters of administration and supply.

291. The tactical function of the battalion is limited to the sum of the functions of the three separate companies in the battalion, as the companies have, in general, separate spheres of action.

292. The major will, however, direct and supervise the training and instruction of the companies in camp and garrison and, will, in the field, direct, supervise, and co-ordinate the work of the companies in the battalion in a manner calculated to furnish the most efficient service of information possible for the division. Under his direction members of each company will be instructed and trained in the duties pertaining to individuals in the other companies of the battalion.

293. It is probable that the major commanding a field battalion will often serve on the staff of the division commander as division signal officer. When such a situation obtains, he will consider himself the technical adviser of the division commander and of the chief of staff in all matters pertaining to signal corps work. He should enjoy the complete confidence of his commander. He will make timely recommendations as to the employment of the units in the battalion and will take appropriate steps to acquaint the above-named officers with the technical and tactical possibilities and limitations of field signal troops as situations arise. When a number of the division staff, he keeps himself informed as to the state of supply of articles of signal corps equipment in the hands of line troops and arranges for the replacement of these articles from the supply depots in rear.

TELEGRAPH SIGNAL TROOPS

Function and Employment

Lines of information may be either strategical or tactical.

Strategical lines of information extend from the seat of government to the several divisional headquarters in the field. All lines of information connecting the division headquarters with any of its component parts are tactical. Tactical lines of information are handled by field signal troops; strategical lines by base line or telegraph signal troops, according to circumstances.

Strategical lines of information are divided into two zones.

The base line or inner strategical zone comprises that portion of the strategical lines of information included between the seat of government and advance base or bases of armies in the field. Information duties pertaining to this zone are handled by base line signal troops.

The telegraph or outer strategical zone embraces that portion of the strategical lines of information included between the advance base or bases of armies in the field and the several divisional headquarters. Information duties pertaining to this zone are handled by telegraph signal troops. In addition, these troops are designed to furnish certain administrative lines of information in the shape of camp telephone systems for the larger units in the field whenever circumstances render the same necessary or advisable.

The duties of telegraph signal troops, although only equipped to install and operate semi-permanent telegraph and telephone lines, include the handling of every class of communication within their prescribed zone. Whenever the installation or operation of radio or cable systems or any other form of communication becomes necessary within the telegraph zone necessary additions to the personnel and matériel of the troops will be made to accomplish the purpose in hand.

On advance the telegraph zone, or a portion of it, will generally become merged into the base line zone. In this case an adjustment of the duties of base line and telegraph signal troops will be necessary. Provision should, if practicable, be made for this beforehand, and the working of these classes of troops, each within its proper zone, now included between new points on the terrain, should be established as rapidly and with as little confusion as possible.

On retirement reverse conditions to advance will generally obtain. A portion of the base line zone (a new telegraph zone) will be surrendered by the base line to the telegraph troops for operation and maintenance.

Cases will, no doubt, frequently arise where base line and telegraph troops will be compelled to operate, for a time at least, in a zone to which they are not normally assigned. As soon as practicable, however, changes should be effected to circumscribe their activities within the properly defined boundaries.

Telegraph signal troops, although construction units, are designed to be mobile. For this reason only a limited amount of construction and operation material is supplied as their equipment. Their capability for construction work is, however, unlimited, provided the requisite material be furnished. Installations of this kind can usually be anticipated and preparation should be made beforehand, whenever practicable, to supply whatever is needed at points convenient for use.

Telegraph signal troops are organized into battalions for proper administration, supervision, and control. One or more telegraph battalions is assigned as a component part of army corps troops. These are directly under the corps commander, who assigns them such duties within their province as necessity demands.

THE TELEGRAPH COMPANY

General Provisions

294. The telegraph company is the principal signal administrative unit in the telegraph zone.

Its employment will be in accordance with the needs of the situation and may be either the working of sections or platoons or the entire company at isolated or on contiguous sections of line as may be necessary. Whenever practicable, a dispersed company should be reassembled, if only for a short period of time, as in this way company administration is facilitated and organization as a whole kept intact.

ORGANIZATION

295. The telegraph company is organized into a company headquarters and two platoons of two sections each. Two of the four sections of the company are telegraph, and two telephone sections. A platoon, commanded by a first lieutenant, may consist of two telegraph or two telephone sections, or it may consist of one telegraph and one telephone section as circumstances may warrant.

For the purpose of enhancing their mobility, telegraph companies are equipped with motor transportation. The sections, both telegraph and telephone, are organized as nearly alike as possible as to transportation, matériel, and personnel, so as to allow an interchange of duties if desirable.

296. The organization, in detail, is as follows:

1 captain.
2 first lieutenants.
2 master signal electricians.
1 first sergeant (sergeant, first class).
1 supply sergeant (sergeant).
1 mess sergeant (sergeant).
5 mechanics (1 sergeant, 4 corporals).
1 clerk (corporal).
1 horseshoer (as blacksmith).
2 cooks.
2 buglers (as messengers, privates, first class).
2 motorcycle drivers (for platoon chiefs, privates, first class).
1 driver (for captain's inspection car, privates, first class).
1 driver, truck (private, first class).
2 telegraph sections (22 men each).
2 telephone sections (18 men each.

DUTIES OF INDIVIDUALS

297. In the telegraph company the duties of the captain, lieutenants, master signal electricians, first sergeant, supply sergeant, mess sergeant, chiefs of section, operators, and messengers assimilate those prescribed for like grades in field companies as far as applicable.

The chief mechanic is assigned to general charge of motor transportation and is responsible to the captain for its efficient working at all times. In addition, he supervises repair work to all other material belonging to the company. In these duties he is assisted by the other mechanics.

The horseshoer is assigned to duty under the chief mechanic.

The drivers are responsible for the efficient working order of motor vehicles under their charge and for their care and adjustment. They are also responsible for the proper handling of vehicles on the road.

The Telegraph Section

COMPOSITION

298. The section, whether telegraph or telephone, is the working unit. All duties performed by platoons, companies, or battalions of telegraph signal troops consist of but the combined work of a number of sections. Units larger than the section are necessary only for efficient administration, supervision, and control.

The telegraph section consists of 22 men.

Its organization, in detail, is as follows:

1 chief of section (sergeant, first class).
1 chief operator (sergeant, first class).

1 chief lineman (sergeant).
6 operators (1 sergeant, 2 corporals, and 3 privates, first class).
8 linemen (1 corporal, 6 privates, first class, 1 private).
3 drivers (privates, first class).
2 messengers (privates).
Total, 22.

ORGANIZATION AND EQUIPMENT

299. The section is organized and equipped to install, operate, and maintain 20 miles of semi-permanent telegraph line. Under ordinary conditions this installation should take place within one working day.

The transportation furnished permits from four to six men to ride upon motorcycles or side cars. The remaining men, with all personal baggage, and the prescribed section technical will be carried upon the section trucks.

After all material carried by the section has been installed, it may be called upon to build other sections of line or it may be called upon to operate the section or sections already in position. In the former case, additional material for daily construction work must be supplied by other transportation. In case of the operation and maintenance of a section of line, the personnel of the section will be distributed over the line in such a manner as will best facilitate this work. The section is expected to be a self-sustaining unit under any and all conditions.

DUTIES OF INDIVIDUALS

300. The chief of section exercises general supervision of his section at all times.

The chief operator exercises the function indicated by his title when the section is operating a section of line. At other times he performs such special duties as may be assigned to him by the chief of section.

The chief lineman supervises construction or maintenance work according as the section is installing or operating line.

The operators (two for each station) operate their stations when installed. During installation they perform such line work as may be assigned to them by the chief of section.

The linemen install or maintain the line as may be necessary under the direction of the chief lineman.

The drivers operate their trucks as may be necessary in installation and maintenance.

The messengers are assigned to duty transporting men or material in the motorcycles or side cars as they may be directed by the chief of section during both installation and maintenance.

NUMERICAL DESIGNATION OF MEMBERS

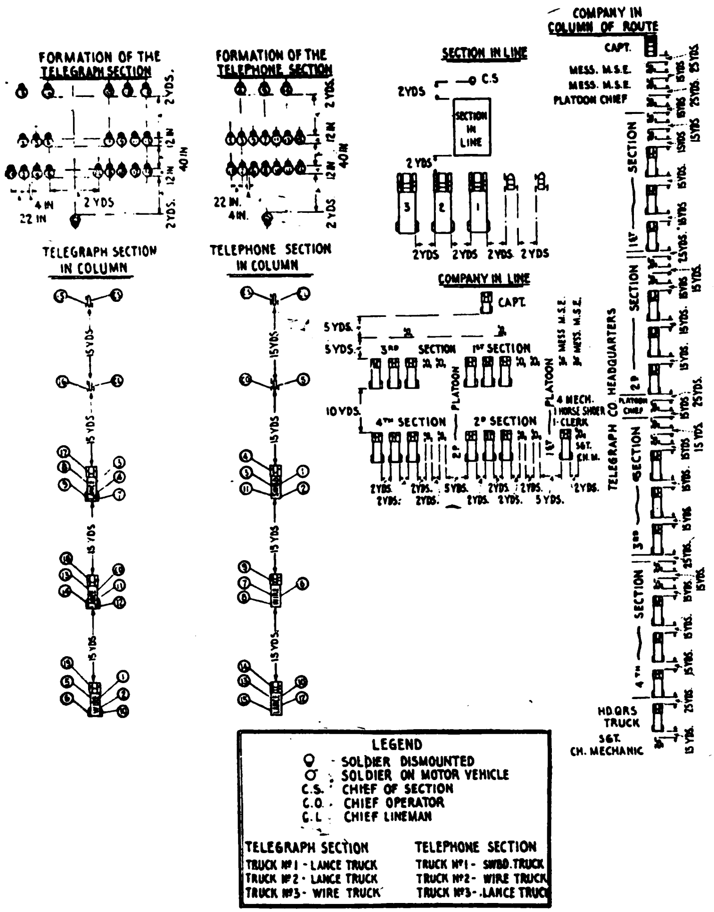
301. The men of the telegraph section, except the chief of section, chief operator, and chief lineman are numbered from 1 to 19 for the purpose of prescribing their positions and duties in various drills and formations.

Specifically, they are numbered as follows:

1. Sergeant, operator. 2. Corporal, operator. 3. Corporal, operator. 4. Private, first class, operator. 5. Private, first class, operator. 6. Private, first class, operator.	Operating squad.
7. Corporal, lineman. 8. Private, first class lineman. 9. Private, first class, lineman. 10. Private, first class, lineman. 11. Private, first class, lineman. 12. Private, first class, lineman. 13. Private, first class, lineman. 14. Private, lineman.	Line squad.
15. Private, messenger. 16. Private, messenger.	Messenger squad.
17. Private, first class, driver. 18. Private, first class, driver. 19. Private, first class, driver.	Driving squad.

C. S.—Chief of section.
C. O.—Chief operator.
C. L.—Chief lineman.

302. The above division into squads has for its purpose only the general grouping of individuals commonly expected to perform similar duties. In forming the section the individuals



THE TELEGRAPH COMPANY AND ITS SUBDIVISIONS are so arranged as to preserve the integrity of the squads. In the performance of technical work the men are assigned to duty without reference to original grouping whenever rapidity and efficiency can be gained thereby.

FORMATION OF THE SECTION

303. The section is formed in line in double rank with the odd numbers in the rear rank and even numbers in the front rank. The chief of section is 2 yards in front and center of his section, the messengers and drivers in the line of the file closers.

POSTS OF INDIVIDUALS

304. Positions of all individuals are as shown in accompanying drawing.

DISTRIBUTION OF MATERIEL FOR TRANSPORT

305. The assignment of matériel to the several carriages for transport is such that each carriage, with its assigned personnel, will have approximately its maximum load. The distribution of personnel and matériel is also planned so as to have these readily available for construction work.

Specifically, the section carriages are loaded as follows:

Truck No. 1: One half the lance poles of the section (300), with insulators for same.

Truck No. 2: Same as truck No. 1, except add digging bars and tamping bars.

Truck No. 3: All wire, tools, station equipment, and other miscellaneous matériel belonging to the section.

The above distribution of matériel is considered normal. It can and should be varied if good reasons for this procedure are apparent.

TO FORM THE SECTION

306. The section falls in as a dismounted double rank at the order of its chief, who posts himself facing it 2 yards from where the center is to rest. The chief of section then calls the roll or otherwise verifies the personnel, and directs it to **call off.** He then directs the file closers to fall out and marches the remainder of the section to the storerooms, where the trucks are brought up by their drivers. He then gives the command: **PACK OUT.** The personnel assigned to each truck then proceeds to load the truck, each with its proper technical matériel, under supervision of the ranking noncommissioned officer present with it.

Ordinarily the corporal lineman (No. 7) supervises the loading of truck No. 1; the chief operator, of truck No. 2; and the sergeant operator (No. 1), of truck No. 3.

The trucks being loaded, all carriages are again formed in park, the personnel forming in line 2 yards in front of the center of the carriages.

The chief of section then makes a minute inspection of the equipment, carriages, and personnel and gives such orders or directions as may be necessary.

SECTION MANEUVER

To Mount and Dismount

307. The section being dismounted in line, the carriages in any formation, the chief of section commands: **MOUNT UP.**

At this command each driver and messenger mounts his carriage and, unless otherwise directed, starts his motor.

The personnel assigned to the various carriages for transport proceed to them by the shortest practicable route and mount.

308. Being in line at a halt to dismount the section, the chief of section dismounts from his carriage and commands: **DISMOUNT.**

At this command the drivers stop their motors, if running, and all personnel dismount and form in line 2 yards in front of the center carriage.

The section at a halt in any formation may be dismounted according to the same principles. In this case the chief of section designates the position where the section dismounted is to form in line.

To Leave the Park

309. The chief of section signals **forward** and moves out in his own carriage. The remaining carriages follow in the prescribed order of route.

To Conduct the Section En Route

310. The section marches in the order prescribed.

All drivers observe strictly the rules of the road. Except in emergency, the gait should not exceed 12 miles per hour.

The prescribed distance of 15 yards between carriages is the minimum safe distance at which the carriages should follow each other. Road conditions will frequently make a greater distance necessary or desirable; the section should remain closed to 15 yards as far as the prudent conduct of travel permits.

If the section is to travel any distance alone, one of the motorcycles, preferably No. 2, should march in rear of the column.

To Halt

311. The chief of section signals **HALT** and stops his carriage. The other carriages halt at 15 yards from the one preceding. The carriages may be directed to close to shorter distances if desired.

To Dismiss the Section

312. The section being in park and the personnel being mounted on the carriages, the chief of section dismounts and commands: **PACK IN.** At this command the trucks proceed to the storerooms and the matériel is unloaded and disposed of under supervision of senior noncommissioned officer on each truck, generally supervised by the chief of section. The drivers then return their trucks to the park. The chief of section marches the section (less driving and messenger squads) to the parade ground and dismisses it. The chief lineman inspects all carriages and thereafter dismisses the drivers and messengers.

TECHNICAL DRILL

General Provisions

313. The lance pole telegraph line is classed as a semi-permanent line. It should, however, be erected as carefully and substantially as practicable, with a view to the elimination of line trouble as well as on account of the fact that it can never be foretold just how long the line will have to be operated before being superseded by permanent construction

314. The technical drill, while minutely described by the exact assignment of duties to the various members of the section, is necessarily but a general guide. The situation will not only vary greatly with establishment of every new section line, but construction will also differ considerably in various parts of any line. The section or other commander should not hesitate to vary from the drill if it appears advisable.

315. Thoroughly substantial construction, completed as rapidly as possible, should be the object sought in the assignment of men, tools, and matériel, and any assignment, as applied to the situation in hand, which best accomplishes this object should be the one employed.

To Prepare to Open Station

316. On arrival at the point where construction is to begin the chief of section halts the section, dismounts, and directs the carriages to close to 5 yards distance. He then commands: **PREPARE TO OPEN STATION.**

At this command all dismount except the drivers and messengers, and each member provides himself with the proper tools or equipment incident to his employment in line construction. The section is then formed in line by the chief of section, who verifies the men and the individual equipment of each.

To Open Station

317. The chief of section commands: **OPEN STATION.**

At this command the first station is installed and construction work is begun, the line being erected generally as follows: The insulators are placed upon the poles, which are dropped at points convenient for erecting. Pigtails are placed on all poles except those intended to be guyed. In straight stretches every fifth pole is guyed usually both ways against the line. Poles to be guyed are equipped with pony insulators. Holes to receive the poles are dug at proper points. The wire which has been laid along the route is inserted in the tail of the pigtail and the poles equipped with these insulators are then erected and thoroughly tamped.

The slack is pulled up at every pole equipped with a pony insulator, the tie being made on this pole while on the ground near the hole dug to receive it. This pole is then erected, tamped, and guyed.

318. The duties of each member of the section incident to constructing the line are as follows:

Chief of section: General supervision of construction, including necessary reconnaissance. Utilizes to best advantage men not specifically engaged and in general takes such steps as may be necessary to accomplish as rapid construction as is consistent with stability.

Chief operator: Sees that station property is unloaded at various stations and that same is properly installed. Assigns operators to stations where necessary. Inspects line after erection of same is complete. Replaces broken poles or insulators where necessary, sees that all guys are taut and in general removes any apparent trouble from the line. Covers the line about one-half mile behind tail of construction party in truck No. 2.

Chief lineman: With No. 8 constitutes first erecting squad. Pulls up slack, ties and guy poles at which this procedure is necessary.

No. 1: Remains at station 1 to care for station property and operate station if necessary.

No. 2: Operator station 2. Rides from station 1 to station 2 on truck No. 3.

No. 3: Rides on truck No. 1 and superintends unloading of poles. Sees that poles are properly spaced and provided with insulators of the proper kind. Sees that double or triple poles are unloaded at road crossings and other proper points. Also sees that guys are dropped in sufficient number at points where same will be needed.

No. 4: Accompanies truck No. 1. Fits insulators on poles and unloads same as per directions of No. 3.

No. 5: Rides on truck No. 3 and pays out wire from reel. Attends splices.

No. 6: Assists No. 5 on truck No. 3. Takes first trick as operator at station 3.

No. 7: Assistant chief lineman: With No. 9 constitutes second erecting squad. Pulls up slack, ties and guys poles where this procedure is necessary.

No 8: Duty with first erecting squad.

No. 9: Duty with second erecting squad.

No. 10: Checks tension from a point midway between ties.

Nos. 11, 12, 13, and 14, Hole diggers: Dig holes and erect and tamp all poles not tied in.

Nos. 15 and 16: Messengers: Relay erecting squads, hole diggers, and No. 10 forward as necessary.

Nos. 17, 18, and 19: Operate the trucks.

To Prepare to Close Station

319. Before recovering the line the section transportation and a large portion of the personnel should be assembled at the point where recovery is to begin. This point should normally be at one end of the section.

Preparatory to recovering the line the chief of section commands: **PREPARE TO CLOSE STATION.**

At this command the operator on duty at the station sends GB to all stations and gets acknowledgment of same. All members of the section procure necessary equipment to be used in recovering the line and form for inspection as in **prepare to open station.**

To Close Station

320. To commence recovery of the line the chief of section commands: **CLOSE STATION.**

The line is recovered generally as follows: The poles are taken down, insulators and guys removed and loaded on the designated truck. The wire is reeled up in approximately ½-mile coils and loaded on truck No. 3.

321. The duties of each member of the section incident to the recovery of the line are as follows:

Chief of section: Same as in constructing line.

Chief operator: Sees that station property is loaded on at first and succeeding stations.

Chief lineman: Assisted by No. 8, removes every alternate guyed pole.

No. 1: Operator at first station. No duties except to load and pack station property on truck No. 3 at proper time.

No. 2: Operator at second station. Duties same as No. 1.

Nos. 3 and 4: Assisted by No. 11, load poles, guys, and insulators on truck No. 1.

Nos. 5 and 6: Assisted by No. 10, reel up wire on truck No. 3. Bind up in ½-mile coils and load on truck.

No. 7: Assisted by No. 9, removes every alternate guyed pole.

No. 8: Assists chief lineman.

No. 9: Assists No. 7.

No. 10: Assists Nos. 5 and 6.

No. 11: Assists Nos. 3 and 4.

Nos. 12, 13, and 14: Same as duties Nos. 3, 4, and 11, but with truck No. 2.

Nos. 15 and 16: Relay the squads removing guyed poles.

Nos. 17, 18, and 19: Operate trucks incident to recovery of line.

322. The technical drill of the section is not expected necessarily to cover the normal or usual case in either construction or recovery. It is prescribed as a drill wholly for the purpose of training the section members in their various duties and for the conduct of the work by squads in an orderly and methodical manner.

In construction work where the line is erected on supports other than lance poles, the chief of section makes such changes in assignments of duty of the various section members as will best facilitate the work in hand.

The drill for closing station assumes that the entire section (less 2 operators) is assembled at one end of the line. If such is not the case (and this condition is usually to be expected), the chief of section gives suitable directions and makes such assignments as are necessary to recover the line prior to assembly, if practicable.

To Work with Reduced Numbers

323. The erection of a semi-permanent telegraph line may be readily effected by a much smaller team than the regular telegraph section if time of construction is not a dominant factor. In fact, the telegraph section is designed as the maximum crew which can be profitably engaged in work at a single point and at the same time operate each station as soon as installed.

The following is a guide for the employment of individuals when the section is reduced below the quota authorized in the organization table:

CONSTRUCTION

324. *With 21 men.*—Omit No. 2. Second station not to be cut in until line is completed.

With 20 men.—Omit Nos. 1 and 2. No station to be established until line is completed. Directions for use of 21 or 20 men assumes operation of stations during the construction period is not imperative. If, however, the operation of one or more stations are necessary, variations will have to be made in the assignment of duties of section members to permit provision for the necessary number of operators.

With 19 men.—Omit No. 6. No. 5 operates wire truck alone.

With 18 men.—Omit No. 11. This leaves one digging bar not in use for the time being. It is carried on the wire truck and used by either erecting squad to dig holes for poles tied in if diggers get behind in their work.

With 17 men.—Omit No. 4. No. 3 handles the poles alone.

With 16 men.—Omit No. 15. Chief of section takes motorcycle and performs this duty as necessary.

With 15 men.—Omit No. 10. Chief of section checks tension in addition to other duties.

With 14 men.—Omit No. 12. This leaves but two hole diggers and two unused bars. One bar is taken by each erecting squad who digs all holes for poles tied in.

With 13 men.—Second erecting squad disbanded. Omit No. 9. Chief lineman, Nos. 7 and 8 constitute only erecting squad and dig holes for tied-in poles.

With 12 men.—Omit No. 8.

With 11 men.—Omit No. 7. Chief operator takes his place.

With 10 men.—Omit chief lineman. Chief of section acts as chief lineman. No. 16 checks tension in addition to his other duties.

With 9 men.—Omit No. 13.

With 8 men.—Omit No. 3 No. 17 frames and drops poles in addition to driving truck.

With 7 men.—Omit No. 16. Chief operator takes motorcycle and performs necessary duty therewith.

With 6 to 3 men.—No specific duties can be prescribed. With such a small number of men the various operations in connection with construction must be performed in rotation by the same men. It is assumed that three men is the smallest number who can erect the line.

RECOVERY

325. *With 21 men.*—No change. No. 1 has no duties.

With 20 men.—No change. No. 2 has no duties.

With 19 men.—Omit No. 3.

With 18 men.—Omit No. 12.

With 17 men.—Omit No. 10.

With 16 men.—Omit No. 8. No. 15 performs No. 8's duties in addition to his own.

With 15 men.—Omit No. 15. Chief operator takes over duties and motorcycle.

With 14 men.—Omit No. 9. Chief lineman, chief operator, and No. 7 take down guyed poles.

With 13 men.—Omit No. 7.

With 12 men.—Omit No. 11.

With 11 men.—Omit No. 13.

With 10 men.—Omit No. 4. No. 17 loads truck No. 1.

With 9 men.—Omit No. 14. No. 18 loads truck No. 2.

With 8 men.—Omit chief lineman. Chief of seciton performs his duties.

With 7 men.—Omit No. 16. Chief of section takes motorcycle.

With 6 to 3 men.—No specific duties prescribed. Operations of recovery must be performed more or less in rotation.

LINE CONSTRUCTION

In the construction of semi-permanent telegraph lines the following directions should be carefully observed.

Reconnaissance

If a preliminary reconnaissance of the route to be followed can be made by the chief of section or chief lineman, much will be gained in the matter of rapidity and stability of installation. This will be usually impracticable, however, as the immediate commencement of work will be necessary at the arrival of the section on the ground. Reconnaissance should be had along the route coincident with, or slightly preceding the construction proper. This can usually be done by the chief of section, who should keep the working parties in rear constantly informed of any unusual conditions affecting line construction which obtain.

Use of Lance Poles

These should never be used if any firmer line supports are available. The section carries only 25 iron and no oak brackets. An ample number of the latter fitted with insulators should be especially supplied to any section about to erect a line where it is known good use can be made of them. Attempt should be made to secure a sufficient number of these locally, and every effort possible made to hang the line on the strongest supports found along the route.

To Take up the Slack

Slack is pulled up wherever a pole is tied in. To do this properly the pole to be tied should be laid upon the ground about 1 foot short of the hole. The slack is then pulled up from the last tied pole by one man 4 or 5 yards forward of the pole about to be tied. The tension is checked by a man standing for the purpose about midway between the two ties. When correct a signal is made to this effect and a round turn is made with the line about the insulator before attaching the tie wire. If this process is properly carried out the tie pole should be exactly erect and with proper tension on the line between the ties.

Guying and Guy Stakes

In straight stretches every fifth pole is usually guyed against the line. A guyed pole infers that it is also tied in. If the line is liable to remain up sometime or stormy weather is anticipated, much greater line strength may be obtained by guying four ways on straights. All corners should be guyed and care should be taken to see that the guy is securely fastened both to the pole and the stake.

No special guy stakes are furnished. Every possible means to fasten guys to stable supports along the line should be utilized. Failing in this, guy stakes should be improvised from material found along the route. In some cases it may be necessary to cut up lance poles to make guy stakes. This procedure should be limited to broken poles as far as possible, the same being preserved for this purpose.

To Cut in Stations

This is always done in series, a convenient way being to use a strain insulator or porcelain knob as a circuit breaker. The station is then connected by cutting to ground or looping, depending on whether or not the instrument is an end or an intermediate station.

Digging Methods

To start the diggers promptly and to provide a method for readily getting them out of the way of the construction proper the following is suggested. No. 11 starts digging the first hole, No. 12 goes to location of second hole and after being lined in by the chief lineman digs that hole. Nos. 13 and 14 are carried forward by motorcycle to fourth and sixth holes, respectively. Each hole digger then lines in on the general line by back sight and digs holes. Every hole digger is relayed forward after digging two holes. Generally two diggers are ready at the same time to be carried forward.

OPERATION AND MAINTENANCE

The section is furnished with sufficient personnel to operate three stations on the section line if the same is desired. On account of limited transportation, only a sufficient supply of stationery and office material is carried to permit the operation of the stations for a very short time. If the operation of the stations for more than two or three days can be anticipated, timely requisition should be made for the necessary telegraph office material to properly equip the stations. The continued use of message books and field message envelopes is not satisfactory on semi-permanent lines. If the stations are expected to operate any great length of time a typewriter should be furnished to each

If the line is to be operated for any extended period the personnel and transportation should be distributed amongst the various stations. No precise rule can be laid down governing this distribution, as it will vary in different cases, but it should in general accord with the following principles.

Sufficient personnel should be attached to each station to permit the greatest ease of operation and maintenance. The transportation should be distributed so that at least one motor vehicle should be at each station, for the purpose of covering the line when necessary. To insure proper supervision, the chief of section, chief operator, and chief lineman should each be at separate stations. The quota of the telegraph section is based upon economy and rapidity in construction work; the section line can be efficiently operated and maintained by a far less number of men.

Lance line in general is hard to maintain. In some cases initial rugged construction will partially obviate this. The presence of motor transportation makes the covering of the line a rapid and an easy matter. Under these circumstances the entire line should be covered daily, weather permitting, and such minute inspection made to locate defects as will in great measure prevent the occurrence of trouble. When trouble does occur immediate action, irrespective of time or weather, should be had to remove it.

The Telephone Section

FUNCTION

326. The primary function of the telephone section is the erection of divisional telephone systems at points where the permanence of the camp makes this procedure necessary or desirable. Furthermore, the telephone section is designed to assist or substitute for telegraph sections in the construction of semi-permanent telegraph lines, if conditions render the performance of such duty advisable.

COMPOSITION

327. The telephone section consists of 18 men. In detail it is as follows:

1 chief of section, sergeant, first class.
1 chief operator, sergeant.
1 chief lineman, sergeant.
3 switchboard operators, corporals.
7 linemen—6 privates, first class, 1 private.
3 drivers, privates, first class.
2 messengers, privates.

ORGANIZATION AND EQUIPMENT

328. The section organized and equipped to install, operate, maintain and recover one divisional semi-permanent telephone system. The installation includes 17 miles of metallic circuit (twisted pair) line, one switchboard, and 20 camp telephones. The board is wired to receive two common battery trunks for long-distance work. No other special additions or arrangements are necessary for this purpose. The installation will ordinarily consume the greater part of two working days.

329. The transportation is identical with that of the telegraph section, and the matériel has many articles in common. The personnel is transported as in the telegraph section.

330. Depending on conditions, the personnel of the section may be assigned to various duties after its matériel is installed. It may remain intact at the station where its equipment is installed, operating and maintaining the system and being in constant readiness to recover the latter and transport it to another theater of operations. It may on completion of the installation be called upon to proceed to other work, leaving the erected system intact and sufficient crew to properly operate and maintain it. As with the telegraph section, the section is expected to be a salf-sustaining unit under all conditions.

DUTIES OF INDIVIDUALS

331. The chief of section exercises general supervision over the work of his section.

The chief operator during installation supervises the setting up of the switchboard and the connection of the various telephones. During operation he supervises the general working of the system especially with reference to the switchboard. If the system is immobilized and but one man is left with it, the chief operator usually is assigned to this duty.

The chief lineman in general supervises the construction, maintenance, or recovery of the line. In installation he is especially charged with the proper location of the several lines.

The switchboard operators take active part in installation and recovery of lines performing such duties as may be specifically assigned; during operation their duties pertain to the handling of the switchboard.

The linemen install, maintain, or recover the lines under direction of the chief lineman or chief of section.

The drivers operate their trucks as may be necessary. When not needed for this purpose they perform other assigned duties.

The messengers perform the duties of linemen during the installation of the system. After this is completed they perform such messenger service as is necessary in connection with the telephone central.

NUMERICAL DESIGNATION OF MEMBERS

332. The men of the telephone section, except the chief of section chief operator, and chief lineman, are numbered from 1 to 15 for the purpose of prescribing their positions and duties in various drills and formations.

Specifically they are divided in squads and numbered as follows:

Switchboard squad:
- Chief operator, in charge.
- 1. Corporal, switchboard operator.
- 2. Private, first class, lineman.
- 3. Private, lineman.
- 4. Private, first class, driver.

First line squad:
- 5. Private, first class, lineman.
- 6. Corporal, switchboard operator, in charge.
- 7. Private, first class, lineman.
- 8. Private, messenger.

Truck squad:
- 9. Private, first class, driver.
- 10. Corporal, switchboard operator, in charge.
- 11. Private, first class, lineman.
- 14. Private, first class, driver.

Digging squad:
- Chief lineman, in charge.
- 12. Private, first class, lineman.
- 13. Private, first class, lineman.
- 15. Private, messenger.

After completion of duty in connection with the intallation of the switchboard and the erecting of the terminal pole a second line squad is formed as follows:

Second line squad:
- 1. Corporal, switchboard operator, in charge.
- 2. Private, first class, lineman.
- 3. Private, lineman.
- 4. Private, first class, driver.

The section is formed so as to preserve the integrity of the above-named squads.

FORMATION OF THE SECTION

333. The section is formed in line in double rank with the odd numbers in the rear rank and even numbers in the front rank. The chief of section is 2 yards in front of the center of his section and the drivers in the line of file closers.

POSTS OF INDIVIDUALS

334. Positions of all individuals are shown in accompanying plate.

The formation in park is identical with that of the telegraph section, the trucks being formed from right to left as follows: No. 1, switchboard; No. 2, wire; No. 3, lance.

DISTRIBUTION OF MATÉRIEL FOR TRANSPORT

335. This is assigned in accordance with the principles which govern the distribution of loads in the telegraph section.

Specifically, the section carriages are loaded as follows:

Truck No. 1: All matériel of the section except that carried on trucks 2 and 3.

Truck No. 2: All wire of section.

Truck No. 3: Three hundred lance poles and necessary insulators therefor.

TO FORM THE SECTION

336. The section is formed in a similar manner to the telegraph section.

On account of the small number of men present with the telephone section, the chief makes such assignments and details for truck loading as will best facilitate the work.

MANEUVER

337. The section is maneuvered by the same commands and in accordance with the same principles as the telegraph section.

TECHNICAL DRILL

General Provisions

338. The general provisions governing the construction of lance-pole telegraph lines apply to telephone work.

It is almost impossible to construct a thoroughly substantial twisted pair line on lance poles. The load limit of the transportation furnished does not permit the carrying of the requisite number of lance poles necessary to support the entire system. For the above reasons advantage should be taken to utilize every stable support about the camp to carry the lines. The survey for the system should be almost entirely based upon the making use of the natural and artificial features available.

339. If conditions permit, all or a portion of the line may be placed underground. The climatic conditions and character of the subsoil will determine whether or not this method will give practical results; if adopted, means for protecting the underground lines at road crossings should be provided.

340. The proper erection of the divisional camp telephone system will generally call for more ingenuity and improvised expedients than are usually necessary in the construction of the typical section telegraph line.

Preliminary Reconnaissance

341. The construction of any telephone system, permanent or temporary, involves a more or less extended reconnaissance of the site where the system is to be located. Only after such reconnaissance is made can an intelligent plan be formulated for the erection of the system.

On receipt of orders to install the system at a certain location, the chief of section and chief lineman will proceed at once, by motorcycle to the point designated to make the required reconnaissance.

342. In conducting the reconnaissance all possible assistance will be rendered by the camp commander or others on the ground, in the matter of supplying information as to the location of telephone stations and other necessary data.

343. After the reconnaissance is complete an intelligent plan for the erection of the system will be formulated, supplemented by a sketch. This should show the location of the central and all telephone stations; the routes to be followed by the various lines; the character of supports for the same with the necessary cabling, and any underground sections of the line, if such be decided upon.

344. Reconnaissance is imperative before any work is commenced. If arrangements can not be perfected to accomplish it before the arrival of the section on the ground, construction work will have to be postponed until it is complete. In the latter case it may be more or less hurried but in no case can it be omitted.

345. Whenever the chief of section leaves the section for this or any other necessary purpose, the section will be conducted en route or perform any other assigned duty under direction of the chief operator or other senior noncommissioned officer in charge.

To Prepare to Open Station

346. When the section has arrived at the camp site at which it is to install the system, the necessary reconnaissance having been made and the plans for the erection of the system formulated, it is parked at a point convenient to the location of the central. The chief of section then commands: **PREPARE TO OPEN STATION.** At this command all dismount from the carriages and each member provides himself with the proper equipment incident to his employment in the work. The section is then formed in line by the chief of section who verifies the men, the individual equipment of each and gives such instructions as are necessary regarding the character and order of construction of the various radiating lines.

To Open Station

347. At the completion of the necessary preliminary directions, the chief of section gives the command **OPEN STATION.** At this command construction work is begun, the system being erected generally as follows:

The switchboard squad unloads the switchboard truck at the proper location of central; it sets up the switchboard in the designated shelter, erects the terminal pole and connects the lines to the board as soon as available.

The digging squad digs holes to receive the poles.

The truck squad drops poles fitted with insulators at points convenient to their erection and lays the necessary wire.

The line squad or squads follow, erecting the line, pulling up slack, tieing, guying, and tamping. The specific duties of the various squads in the erection of the system are as follows:

Switchboard squad: Unloads switchboard truck, sets up switchboard and erects terminal pole. Connects all loose lines at pole on completion of erection of same. The work in connection with the board being complete, Nos. 1, 2, 3, and 4, under charge of No. 1, become a second-line squad and report to the chief of section for assignment to duty in erecting lines. After completion of the central station the chief operator installs and connects all telephones at the various places as fast as the several lines from the board to each are intact. He also connects into the board any loose line at any time found at the terminal pole.

Truck squad: Nos. 10 and 14, with truck No. 3, drop lance poles fitted with insulators at points convenient for erection; also drop guys and stakes at proper points for use. Nos. 9 and 11, with truck No. 2, lay the lines from the reel attached to the rear end of the truck.

Digging squad: Under supervision of the chief lineman digs holes to receive lances or other supports to be used in erection of the line. When all work of digging is completed the digging squad becomes a third line squad and proceeds to perform such erecting work as may be assigned to it.

Line squad: Erects poles, stretches wire, ties in, guys, and tamps.

The duties of the separate individuals of the section except as above described are not definitely specified. The members of the various squads are assigned by their chiefs to such therewith as may be necessary to facilitate the work.

To Prepare to Close Station

348. Preliminary to the recovery of the system it is assumed that sufficient notice will be given the section to allow it to break camp and properly dispose of the individual equipment of its members.

This having been done and the trucks parked at a point convenient to central, the chief of section commands: **PREPARE TO CLOSE STATION.** At this command the section forms similarly as in preparing to open station. Detailed instructions and directions are then given the section relative to the recovery of the lines.

To Close Station

349. All preliminary arrangements having been completed, to recover the system, the chief of section commands: **CLOSE STATION.**

The line is generally recovered as follows:

The switchboard and telephones are disconnected, recovered, and packed away, together with all miscellaneous material on the switchboard truck. The poles are taken down and loaded on the proper trucks. The wire is reeled up, bound in suitable coils, and loaded on the wire truck.

The specific duties of the various squads in the recovery of the system is as follows:

Switchboard squad: Chief operator and No. 2 disconnect the switchboard and prepare it for loading. Also disconnect, recover, and pack all telephones, bringing in same to switchboard station in motorcycle and side car. Nos. 1, 2 and 4 recover the allotted quota of lances and insulators (all over 300) to be carried on truck No. 1, and load same. Truck No. 1 is then brought to the central station, and the terminal pole is taken down, if to be recovered. All supplies carried by truck No. 1 are then loaded on it by the entire switchboard squad under the direction of the chief operator.

Line squad: Assisted by No. 12, removes poles and unties the line therefrom. Recovers all guys and such stakes as may be ordered.

Truck squad: No. 10, assisted by No. 13, removes insulators from poles and loads poles and insulators on truck No. 3.

No. 11, assisted by No. 15, reels up wire, ties same in proper sized coils, and then loads on truck No. 2.

If necessary to expedite the work of recovering the wire, truck No. 1, after being loaded, will reel up wire, using for this purpose the extra reel operated by members of the switchboard squad.

350. The above assignment of construction duties to the various members of the section is intended as a guide, but one which should be generally followed in erecting the lines on lances. Where other supports for the lines are used, the chief of section will make such changes in assignments of duties as the use of different material requires.

To Work With Reduced Numbers

351. The following is prescribed as a guide for constructing and recovering the divisional telephone system when for any reason the section is reduced below its normal quota.

CONSTRUCTION

352. *For 17 men.*—Omit chief operator. No. 1 acts as chief operator in addition to his other duties. Telephones are not installed until line completed unless other arrangements can be made.

For 16 men.—Omit No. 3. Nos. 1, 2, and 4 constitute switchboard squad. After completion of duties at the board become second-line squad of three men; are assisted when necessary by chief of section.

For 15 men.—Omit No. 2. Switchboard squad consists of Nos. 1 and 4. First-line squad assists in erection of terminal pole. After completion No. 1 installs telephone; No. 4 joins first-line squad. No second-line squad is formed.

For 14 men.—Omit No. 8.

For 13 men.—Omit No. 1. No. 6 acts as chief operator. First-line squad takes over duty of switchboard squad entire in addition to other duties.

For 12 men.—Omit No. 15.

For 11 men.—Omit No. 10. No. 14 puts off poles in addition to driving his truck.

For 10 men.—Omit No. 11. Trucks Nos. 2 and 3 alternate in laying wire and dropping poles as may be necessary. Nos. 9 and 14 attend each truck separately, other truck remaining idle.

For 9 men.—Omit chief lineman. Chief of section performs his duties.

For 8 men.—Omit No. 12. Switchboard and first line squad are combined, consists of Nos. 4, 5, 6, and 7. Truck squad and digging squad are combined, consists of chief of section, Nos. 9, 13, and 14. Squads perform duties alternately as may be necessary.

For 7 men.—Omit No. 13. Chief of section and No. 9 man wire truck in laying wire and No. 14 drops off poles in addition to driving truck.

For 6 men.—Omit No. 6. Chief of section performs his duties. Trucks Nos. 2 and 3 alternate in laying wire and dropping poles. Nos. 9 and 14 attend each truck separately, leaving other truck idle.

For 5 men or less.—The duties are performed in rotation by the squads as may be necessary to best facilitate the work. Four men is the minimum number which can install the system.

RECOVERY

353. *For 17 men.*—Omit No. 12.

For 16 men.—Omit No. 3.

For 15 men.—Omit No. 8. Chief lineman takes his place.

For 14 men.—Omit No. 7.

For 13 men.—Omit chief operator. Chief of section takes his place.

For 12 men.—Omit No. 2. Nos. I and 4 assist chief of section in preparing switchboard for loading before recovering poles. Chief of section recovers telephones alone.

For 11 men.—Omit No. 13.

For 10 men.—Omit No. 5.

For 9 men.—Omit No. 10. No. 9 recovers poles in addition to driving truck.

For 8 men.—Omit No. 15. No. 9 takes his place. Trucks Nos. 2 and 3 alternate in loading poles and reeling in wire.

For 7 men.—Omit No. 11. Chief of section, Nos. 1, 4, 9, and 14 perform duties of switchboard squad on completion of which the poles are loaded and wire reeled in simultaneously by two trucks assigned to these duties by chief of section.

For 6 men.—Omit No. 1.

For 5 men or less.—Duties incident to recovery are performed in rotation by the squads as is necessary to best facilitate the work. Three men are the minimum number which can recover the system.

LINE CONSTRUCTION

In the construction of the semi-permanent divisional system the following directions should be carefully observed.

Use of Lance Poles

Lance poles will only be used when no better line supports are available. Every local advantage, such as trees, tent poles, and telegraph poles should be utilized in construction work. Similarly, cut logs, poles, heavy timbers, or other suitable lumber in the vicinity of the camp should be substituted for lances wherever possible.

If lance poles are used, one pole is erected for each twisted pair carried, up to a maximum of four poles. Where more than one pole is used for this purpose, the poles will be tightly lashed with No. 14 GI wire or other material of equal strength. If two poles are used together they should be lashed in three places; once at each end and once in the middle. Clusters of three or four poles should have four lashings. In all cases the top lashing should be flush with iron pole tip.

Poles should be spaced at distances not to exceed the following: 35 yards when one or two pairs are carried; 30 yards when three to five pairs are carried; and 25 yards when five to eight pairs are carried.

Cabling

All lines will be cabled wherever practicable, as a stronger system and one less liable to damage from camp traffic is gained thereby. Eight pairs is the maximum-sized cable which should be carried on lances. Up to three pairs the lines may be cabled by three lashings of marlin or insulated wire spaced at equal distances between supports. If a line consists of more than three pairs, it should be cabled throughout with marlin.

Depth of Poles

Lances should be sunk to a depth of 14 to 20 inches depending on the size of the cluster. Fourteen inches is the minimum depth for a single lance pole.

Terminal Poles

If practicable, some form of terminal pole should be rigged up and carried with the section. Such a pole, if of sufficient size and properly guyed, can be rigidly set up flush with the ground. If no terminal pole is carried every effort should be made to secure a suitable piece of material from which to make one on arrival at the location for the erection of the system. Failing in this, five lance poles heavily lashed will answer as a terminal pole. In all cases terminal poles should be framed with brackets and insulators before erection and should be strongly guyed four ways.

Guying and Guy Stakes

On straight stretches lances should be guyed both ways, as follows: Every fifth pole carrying one or two pairs; every third pole carrying from three to five pairs; every pole carrying more than five pairs. For guying, if using No. 14 iron wire, guys should be made up to allow one strand of iron wire for each twisted pair carried on the pole. If No. 9 wire is available a single strand will suffice in all save exceptional cases. No. 9 double will take care of any case. Every corner should be guyed against the strain according to the above principles.

Guy stakes as needed should be improvised from material found in the vicinity of the camp. The utilization of every possible means along the lines to which guys can be anchored will limit the number of guy stakes necessary.

Insulators

One insulator fitted to single or double lances and two to triple or quadruple clusters should be used. As many pairs as possible should be split over the insulator before the tie is made. A tie of at least four wraps of insulated wire on each side of the insulator is made on every pole.

To Take Up Slack

Stretch the wire as tautly as possible to the pole about to be erected, which is laid on the ground about 15 inches short of the hole. The strength of two men without blocks or rope is sufficient for this purpose. Make the tie and erect the pole. The pole should then stand absolutely erect and the line have no excess slack.

OPERATION AND MAINTENANCE

The operation and maintenance of the divisional system should give little trouble if proper care is used in installation.

The switchboard operators operate the board on a 24-hour shift, if necessary, supervised by the chief operator. At least two competent linemen should be on duty continuously during the day at central to make immediate repairs to telephones or remove any apparent line trouble.

If the system is immobilized, by an order for the section to perform duty elsewhere, four men, including the chief operator, should be left to care for the system, any necessary assistance being given them in this work by details of line troops. A withdrawal of the section entire from the erected system should never be done except in grave emergency. In such a case at least one man, preferably the chief operator, should be left with the system, timely arrangements being made to secure a competent detail from other troops to substitute for the regular operation and maintenance crew.

As soon as the system is erected and is in working order, the chief of section and chief lineman make a minute and careful inspection of the whole. All apparent defects will be at once corrected and every expedient possible calculated to strengthen the lines or preclude trouble thereon will be utilized.

UNDERGROUND CONSTRUCTION

When necessary or desirable to place all or part of the system underground the following notes may be found useful.

Trenching

This can best be done with a gang of pick-and-shovel men. This method is very slow unless there is a large detail equipped with digging tools to assist the section in this work. A plow is included with each section equipment for this purpose and should be ordinarily used to turn out a furrow trench. The plow is used attached to a truck which furnishes tractive power therefor. The plow should be fastened so as to tow directly behind the middle of the truck at a distance of about 8 feet. In moist soil it will be found necessary to employ mud chains on the wheels to get sufficient traction. Unless the plow used turns a furrow 10-12 inches deep, a second plowing to deepen the trench is necessary. All loose dirt in the furrow trench should be removed by shovel men. After this the trench may be improved if desired by driving a truck with a hind wheel following therein, this making a smooth flat bottom.

Cabling

When more than one pair is trenched the wires should be cabled up to 3 pairs; ties at 10-foot intervals will be found sufficient. Above three pairs the wires should be cabled throughout.

Covering

This is not practicable with the plow. It should be carefully done with shovels and packed as tightly as possible; after which a truck should be run along the trench to complete the tamping.

Guards

Guards of timber, logs, old pipe, or any suitable material should be employed to protect the trench at all road crossings and other points of apparent danger. Due to the inferior grade of insulation the greatest care must be used in handling wires throughout construction to eliminate the possibility of short circuits and subsequent line trouble.

THE PLATOON

FUNCTION AND ORGANIZATION

354. The platoon consists of two sections. These sections may be both telegraph, both telephone, or one of each. Necessarily, therefore, the function of the platoon is so variable that no accurate description of it is possible.

A platoon is commanded by a first lieutenant, who is responsible for its efficiency while attached to the company, and who supervises its technical work when detached for duty. He is specially charged with the necessary supply of his sections wherever his platoon is detached.

FORMATIONS

355. Platoon formations are but combinations of the normally formed sections. In park the platoon may be arranged in either of two ways, as follows: Sections in line abreast of each other at 5 yards interval; sections in line one behind the other at 10 yards distance. The decision as to which formation will be taken will usually depend on the ground available. In either case the post of the platoon chief is 5 yards in front of the center of his platoon.

356. In column of route the sections follow each other in the order prescribed by the platoon chief. The post of the platoon chief is normally 25 yards in front of the leading carriage of the leading section. Otherwise he goes wherever his presence is necessary. A minimum distance of 25 yards is prescribed between sections on the road.

TO FORM THE PLATOON

357. The sections are formed by their chiefs as prescribed in paragraph **306,** the kind of park formation desired having been previously indicated by the platoon chief.

On completion of the inspection by the chief of section they report to the platoon chief from right to left, or front to rear, according to the formation; **(Such) Section, IN ORDER, SIR,** or if anything missing or out of order they so report.

MANEUVER

358. The platoon is maneuvered in accordance with principles prescribed for the section.

TECHNICAL DRILL

359. There is no technical drill prescribed for the platoon as such. The section is the largest unit which can operate technically in a single location.

METHODS OF EMPLOYMENT

360. The functions of the platoon vary so greatly that any well-defined method of employment can not be stated.

A telegraph platoon will ordinarily be assigned to semi-permanent line building the extent of which makes the employment of more than one section unit desirable. Again, it may operate for some time an extended system of a semi-permanent line. In the first case the platoon chief acts as construction superintendent, co-ordinating the work of the sections and providing for their timely supply of technical material. In the latter case he acts as superintendent of operation and maintenance with reference to the line operated by his platoon. It may happen that the sections do not construct or operate in contiguous fields. In this case he is charged with general supervision of each.

A telephone platoon necessarily performs its functions with its sections located in different theaters of operations. General and intermittent supervision of construction, operation, and supply is in this case the role of the platoon chief.

Operations carried on by mixed platoons will usually partake of a combination of telegraph and telephone section work and will, in general, be governed by the principles laid for the handling of these units.

The Company

FORMATIONS AND POSTS OF INDIVIDUALS

361. The company is formed **in line** or **in column of route.**

362. It is **in line** when the platoons, with their sections in line one behind the other, are formed abreast of each other.

363. It is **in column of route** when the platoons, each in column of sections in road formation, follow each other in such order as may be directed.

364. The company is habitually parked in line, the carriages of the captain and platoon chiefs being parked on the right of those of the headquarters messengers.

Sections 1 and 2 are telegraph sections; sections 3 and 4, telephone sections. Normally sections 1 and 2 constitute the first platoon and sections 3 and 4 the second platoon. The integral sections of the platoon may be varied by the company commander when necessary.

The drawing shows the formation of the company in line and in column of route.

The transportation assigned to company headquarters consists of 1 inspection car (company commander), 5 motorcycles with side cars (1 each platoon chief, 1 first sergeant, and 2 messengers), and 1 headquarters truck.

The personnel of company headquarters (less drivers of carriages of captain and platoon chiefs) are transported as follows: Motorcycle No. 1, first sergeant and sergeant mechanic; motorcycles Nos. 2 and 3, messengers and master signal electricians; company headquarters truck, mechanics, horseshoer, and clerk. The supply and mess sergeants and the cooks are carried on the field transportation.

TO FORM THE COMPANY

365. The company is formed by the first sergeant, the sections falling in in order of their numbers from right to left, as prescribed in forming the company dismounted, after which he commands: **By section, FALL OUT.** The procedure outlined in paragraphs **306** and **333** is followed by the sections.

The first sergeant forms the company in line and takes his post.

Each platoon chief, having received the report of his section chiefs, makes a general inspection of his platoon and commands: **REST.**

Upon the approach of the captain, the platoon chiefs call their platoons to attention, and as soon as the captain takes his place in front, report in succession from right to left: **(SUCH) PLATOONS IN ORDER, SIR;** or if anything is missing or out of order they so report. As soon as the platoon chiefs have reported to the captain, the first sergeant reports to the captain as prescribed in forming the company dismounted.

The enlisted personnel of company headquarters forms when the first sergeant takes his post as follows: Master signal electricians and messengers dismounted in front of their respective carriages and on line with front dismounted rank of foremost sections; personnel of headquarters truck, first sergeant, and sergeant mechanic dismounted in double rank on line with dismounted ranks of rearmost sections, first sergeant on the right.

On the approach of the captain the platoon chiefs and their drivers post themselves dismounted facing to front beside their respective carriages; platoon chiefs on the right, drivers on the left. The captain dismounts to receive the report of the platoon chiefs.

TO DISMISS THE COMPANY

366. The company being in line and the personnel being mounted on the carriages the captain commands: **DISMISS THE COMPANY.** The platoon chiefs and master signal electricians fall out, their carriages being parked in proper place by the drivers. The first sergeant takes charge of the company and commands: **By section, FALL OUT.** The sections are dismissed as prescribed in paragraph **312.** The personnel of the headquarters truck under charge of chief mechanic sees to the proper disposal of the headquarters property and thereafter is dismissed by the latter.

MANEUVER

367. The company is maneuvered in accordance with the principles prescribed for the section and platoon.

En route the captain may direct one or both of the platoon chiefs to march in rear of the column, if deemed desirable.

EMPLOYMENT IN THE FIELD

368. There is no technical drill for the telegraph company as such. It functions wholly through the operations of its platoons or sections. Unity of action will occur in case all four sections are assigned to contiguous telegraph work, permitting direct technical control of all from company headquarters. This, however, will be exceptional rather than the rule of employment.

Sections or platoons generally function while dispersed and isolated, the company headquarters exercising the duties of administration and furnishing reserve supplies, material, and technical assistance when needed.

Telegraph company units will frequently be called upon to work over terrain not necessarily occupied by other troops. This will require independent messing facilities and special arrangements for supply. Duties incident thereto pertain to company headquarters, the same being facilitated by the presence of motor transportation.

The telegraph section carries one day's supply of construction material and only a limited supply of operation material. Timely arrangements must be made by company headquarters for a steady daily flow of technical matériel to the section it they are to be kept employed. Well-defined plans for this work will be formulated on receipt of orders detaching a section or platoon for duty.

The supply of reserve matériel in the company is practically nil. Requisitions through the battalion commander to the advanced signal depot should be wired in as soon as the need is apparent. These requisitions should state amounts desired and the times and places of delivery. Ordinarily transportation should be furnished by the Quartermaster Corps but unless the same is assured, any motor carriages which are idle should be used for the purpose, if necessary calling on the battalion commander for assistance. It will frequently happen that all the sections of the company are not engaged in work at the same time. In this case idle sections should be utilized locally to supply those at work.

Telegraph companies, especially when engaged in telegraph work proper, differ materially from field companies from the fact that the former lay semi-permanent and the latter wholly temporary lines. The general role of the telegraph company headquarters is administrative, but whenever practicable, it co-ordinates the work of its units. Its prime factor is their proper maintenance and supply.

THE TELEGRAPH BATTALION

FUNCTION

369. The telegraph battalion is habitually assigned to duty with the army corps. Its function is to maintain communication between the advanced base of the corps and the headquarters of the several divisional units and to furnish such local telephone systems for these units as may be necessary.

ORGANIZATION

370. The telegraph battalion is composed of one battalion headquarters, one supply detachment, and two telegraph companies.

In detail battalion headquarters and the supply detachment is as follows:

1 major
1 adjutant (first lieutenant).
1 supply officer (first lieutenant).
1 sergeant major (sergeant, first class).
1 supply sergeant (sergeant).
2 drivers field train (privates, first class).
2 clerks (privates, first class).
3 drivers officers' carriages (privates).
Total, commissioned, 3; enlisted. 9.

The transportation furnished the battalion consists of one inspection car, two motorcycles with side cars, and two field trucks.

371. The major rides in the inspection car, the adjutant and supply officer normally on the motorcycles or side cars. An allowance of one driver for each of these carriages is provided in the enlisted personnel of headquarters. The remaining men of battalion headquarters personnel are carried on the field train.

372. The technical equipment of the battalion is very limited in extent. It consists of certain signaling instruments, the employment of which in the telegraph zone will be exceptional, and a few other necessary miscellaneous articles.

FORMATIONS AND POSTS OF INDIVIDUALS

373. The battalion may be formed **in line** or **in column of route.**

374. It is **in line** when the companies, each in line, are formed abreast of each other. The normal interval between companies in the battalion is 10 yards.

375. It is **in column of route** when the companies each in column of route follow each other in designated order. The minimum distance between companies in column of route is 50 yards.

376. The posts of individuals in the telegraph battalion staff assimilate those of the field battalion, such changes being made as are necessary to accord with the presence of motor transportation.

MANEUVER

377. The formation of the telegraph battalion is wholly informal in nature. The major sends directions by his adjutant as to the character of the formation and the position of the base company. The battalion is then formed accordingly and on completion thereof the adjutant reports to the major.

378. No specified maneuvers are prescribed for the telegraph battalion. The major gives directions verbally or through a staff officer to the captains, so as to cause the battalion to take up the desired formation.

EMPLOYMENT OF THE BATTALION

379. The telegraph battalion performs its functions through its company, platoon, and section units. Battalion headquarters co-ordinates the work of the detached units where necessary and renders to them all assistance possible especially in the matter of supply.

380. The battalion commander utilizes companies or parts of them to assist others when circumstances demand. He acts as technical inspector of all forms of communication established in his zone and performs such administrative duties as the needs of his battalion require.

BASE-LINE SIGNAL TROOPS

General Provisions

Function

Base-line signal troops are those troops which furnish the lines of information to connect commercial systems with the advanced bases of armies in the field and which supplement or supplant the latter service wherever and whenever necessary.

The function of base-line signal troops is broad and varied; broad in that it may extend from the theater of operations to the seat of government itself; varied in that it may comprise any or all forms, means and methods of transmitting information. On this account the employment of these troops, except in a very general way, can not be stated. They are designed to furnish the most suitable means of communication necessary to complete the chain or otherwise supplement or supplant commercial systems in maintaining uninterrupted military lines of information at all times.

Zones of Operation

There are none in particular prescribed. Base-line signal troops may operate all or any part of the inner strategical zone if required to do so in performing their function. The operation of these troops in the outer strategical zone will probably be occasionally required due to the fact that they gradually supersede telepraph signal troops in advance and are replaced by them in retirement. The most usual theater of operations for these troops is, however, in that portion of the inner strategical zone immediately in rear of the telegraph signal troops. For in such locations commercial systems are either entirely lacking or inadequate and reasons for systems operated by troops greatest. Base-line systems should not supplant regular commercial systems unless the latter cannot furnish satisfactory service, or good military reasons exist for effecting the change.

Organization

Base-line signal troops are organized as telegraph signal troops. No regular equipment is specified. Transportation, construction and operation material, tools, and technical supplies are furnished these troops as the needs of any special situation may require. Base-line signal troops require a maximum of civil technical skill and a minimum of military training. For this reason these troops will probably be recruited by organization entire from commercial companies and subjected to such military training as may be necessary to cause them to properly function as military units.

Base-line signal troops are administered by company and battalion as in the case of other signal troops. While, as a rule, these troops will operate dispersed, their location along well-defined lines of communication render the details of administration and supply comparatively easy.

CHARACTER OF EMPLOYMENT

General Provisions

Base-line signal troops are employed in any way necessary to effect or maintain communication within their assigned sphere of operations.

The operations of these troops can be divided generally into two classes—construction and operation, together with necessary maintenance, of systems already installed. Employment in either field is limited in extent only by existing means and methods for the transmission of information.

Replacement of Semi-Permanent Lines

Telegraph signal troops establish semi-permanent lines only when necessary. Where permanent existing lines are found within the telegraph zone their function is solely that of operation. When on advance the telegraph zone becomes merged into the base-line zone, and the troops of the latter replace those of the former. If desirable, they remove such semi-permanent lines as may be found. This will probably be done both on account of the unstability of construction of the lines, and to obviate the necessity of employing special instruments in their operation. Wherever permanent lines exist in this zone, base-line troops take over their operation.

Base-line signal troops may be frequently called upon to perform this duty, the principal reason being to provide military supervision, discipline, and control over systems whose primary function is the transmission of military information. Arrangements for troops to replace civil personnel are made by the Chief Signal Officer of the Army, under instructions of the War Department. Such arrangements should provide for taking over entire systems or zones, and care should be taken to distinctly segregate civilian and military operators, thus avoiding any conflict of authority or division of responsibility.

The replacement of civil by military personnel applies to all forms of systems of communication, telegraph or telephone, wire, radio, or cable.

Ordinarily the nearer the theater of active operations the lines of information approach, the more reason will exist for handling the same by troops in preference to civilians.

The conduct of operations of base-line signal troops will be in accordance with the Signal Corps manuals, covering the various phases of permanent construction and operation.

Portable Radio Systems

These systems are distinctly military and may be horse drawn or motorized, usually the latter. They will frequently be used to supplement wire systems, both permanent and semi-permanent, and will usually be located at various points in the outer portion of the inner strategical zone. Corps and Army headquarters will be supplied with these sets, which will form independent lines of information between themselves, to divisional units in front and to important points in rear. These systems will be operated by base-line signal troops properly organized and equipped for this service, under the provisions established for the operation of military radio stations in general.

Supervision and Control

Base-line signal troops are organized into companies and battalions in order to permit proper supervision and control in their operations. Sectors or areas will be assigned to units for construction or operation and maintenance, as the case may be, and the unit commander thereof charged with efficient supervision and control therein. Separate units will be assigned, if practicable, to function wholly within the jurisdiction of a single higher commander to whose orders they will be subject for administration and discipline, and to whom they look for supply.

The signal officer of the line of communications is charged with the technical supervision and inspection of base-line signal troops within his jurisdiction.

DEPOT SIGNAL TROOPS

These troops are organized into companies for service in peace and into battalions for service in war.

In peace these companies are primarily formed for the purpose of administration. The personnel performs, in general, detached duty in connection with the installation, operation, and maintenance of interior systems of communication. In so far as applicable, they perform such duties of base-line troops as exist in peace time.

In war these troops are organized into battalions as administrative and training units designed to keep the ranks of active organizations supplied with trained personnel as the needs require. Depot battalions in war should be organized on a basis of one to each Army corps.

The companies of depot battalions are composed as follows:

1 captain.
5 first lieutenants.
3 master signal electricians.
1 first sergeant (sergeant, first class).
1 supply sergeant (sergeant).
1 stable sergeant (sergeant).
1 mess sergeant (sergeant).
4 mechanics (corporals).
2 clerks (corporals).
1 horseshoer.
1 driver (private, first class).
3 cooks.
2 buglers.
1 wire-section (14 men).
1 radio pack section (10 men).
1 radio wheel section (20 men).
1 outpost platoon (21 men).
1 telegraph section (22 men).
1 telephone section (18 men).
45 recruits for training.
Total, 6 officers and 170 men.

The depot battalion is composed of a headquarters and supply detachment, as prescribed for the telegraph battalion, and two depot companies.

Active and intensive training will be had by classes designed to qualify men to fill specific vacancies whenever requisitioned for by organizations engaged in duty at the front.

CEREMONIES

General Rules

On occasions of ceremony, except funerals and reviews of large forces, troops will be arranged from right to left in line and from head to rear in column in the following order: First, Infantry; second, Field Artillery; third, Cavalry.

Artillery, Engineers, and Signal Corps troops, equipped as Infantry, are posted as Infantry; dismounted Cavalry and Marines attached to the Army are on the left of the Infantry in the order named; companies or detachments of the Hospital Corps and mounted detachments of Engineers are assigned to places according to the nature of the ceremony; mounted companies and detachments of signal troops are posted as Cavalry. When Cavalry and Field Artillery are reviewed together without other troops the Artillery is posted on the left. Troops in column in funeral escorts will be arranged from head to rear in the following order: First, Cavalry; second, Field Artillery; third, Infantry. In the same arm, Regulars, Militia in the service of the United States, and Volunteers are posted in line from right to left or in column from head to rear in the order named. In reviews of large bodies of troops the different arms and classes are posted at the discretion of the commanding general, due regard being paid to their position in camp. On all other occasions troops of all classes are posted at the discretion of the general or senior commanding officer.

At formations for ceremony sabers are drawn. Mounted officers in facing toward the line and in resuming their front always execute a left about.

Staff officers, when it is not otherwise prescribed, draw and return saber with their chief.

A non-commissioned officer in command of a company takes post on the right of the company in line with it. After aligning it he takes the post of the captain when the battalion is in column.

REVIEWS

General Rules

The adjutant or adjutant general posts men or otherwise marks the points where the column changes direction, in such manner that the right flank in passing the reviewing officer shall be about 10 yards from him.

The post of the reviewing officer, usually opposite the center of the line, is marked by a flag.

The reviewing officer and others at the reviewing stand salute the standard as it passes; when passing around the troops, the reviewing officer and those accompanying him salute the standard when passing in front of it. The reviewing officer returns the salute of the commanding officer of the troops only. Those who accompany the reviewing officer do not salute.

The staff of the reviewing officer is in single rank, 6 yards in rear of him, in the following order from right to left: Chief of Staff, officers of the General Staff Corps, adjutant general, aids, then the other members of the staff in the order of rank, the senior on the right; the flag and orderlies place themselves 3 yards in the rear of the staff, the flag on the right.

Officers of the same or higher grade and distinguished personages invited to accompany the reviewing officer place themselves 3 yards in rear of the staff, the flag on the right.

Officers of the same or higher grade and distinguished personages invited to accompany the reviewing officer place themselves on his left; their staff and orderlies place themselves, respectively, on the left of the staff and orderlies of the reviewing officer; all others who accompany the reviewing officer place themselves on the left of his staff, their orderlies in rear. A staff officer is designated to escort distinguished personages and to indicate to them their proper positions.

When riding around the troops, the reviewing officer may direct that his staff, flag, and orderlies remain at the post of the reviewing officer or that only his personal staff and flag shall accompany him; in either of these cases the commanding officer alone accompanies the reviewing officer. If the reviewing officer is accompanied by his staff, the staff officers of the commander place themselves on the right of the staff of the reviewing officer.

While passing in review or riding around troops the staff is formed in one or more ranks, according to its size.

The staff, flag, and orderlies of brigade commanders place themselves in the order prescribed for the staff, flag, and orderlies of the reviewing officer.

When the reviewing officer is not in front or in rear of a regiment, or other separate organization, its commander may cause it to stand *at ease,* to *rest,* or to *dismount and rest,* and to resume *attention* and *mount,* but so as not to interfere with the ceremony.

When the commanding officer of the troops turns out of the column his post is on the right of the reviewing officer; his staff, in single rank, on the right of the staff already there; his flag and orderlies in rear of his staff.

When the column has passed, the commanding officer, without changing position, salutes the reviewing officer and then with his staff and orderlies rejoins his command.

If the person reviewing the command is not mounted, the commanding officer and his staff, on turning out of the column after passing the reviewing officer, dismount preparatory to taking post on the right of the reviewing officer and his staff. In such case the salute of a commanding officer, prior to rejoining his command, is made with the hand before remounting.

When the general, the colonel, or the major faces the line to give commands, the staff and orderlies do not change position.

Each guidon and, when the rank of the reviewing officer entitles him to the honor, each regimental standard salutes at the command, **HAND SALUTE;** and again in passing in review when 6 yards from the reviewing officer. The standard and guidons are raised at the command, **TWO,** or when they have passed six yards beyond the reviewing officer.

The band of each battalion, corps, or regiment plays while the reviewing officer is passing in front of and in rear of the organization.

During the march in review each band, immediately after passing the reviewing officer, turns out of the column, takes post in front of and facing him, and continues to play until its organization has passed, then ceases playing and follows in rear of its organization; the band of the following organization commences to play as soon as the preceding band has ceased. The buglers of each organization, except those pertaining to the organization commanders, are consolidated in rear of the band.

If the band be not present, the buglers of each organization, with the exceptions just noted, are consolidated and posted in single rank in a position corresponding to that of the band. They conform to what is prescribed for the band, the bugler chief taking post and performing the duties of the drum major.

This rule applies to all ceremonies.

If the rank of the reviewing officer entitles him to the honor, the *march,* or *flourishes* are sounded by the field music when sabers are presented, and are sounded again in passing in review at the moment the standard salutes, by the musicians halted in front of the reviewing officer.

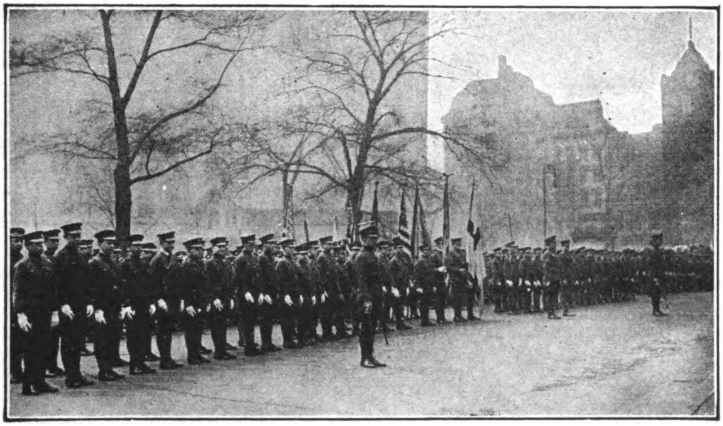
Buglers with the organization commanders do not sound the march or flourishes.

The formation for review may be modified to suit the ground, and the present saber and the ride around the line by the reviewing officer may be dispensed with.

If the post for the reviewing officer is on the left of the column the troops march in review with the guide left; the commanding officer and his staff turn out of the column to the left, taking post as prescribed above, but to the left of the reviewing officer.

Mounted companies of the Signal Corps pass in review at a walk, trot, or gallop. When passing at the trot or gallop no salutes are made except by the commander of the troops when he leaves the reviewing officer.

When the command is to pass at an increased gait the band (or buglers, if no band is present) remains in front of the reviewing officer and continues to play until the column has completed its second change of direction after passing the reviewing officer. As soon as the increased gait is taken up by the column the band plays in appropriate time, ceasing when the column has again completed the second change of direction after passing the reviewing officer. Upon the completion of the review, the band returns to the position it occupied before marching in review or is dismissed, as may be directed. If there be more than one band, the band last in the column remains in front of the reviewing officer; the others turn out



REVIEW OF FOUR BATTALIONS OF THE JUNIOR AMERICAN GUARD, DISMOUNTED

of the column when the increased gait is taken up by their respective organizations, and rejoin them, or are dismissed on the termination of the review.

In reviews of brigades or larger commands each battalion, after its rear has passed the reviewing officer 50 yards, takes an increased gait for 100 yards in order not to interfere with the march of the column in rear.

The troops, having passed the reviewing officer, return to their camps by the most practicable route, being careful not to delay the march of the troops in rear of them.

When Signal troops are reviewed in line with Cavalry, Infantry, or Field Artillery, they are formed with the leading men aligned on the front rank of the Infantry or on the rank of Cavalry, or on the lead drivers of the Artillery.

At the command *close ranks, march,* with infantry, or *attention, posts,* with cavalry or field artillery, the Signal Corps commander commands: **1. Attention, 2. POSTS.** The chiefs of platoon and standard bearers resume their posts in line.

The instrument, shop, and field wagons do not accompany the companies at the review unless so ordered.

When it is necessary that an organization should be reviewed before an inspector junior in rank to the commanding officer, the commanding officer receives the review and is accompanied by the inspector, who takes post on his left.

Battalion Review

The battalion being in line, the major faces to the front; the reviewing officer takes his post; the major turns about and commands: **1. Prepare for review, 2. MARCH.** The staff remains in position, facing to the front.

At the command *march,* the chiefs of platoons, and the standard bearers, if present with the standards, move up on the line of captains. Non-commissioned officers acting as chiefs of platoon do not move up.

The major then faces to the front.

The reviewing officer moves a few yards toward the major and halts; the major turns about, commands: 1. **Hand,** 2. **SALUTE,** and again turns about and salutes.

The reviewing officer returns the salute, the major turns about, commands: **TWO,** and again turns to the front.

The reviewing officer approaches to within about 6 yards of the major, the latter salutes, returns saber, joins the reviewing officer, takes post on his right, and accompanies him around the battalion. The reviewing officer proceeds to the right of the band, passes along the front of the officers to the left of the line, and returns to the right, passing in rear of the line. The reviewing officer and those accompanying him salute the standard when passing in front of it.

While the reviewing officer is riding around the battalion the band plays, ceasing when he leaves the right to return to his post.

On arriving at the right of the line the major salutes, halts, and, when the reviewing officer and staff have passed, moves directly to his post in front of the battalion, faces it, draws saber, and commands: **1. Attention, 2. POSTS.** The chiefs of platoon and standard bearers execute a left about and take their posts in line. The major commands: **1. By the right flank; 2. MARCH; 3. BATTALION; 4. HALT.** The command *halt* is given as soon as the sections have completed the turn. The band takes post 36 yards in front of the leading company.

The column being formed, the major commands: **1. Pass in review; 2. Forward; 3. MARCH.** At the command *march* the column marches off, the band playing. Without command from the major the column changes direction at the points indicated, and columns of companies or platoons at full distance with guide to the right is formed successively to the left at the second change of direction. The major takes his post 24 yards in front of the band, immediately after the second change. The band, having passed the reviewing officer, turns to the left out of the column, takes post in front of and facing the reviewing officer, and remains there until the review terminates.

When the major is 6 yards from the reviewing officer he and his staff salute, turning the head and eyes sharply to the right. When the major has passed 6 yards beyond the reviewing officer he and his staff resume the carry, turning the head and eyes to the front.

The other officers, non-commissioned staff officers and the drum major, salute at the point prescribed for the major, turning the head and eyes as above described. Non-commissioned officers and officers commanding platoons salute with the hand.

The reviewing officer returns the salutes of the major only and salutes the standard.

The major, having saluted, takes post on the right of the reviewing officer, remains there until the rear of the battalion has passed, then salutes and rejoins his battalion.

When the battalion arrives at its original position in column the major commands: **1. Trot (or Gallop); 2. MARCH.**

The battalion passes in review as before, except that no salutes are rendered except by the major when he leaves the reviewing officer.

The review terminates when the rear company has passed the reviewing officer; the band then ceases to play and rejoins the battalion or is dismissed. The major and his staff rejoin the battalion.

The reviewing officer may prescribe how often the column shall pass in review and the gait or gaits to be used.

Review of a Battalion With Closed Intervals

The battalion is formed in line, each company being at closed intervals. The review is conducted according to the principles previously explained, except that instead of first executing by the right flank the battalion is formed in column of companies with closed intervals, but full distances, and passes in review in that formation.

When space is limited the battalion may be formed in line with each company in platoon column. The review will be conducted on the general principles previously explained, the battalion passing in review either in platoon column or in column of companies at full distance, as before.

INSPECTIONS

Dismounted Inspections

COMPANY INSPECTION

The company being in line, dismounted, the officers at carry saber, the captain causes the company to **open ranks.**

The captain then commands: **PREPARE FOR INSPECTION.**

The captain returns saber, inspects the chiefs of platoons and of sections, the ranks, and the file closers, beginning on the right of each and returning by the left and rear. Each man as approached executes **INSPECTION, PISTOL,** and after being passed by the inspector executes **RETURN PISTOL.** During the inspection of the ranks the lieutenants face about and stand at ease; they may be directed to accompany the captain or to assist in the inspection. Upon the completion of the inspection the lieutenants face to the front and resume the attention. The captain causes the company to **close ranks.**

Should the inspector be other than the captain, the latter prepares the company for inspection and when the inspector approaches brings the company to attention, and from his post in front of the right of the company salutes. The salute acknowledged, the captain carries saber, faces to the left, commands: **PREPARE FOR INSPECTION,** and again faces to the front.

The inspection proceeds as before; the captain returns saber and accompanies the inspector as soon as the latter has inspected him.

At inspection of quarters the inspector is accompanied by the captain and followed by the other officers, or by such of them as he may designate; the men, without accouterments, stand uncovered near their respecive bunks; in camp they stand covered, without accouterments, in front of their tents; upon the approach of the inspector the first sergeant commands **ATTENTION,** salutes, and leads the way through the quarters or camp.

BATTALION INSPECTION

Battalion inspection will be conducted in accordance with the principles and by the methods and means laid down in Company Inspection, Dismounted, and Battalion Inspection, Mounted.

MOUNTED INSPECTIONS

Organizations will be considered as mounted when the animal or motor transportation prescribed as a part of the equipment of the organization is present.

Inspections will habitually be had mounted. Signal troops carry, for inspection mounted, every article that is prescribed as a part of the regular equipment and for which there is a specially designated place on the transportation.

COMPANY INSPECTION

The company being in line at normal intervals, the captain gives the proper commands for forming the men of the sections in line (in double rank in the cases of outpost and telegraph companies) in front of the section transportation.

He then draws saber and commands: **1. Prepare for inspection: 2. MARCH; 3. FRONT.**

In the cases of outpost and telegraph companies the second command is preceded by the command **Open ranks.**

At the first command the captain goes to the right of the company and takes post facing to the left, 8 yards in front of the guidon; and the bugler or buglers take post 2 yards to the right of and abreast of the guidon.

At the second command the chiefs of platoons move forward 8 yards, and all men dress to the right.

The captain verifies the alignment of the chiefs of platoons of the men in line and of the transportation, returns to his post in front of the guidon on line with the chiefs of platoons, commands **FRONT,** and faces to the front.

The chiefs of platoons cast their eyes to the front as soon as the alignment is verified.

As the inspector approaches, the men take the position of **Inspection pistol** and the buglers raise their bugles for inspection. Pistols are returned as soon as inspected.

The inspector begins the inspection by passing around and inspecting the chiefs of platoons, who, after being inspected, face to the rear and remain at ease at their posts unless directed to assist in the inspection. The inspector then goes to the right of the company and inspects the buglers and guidon, after which he inspects each section in turn, commencing at the right flank, passing along the front of the section, and returning in the rear of the sections.

To inspect the company more minutely the captain may cause such men as are mounted to dismount, and, without forming ranks, conducts the inspection.

To inspect the technical signal equipment carried the captain dismounts all men, if not already dismounted, forms ranks, and commands: **1. Inspection; 2. Equipment.**

At this command the horses of sections equipped with individual mounts are turned over to the horse holders, and the men fall in, in front of their horses. The chiefs of sections march the sections by the right flank of the sections to the rear of the transportation, faces them to the front, and commands **FALL OUT.**

The equipment is then removed from the transportation and placed upon the ground in such order as may be directed.

When the equipment has been laid out, the section will form in single rank in rear of the equipment, facing to the front.

Upon the completion of the inspection of a section its equipment is replaced without command, and the section is formed and marched back to its proper place, where the men stand at ease until the completion of the inspection. All sections when not being inspected stand at ease awaiting the approach of the inspector, and are brought to attention by the chiefs of sections on his approach.

In an animal-equipped company, when the captain dismounts the mounted men in the company, the guidon dismounts with them the chiefs of platoons return saber, dismount, and stand to horse facing their platoons; the captain returns saber and dismounts, and his horse is held by a bugler. If the arms are not to be inspected the commands therefor are omitted.

The chiefs of platoons, when the inspection of the rank begins, face toward the company and remain at ease, resuming front on the completion of the inspection of arms, or the captain may require them to assist him. If dismounted, their horses, if they be so mounted, are held by buglers. The captain may require each chief to inspect his own platoon, while he makes a general inspection.

While inspecting the company or accompanying the inspector the captain does not return his saber while mounted; if dismounted, he returns saber.

On the completion of the inspection the captain brings the company to attention and commands **POSTS.**

In an animal-equipped company the captain gives the necessary commands for mounting the dismounted men before giving the command **POSTS.** The chiefs of platoons and the buglers execute an about, resume their posts, and face to the front. The captain then gives the necessary commands for resuming the normal formation.

Should the inspector be other than the captain, the latter prepares the company for inspection and awaits the arrival of the inspector. Upon the approach of the inspector the captain at his post in front of the guidon salutes, the inspector returns the salute and informs him of the character of the inspection desired; the captain gives the necessary commands, faces to the front, and, when inspected, accompanies the inspector.

BATTALION INSPECTION

The battalion is formed in column of companies, each company in line. On the approach of the inspector the major commands: **1. Prepare for inspection; 2. MARCH.**

The companies are prepared for inspection as already prescribed.

The battalion staff officers place themselves in line with 1-yard intervals about 30 yards in front of the column, opposite the center, in order of rank from right to left; the noncommissioned staff form in a similar manner 6 yards in rear of the staff officers; the guard of the standard marches to the front and takes post 6 yards in rear of the center of the line of the noncommissioned staff. The major takes post in front of the center of the column 6 yards in front of the staff.

Field and staff officers senior in rank to the inspector do not take post in front of the column, but accompany him.

The inspector inspects the major and, accompanied by the latter, inspects the staff officers.

The major and his staff, as soon as inspected, return saber and accompany the inspector. The noncommissioned staff officers return saber when inspected.

The inspector, commencing at the head of the column, inspects the noncommissioned staff and guard of the standard. The noncommissioned staff and guard of the standard may be dismissed as soon as inspected.

The captain of each company not undergoing inspection dismounts such men as are mounted and brings the men to rest. As the inspector approaches the company the captain brings it to attention and, in the case of animal-equipped companies, mounts such mounted men as are dismounted; as soon as he himself has been inspected he gives the necessary commands, returns saber, and accompanies the inspector. The inspector proceeds as in company inspection. At its completion the captain commands **POSTS,** dismounts his mounted men, if not already dismounted; and brings the company to rest. Upon intimation from the inspector the major may direct that each company in turn be dismissed as soon as inspected.

The battalion may be inspected in line. The inspection is conducted according to the same principles as when formed in column. The major and his staff are inspected at their posts in front of the center of the line; the band, which remains at its post on the right, is next inspected; then the companies in order from right to left.

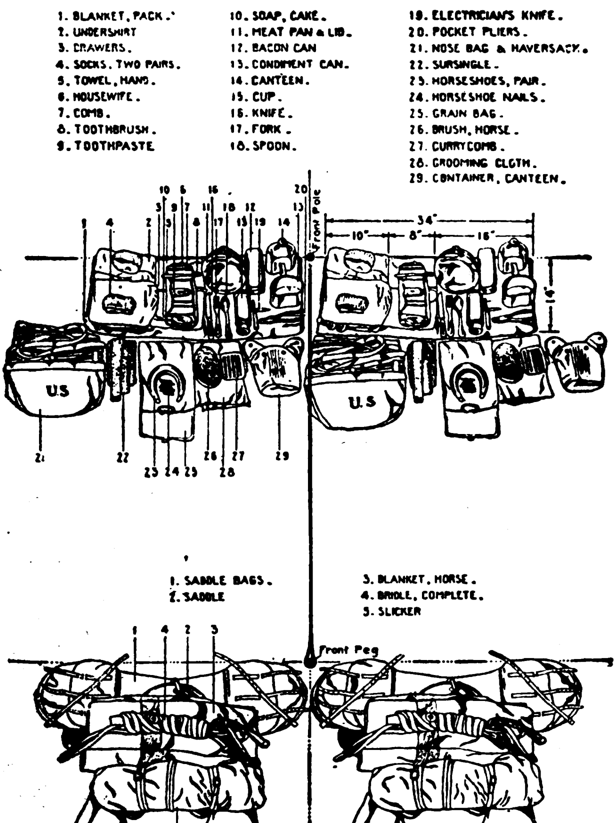
If the major is himself the inspector the inspection is conducted according to the same principles.

INSPECTION OF SHELTER-TENT CAMPS

To inspect an organization in shelter-tent camp the organiation is caused to pitch a model camp, each man displaying his equipment in front of his shelter tent, as shown in the drawing.

Men equipped as Infantry omit the individual mounted equipment shown and place haversack and pack carrier, where saddle equipment is shown. Haversack is placed on the ground so that lettering thereon is read from the front and the pack carrier is placed on top of the haversack.

As soon as equipment is disposed men take position 1 yard in front of the center of their tent halves, facing the front, and stand at ease. On the approach of the inspector the organization is brought to attention and aligned by the organization commander.



DISPLAY OF EQUIPMENT FOR INSPECTION.

FUNERAL ESCORT

The composition and strength of the escort are prescribed in Army Regulations.

The escort is formed with its center opposite the quarters of the deceased, the mounted men in line to the front; the band (or musicians) on that flank of the escort toward which it is to march.

Upon the appearance of the coffin the commander of the escort commands: **1. Hand, 2. SALUTE,** salutes, and the band plays an appropriate air; the command: **TWO** is given, and the escort is formed in section column.

The procession is formed in the following order: **1. Music; 2. Escort; 3. Clergy; 4. Coffin and pallbearers; 5. Mourners; 6. Members of the former command of the deceased; 7. Other officers and enlisted men; 8. Distinguished persons; 9. Delegations; 10. Societies; 11. Civilians.**

Officers and enlisted men (Nos. 6 and 7), with side arms, are in the order of rank, seniors in front.

The escort marches at a walk to solemn music, and on arriving at the grave is formed in line with the center opposite the grave; the sections then form line to the front; the coffin is carried along the front of the escort to the grave; hand salute is given, and the band plays an appropriate air; the coffin having been placed over the grave, the music ceases and hands are dropped to the side at command.

After the coffin is lowered into the grave and the funeral services are completed, a trumpeter sounds taps over the grave.

The escort is then formed into column, marched to the point where it was assembled, and dismissed.

The band does not play until it has left the inclosure.

The funeral ceremony for an enlisted man is the same as for an officer, except that the commands for saluting are omitted;

the sergeant in command of the escort salutes with the hand on the appearance of the coffin at the quarters of the deceased and also when the coffin is carried along the front of the escort to the grave.

When the distance to the place of interment is considerable, the escort after leaving the camp or garrison may march **at ease** until it approaches the burial ground, when it is brought to attention. The music does not play while marching at ease.

In marching at attention the field music may alternate with the band in playing.

When it is impracticable for transportation to approach the grave, it is left outside the inclosure. If the escort consists of Signal Corps only, the officers, non-commissioned staff officers, and all individually mounted men dismount, turn over their horses to the horse holders, and the officers draw saber; a suitable formation is then taken and the coffin is escorted to the grave, where line is formed and the same ceremonies are performed as before prescribed. The ceremony at the grave having been completed, the command remains in line until the bugler sounds taps over the grave.

Should the entrance to the cemetery prevent the hearse accompanying the escort till the latter halts at the grave, the column is halted at the entrance long enough to take the coffin from the hearse, when the column is again put in march. The Cavalry, Artillery, and Signal Corps of the escort, when unable to enter the inclosure, turn out of the column and salute the coffin as it passes.

In all funeral ceremonies six pallbearers will be selected as far as practicable from the grade of the deceased. If the deceased is a commissioned officer, the coffin is borne by six commissioned officers; if a non-commissioned officer or private, by six privates.

When arms are presented at the funeral of a general officer, the trumpeters sound the *march* or *flourishes*, according to the rank of the deceased, after which the band plays an appropriate air.

At the funeral of a mounted officer or enlisted man, his horse, in mourning caparison, follows the hearse.

When necessary to escort the remains from the quarters of the deceased to the church before the funeral service, arms are presented upon receiving the remains at the quarters and also as they are borne into the church.

Before the funeral the commander of the escort gives the clergyman and pallbearers all needed directions.

THE STANDARD

Whenever in these regulations the term *the standard* is used it includes both the national and the battalion standards; if either alone is to be referred to, the term *the national standard* or *the battalion standard* is used.

The manual of the standard is as prescribed for the guidon except that at carry standard, dismounted, the ferrule of the lance is supported at the right hip.

The standard salutes an officer entitled to the honor, but in no other case.

The guard of the standard.—The guard of the standard consists of the color sergeants and of two experienced men selected by the commanding officer. The guard is habitually formed in line, the color sergeants in the center.

The national standard is carried by the senior color sergeant, who is nearest to the right flank of the guard and who commands the guard. The Signal Corps standard is carried by the other color sergeant. The latter conforms to the movements of the former, maintaining his position on the left.

The standard, kept at the quarters or office of the commanding officer, is escorted by the guard to the place of formation of the battalion and is similarly returned.

Post of the standard.—At the formation of the battalion, as soon as the companies have taken their places, the guard of the standard takes post midway between the two center companies in line abreast of the front ranks of the sections; in column, at the center of the column.

If the formation of the battalion is changed from line to column or the reverse, the standard conforms to the movement, taking its new position by the most direct route.

When during exercises the battalion formation is broken up, the standard joins the commanding officer or is dismissed, as may be directed by the adjutant.

THE GUIDON

The position of carry guidon, dismounted.—The lance of the guidon is held vertically in the right hand, thumb in front of the lance, forefinger along the side, ferrule about 6 inches from the ground. It is thus carried in marching.

When leading the horse the lance is held in a corresponding position in the left hand.

The position of order guidon.—The ferrule of the lance rests on the ground on a line with and touching the toe of the right shoe; the right hand grasps the lance in the same manner as when at carry.

The position of parade rest.—The ferrule of the lance is on the ground as at the order; the lance is held with both hands in front of the body, left hand uppermost.

To mount and dismount—The position of carry guidon, mounted.—At stand to horse the ferrule of the lance rests on the ground on a line with and touching the toe of the left shoe, lance vertical and supported by the left hand; hand at the height of the neck, elbow and forearm closed against the lance.

Preparatory to mounting, grasp the reins and a lock of the mane in the left hand, lance held in the same hand, reins on the near side of the lance; place the right hand on the pommel and mount in the usual manner. After mounting, grasp the lance with the right hand under the left, which lets go of it without quitting the reins; carry the lance to the right side, lower and place the ferrule in the stirrup socket. The right hand then grasps the lance, forearm nearly horizontal, the arms through the sling, lance vertical; this is the position of *carry guidon, mounted.*

Dismounting with the guidon is executed in a manner the reverse of the foregoing.

(Note.—Mounting and dismounting with the wire pike should be similarly executed.)

Salutes—Being mounted.—Lower the guidon to the front until the lance (under the right arm) is horizontal.

Being dismounted.—Slip the right hand up the lance as high as the eye, then lower the lance to the front by straightening the right arm to its full extent.

If marching, the salute is executed when at 6 yards from the officer entitled to the salute; the carry is resumed after passing 6 yards beyond him.

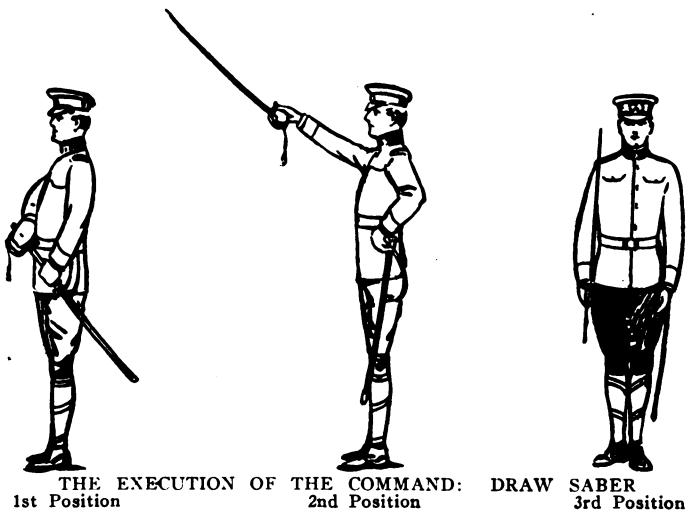
At the halt the salute is executed at the command: **1. Hand, 2. SALUTE.** The carry is resumed at the command **TWO.**

MANUAL OF THE SABER

1. Draw, 2. SABER.

At the command *draw,* unhook the saber with the thumb and first two fingers of the left hand, thumb on the end of the hook, fingers lifting the upper ring; grasp the scabbard with the left hand at the upper band, bring the hilt a little forward, seize the grip with the right hand, and draw the blade 6 inches out of the scabbard, pressing the scabbard against the thigh with the left hand.

At the command *Saber,* draw the saber quickly, raising the arm to its full extent to the right front, at an angle of about 45 deg. with the horizontal, the saber, edge down, in a straight line with the arm; make a slight pause and bring the back of the blade against the shoulder, edge to the front, arm nearly extended, hand by the side, elbow back, third and fourth fingers back of the grip; at the same time hook up the scabbard with



THE EXECUTION OF THE COMMAND: DRAW SABER
1st Position 2nd Position 3rd Position

the thumb and first two fingers of the left hand, thumb through the upper ring, fingers supporting it; drop the left hand by the side.

This is the position of carry saber dismounted.

Officers and non-commissioned officers armed with the saber unhook the scabbard before mounting; when mounted, in the first motion of "draw saber" they reach with the right hand over the bridle hand and without the aid of the bridle hand draw the saber as before; the right hand at the "carry" rests on the right thigh.

On foot the scabbard is carried hooked up.

When publishing orders, calling the roll, etc., the saber is held suspended from the right wrist by the saber knot; when the saber knot is used it is placed on the wrist before drawing saber and taken off after returning saber.

1st POSITION OF: PRESENT SABER (or ARMS)

Being at the order or carry: **1. Present, 2. SABER (or ARMS).**

At the command "present" raise and carry the saber to the front, base of the hilt as high as the chin and 6 inches in front of the neck, edge to the left, point 6 inches farther to the front than the hilt, thumb extended on the left of the grip, all fingers grasping the grip.

At the command "saber," or "arms," lower the saber point in prolongation of the right foot and near the ground, edge to the left, hand by the side, thumb on left of grip, arm extended. If mounted, the hand is held behind the thigh, point a little to the right and front of the stirrup.

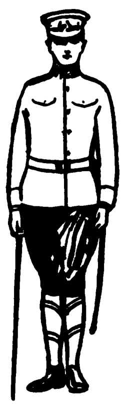
In rendering honors with troops officers execute the first motion of the salute at the command "present", the second motion at the command "arms"; enlisted men with the saber execute the first motion at the command "arms" and omit the second motion.

Being at a carry: **1. Order, 2. SABER** (or **Arms**).

Drop the point of the saber directly to the front, point on or near the ground, edge down, thumb on back of grip.

Being at the "present saber," should the next command be "order arms," officers and noncommissioned officers armed with the saber "order saber;" if the command be other than "order arms," they execute "carry saber."

When arms are brought to the order the officers or enlisted men with the saber drawn "order saber."



Order Saber

Parade Rest

Carry at Double Time

The saber is held at the carry only while giving commands, marching at attention, or changing position in quick time.

When at the order, sabers are brought to the carry when arms are brought to any position except the "present" or "parade rest."

Being at the order: **1. Parade, 2. REST.**

Take the position of parade rest except that the left hand is uppermost and rests on the right hand, point of saber on or near the ground in front of the center of the body, edge to the right.

At the command "attention" resume the order saber and the position of the soldier.

In marching in double time the saber is carried diagonally across the breast, edge to the front; the left hand steadies the scabbard.

Officers and noncommissioned officers armed with the saber, on all duties under arms draw and return saber without waiting for command. All commands to soldiers under arms are given with the saber drawn.

Being at a carry: **1. Return, 2. SABER.**

At the command "return" carry the right hand opposite to and 6 inches from the left shoulder, saber vertical, edge to the left; at the same time unhook and lower the scabbard with the left hand and grasp it at the upper hand.

At the command "saber" drop the point to the rear and pass the blade across and along the left arm; turn the head slightly

1st POSITION: RETURN SABER

to the left, fixing the eyes on the opening of the scabbard, raise the right hand, insert and return the blade; free the wrist from the saber knot (if inserted in it), turn the head to the front, drop the right hand by the side; hook up the scabbard with the left hand, drop the left hand by the side.

Officers and noncommissioned officers armed with the saber, when mounted, return saber without using the left hand; the scabbard is hooked up on dismounting.

At inspection enlisted men with the saber drawn execute the first motion of "present saber" and turn the wrist to show both sides of the blade, resuming the carry when the inspector has passed.

PART III—TECHNICAL INSTRUCTION AND APPARATUS

TELEGRAPHY AND TELEPHONY

THE VOLTAIC CELL, OHM'S LAW AND PRIMARY AND SECONDARY BATTERIES

THE VOLTAIC CELL

If zinc and carbon are immersed in an acid or saline solution and the two connected externally by a wire, an electric current will flow from one to the other. Any two dissimilar metals when immersed in an acid solution which acts on one more than on the other and connected externally by a wire will produce results. There are a few non-metallic substances which if used in a voltaic cell in the place of metal elements will produce the same result. The submerged substances are termed plates or elements, and the solution is termed electrolyte. The combination of plates or elements, electrolyte, and containing vessel constitutes a *voltaic cell.*

Authorities differ as to just why a current of electricity flows under the conditions just stated. Suffice it to say that it does flow, and that invariably one of the plates is acted upon (decomposed or eaten away) to a very much greater degree than the other. Experiment has shown that under the before-mentioned conditions substances which are acted upon equally do not cause a current of electricity to flow.

Where carbon and zinc are used as the plates in the voltaic cell, the carbon is termed the *negative* plate or element and the zinc is termed the *positive* plate or element. The carbon or negative element forms the positive pole of the battery, and the zinc or positive element forms the negative pole. The reason for this apparent contradiction is as follows: In any source of electricity the current flows from positive to negative, and in the voltaic cell, with plates connected externally with a wire, the current flows from zinc through electrolyte to carbon; this is termed the *internal circuit.* Outside the battery current flows from carbon plate through wire to zinc; this is termed the *external circuit,* thus it will be noted that in the internal circuit the current flows to and from directly opposite plates to those in the external circuit. Figure 1 illustrates this.

The term "circuit" is applied to the entire path through which the current of electricity flows. The wire joining the plates is a conductor. Bringing the ends of the conductor into contact is called making or *closing the circuit,* and their separation, opening or *breaking the circuit.* A substance through which the current readily flows is a *conductor.* Any substance which offers an extremely high resistance to the flow of an electric current is an *insulator.* Most

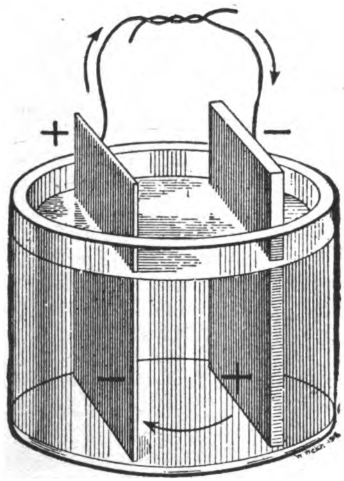


FIG. 1—VOLTAIC CELL

metals are good conductors, while mica, glass, porcelain, dry wood, dry atmosphere, rubber, etc., are insulators.

OHM'S LAW

With any circuit through which a direct current of electricity is flowing there are the three governing factors which follow:

(1) The difference of potential between the positive and negative pole of the generating medium, known as the pressure or *electro-motive force,* the unit of which is the *volt.* (Abbreviated V., E., or E.M.F.) One volt is that electro-motive force which would maintain, in a circuit having 1 ohm resistance, a current strength of 1 ampere.

(2) The *resistance* or opposition by the conductor to the flow of current, the unit of which is the *ohm.* (Abbreviated R.) One ohm is that resistance in a circuit which, if impressed with an electro-motive force of 1 volt, allows a current strength of 1 ampere to flow through the circuit. One ohm is the resistance of a column of

mercury about 42 inches high and 0.00155 square inch in cross-sectional area at zero centigrade.

(3) The *current strength* or rate of flow, the unit of which is the *ampere*. (Abbreviated I.) One ampere is that strength of current which would be maintained in a circuit having 1 ohm resistance if impressed with an electromotive force of 1 volt.

From the foregoing it will be noted that a definite relation exists between these factors, so that the value of any one of them can be found if the values of the other two are known. This relation, expressed by Ohm's law, is as follows:

(*a*) The *current strength* in a circuit may be found by dividing the pressure, or electromotive force, applied to it by the resistance.

$$\text{I (in amperes)} = \frac{\text{E M F (in volts)}}{\text{R (in ohms)}}$$

(*b*) The *electromotive* force, or pressure, required to maintain a certain current strength in a circuit may be found by multiplying the current in amperes by the resistance in ohms.

(*c*) The resistance in any circuit may be found by dividing the electromotive force by the current strength.

$$\text{R (in ohms)} = \frac{\text{E M F (in volts)}}{\text{I (in amperes)}}$$

When the total electromotive force is used in Ohm's law, the total resistance must be used to calculate the current strength. For example, if a coil of 0.5 ohm resistance is connected to a cell of 2 volts E.M.F., the current through the coil would not be

$$(E \div R) \text{ or } (2 \div 0.5) = 4$$

amperes as might be supposed. It requires a certain part of the cell's E.M.F. to force the current through the internal circuit; therefore, the internal and external resistances must always be added together and divided into the total E.M.F. to find the current flowing. Now, if the internal resistance of the cell were 0.5 ohm, the total resistance would be $0.5 + 0.5 = 1$ ohm and

$$I = (E \div R) = (2 \div 1) = 2 \text{ amperes, or half}$$

of the first result.

Ohm's law applies also to any part of a circuit the same as to the whole circuit. When applied to part of a circuit care must be taken to use only the E.M.F., resistance, and current strength of that portion of a circuit considered. Therefore, when E is used as total E.M.F., R must be the total resistance, and when E is used as the pressure applied to part of a circuit, R to correspond must be the resistance of that part of the circuit to which the E was applied. This application of the law may be illustrated by the following problem:

The E.M.F. of a cell is 2 volts; its internal resistance 0.5 ohm. It is connected to three spools of wire in series. By measurement we find that the E causing the current to flow through one of the spools, of which the R = 0.4 ohm, is 0.6 volt. What current is flowing through this spool?

By Ohm's law $I = \frac{E}{R} = \frac{0.6}{0.4} = 1.5$ amperes.

Now, since the current is the same in all parts of a series circuit, 1.5 amperes flow through each of the spools and also through the internal resistance. This also illustrates the difference between the E.M.F. and potential difference. The difference of potential or pressure between the ends of the spool is 0.6 volt, while the E.M.F. of the cell is 2 volts.

What part of the total E.M.F. is used in overcoming the internal resistance of the cell in the above problem?

By Ohm's law $E = I \times R = 1.5 \times 0.5 = 0.75$ volt.

This gives pressure lost or "volts drop" inside the cell.

The resistance of any conductor increases with its length and decreases with area of cross section and for most conductors the esistance increases with rise of temperature.

Electric current so far discussed has been direct or undirectional s appertaining to its flow in a circuit and is termed "direct current." (Abbreviated D.C.) This current may be so treated that it will become either *alternating* or *pulsating* in character. When this occurs Ohm's law still applies, but there are other factors that must be considered in computing values of I., E.M.F., or R.

With an *alternating current* (abbreviated A.C.) the flow in a circuit is continually *reversing* in direction. Certain types of generators produce alternating currents which change direction periodically and uniformly, the speed of rotation of the rotor of such generators being constant. Such currents are expressed in number of cycles per second, 60 cycles being the most commonly used for commercial electric lighting and power systems. Two alternations hange of direction) are contained in a cycle.

Unlike this current, the alternating current produced in telephonic communication is not periodically uniform nor is the E.M.F. in any way constant. The E.M.F. of these alternating currents is usually extremely high and the current strength very low, consequently the source of the current for transmitting the voice waves from a single instrument need only be capable of producing a comparatively weak current strength. For this reason a person coming into contact with both sides of a talking circuit will not be injured by the talking current.

A *pulsating current* is one which varies in magnitude. As ordinarily employed the term refers to undirectional current. A pulsating current may also be formed by superimposing upon a direct current an alternating current. When the alternating current is flowing in the same direction as the direct current the former accentuates the latter, and when flowing the reverse direction it counteracts, in a degree, the direct current. These currents will be encountered in the study of the operation of the telephone and similar apparatus.

STANDARD BATTERIES SUPPLIED BY THE SIGNAL CORPS

There are two classes of batteries, viz., *primary* and *secondary*, the latter sometimes being known as *storage batteries* or *accumulators*.

Primary batteries are divided into two classes, known as open-circuit and closed-circuit, and while there is a great variety of each class, the basic principle employed is the same.

Open-circuit cells are used for intermittent service where current is required for only short intervals of time, such as in operating electric bells. Open-circuit cells kept in continuous service for some time become polarized or completely exhausted, but will recuperate to a considerable degree on open circuit. The dry-battery is an excellent example of the open-circuit type.

Closed-circuit cells are adapted for supplying current continuously until the energy of the chemical is nearly expended. This is the form of primary cell most extensively used in telegraphy, where a small but constant current is required.

While formerly the Signal Corps issued several different kinds of open-circuit primary battery cells, such as the Laclanche, Gonda, and the Sampson, all of which employed carbon and zinc for elements, sal-ammoniac dissolved in water as electrolyte and a containing jar of glass, experience has shown that the dry-cell type of primary battery is most satisfactory, and consequently this type forms the standard issue of the Signal Corps.

While all dry cells of this type conform in general with the following description, it is found that different makes vary in efficiency. In order to ascertain the comparative merits of each make, a careful life test is periodically made in the Signal Corps laboratory, Washington, D. C.

The dry battery is a form of sal-ammoniac battery in which the zinc plate constitutes both the containing vessel and negative pole, thereby doing away with the breakable glass jar. An absorbent porous material with a deplorarizing mixture around it fills the space between the carbon in the center and the zinc vessel. This porous material is saturated with a solution containing chloride of zinc and sal-ammoniac. The top of the cell is sealed with asphalt or similar material. Binding posts for zinc and carbon elements, and pasteboard cover to prevent short circuiting with adjacent cells, complete this form of battery. These cells when carefully manufactured and properly stored are reliable. The cell can not be renewed, but their low cost and the convenience afforded by nature of the construction makes them superior to the wet cell for general use.

When these cells are exhausted, a short period of usefulness may be obtained from them in the following manner: Punch a number

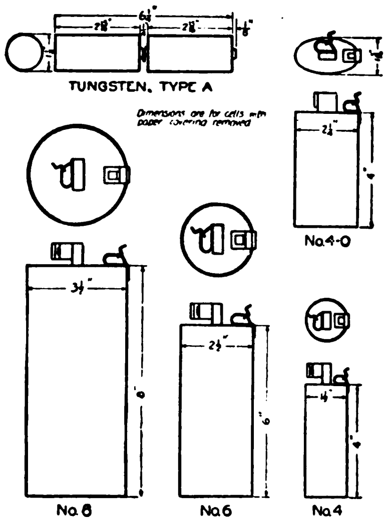


FIG. 2.—DRY CELL BATTERIES OF STANDARD SIZES

of holes through the zinc containing case and place them in jars containing a solution of sal-ammoniac and water. Salt solution for this purpose may be used, but it is not as effective as the sal-ammoniac. The standard sizes of the dry cell are shown in figure 2, but only two of these sizes are in general use with post telephone systems and with instruments used in the field. Size No. 6, figure 2, is invariably used when a local battery is desired for telephones of post telephone systems.

The tungsten type A battery shown in figure 2 is used with the service buzzer, the 1914 induction telegraph set, the camp telephone, radio test buzzer, and the hand flashlight. This type of battery is similar in construction to that first described, but in order to obtain a comparatively high voltage with minimum weight and bulk, the cells are of small diameter and two cells are so placed in a rigid paper tube that they are connected in series. This combination gives a total voltage of 3—1½ being normal voltage of each cell.

RESERVE TYPE DRY CELL

The ordinary type of dry cell deteriorates if kept long in storage, even though not in use. To provide a type of dry cell which could be kept in storage without deterioration, the Signal Corps issues a dry cell known as the "reserve type," shown in figure 3. This

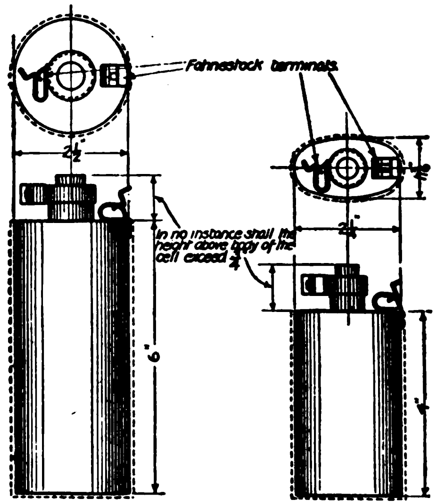


FIG. 3.—RESERVE DRY CELL BATTERIES, STANDARD SIZES

cell, although containing all the elements and ingredients of an ordinary dry cell, does not become active until water has been poured into a cavity of the carbon element. To place the cell in service, remove the plug from the top of the carbon element and fill with water (rain water preferred). As soon as this is absorbed, fill again, until the following amounts of water have been added: Type 4-0, 1¼ ounces; type 5, 2½ ounces; type 6, 3½ ounces; after which no more water should be added to these dry batteries.

Great care should be exercised in pouring the water, in order to avoid wetting the cardboard cover. If no funnel is available it is advisable to remove cardboard container during filling. When the cell becomes weak through use, a little sal-ammoniac solution placed inside the carbon element will rejuvenate it to some extent.

Referring to figures 2 and 3, it will be noted that the two sizes of reserve dry cells correspond in dimensions with cells of similar number not of the reserve type. The reserve type has practically been adopted by the Signal Corps. The No. 5 size is not a standard issue.

The voltage of a cell is important and should in no case be less than one volt, but the internal resistance is of greater importance since the cell which is nearly exhausted may at times show a comparatively high E.M.F.

With an ammeter connected directly to the terminals of a No. 6 cell, new cells should show a reading of at least 15 amperes (some cells will show 24). The voltage reading of a new cell on open circuit shoud be at least 1.4. Ammeter readings should be accomplished as quickly as possible, as in making the test the cell is practically short circuited, the ohmic resistance of an ammeter being very low.

Ordinarily, dry cells which when tested show a voltage lower than 1 or a reading of ammeter less than 2 should under no circumstances be turned into supply depots or transferred to accountable officers. This does not apply to the reserve type of cell unless it has been put in commission by the addition of water.

Dry cells in good condition have a voltage of about 1.45. The internal resistance and weights of the various types are about as follows:

Size	Internal resistance	Weight	Size	Internal resistance	Weight
	Ohms	Ounces		Ohms	Ounces
4-0	0.25	11¼	8	0.10	80
4	.25	9	Reserve 4-0...	.29	11¼
5	.20	18	Reserve 5.....	.22	18
6	.20	32	Reserve 6.....	.19	32
7	.12	56	Type A tungsten[1]...	.30	8

[1] Internal resistance shown is for each cell of the unit. Weight shown is for the unit complete, includng cardboard container.

CLOSED-CIRCUIT BATTERIES

The gravity, Fuller, and Edison are the types of closed-circuit cells supplied by the Signal Corps. Useful data on these cells is shown in the following table:

Type of Cell	Voltage	Weight	Internal Resistance
		Pounds	Ohms
Gravity	1.00	11¾	3.0
Fuller	2.00	12	.2
Edison	.67	11	.07

GRAVITY CELL

This is the form of primary cell most extensively used in telegraphy and telephony when a small but constant current is required. The usual form is shown in figure 4.

These cells have been furnished previously in two sizes, each being designated by dimensions of containing jar. One size is 6 by 8 inches and the other is 5 by 7 inches. The latter size has been recently adopted by the Signal Corps as standard, and this size only will hereafter be issued. In the bottom of the jar are placed three strips of sheet copper, riveted together, as shown in

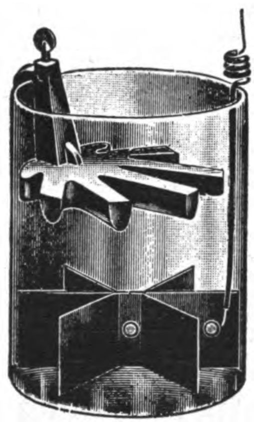


FIG. 4.—GRAVITY BATTERY CELL

the figure, with a rubber-insulated wire attached to one of the strips. There are many forms of zinc, but the "crowfoot" is the form now almost universally used.

To set up the cell, place about 3 pounds of bluestone (sulphate of copper) in the cell after putting in the copper, then hang the zinc and fill with water. The bluestone should be allowed to settle without any attempt to dissolve it by stirring or other means. The cell or cells are then "short-circuited" (zinc and copper connected together) and allowed to stand several days. By that time part of the bluestone will have dissolved, the blue line being well defined. Above this will be a clear solution of sulphate of zinc, formed by the action of the battery; the sulphate of zinc, being of less specific gravity than the copper sulphate solution, will remain on top if the cell is not shaken or stirred up. The battery may now be put into service.

If in a hurry for the cell, it may be started off at once by stirring up about a tablespoonful of salt with the water before pouring into the cell; but this method is likely to make a battery dirty and considerably shorten its period of usefulness. Any long, dark masses forming on the lower part of the zinc should be removed with a stick. The zinc sulphate solution will grow stronger and stronger, until finally the white salts will begin to creep or climb up the sides of the jar and the zinc. As they will corrode the connections and cause dirt and loss of insulation around the cells, they should be removed. Much of the trouble will be obviated if, as soon as they appear, part of the zinc sulphate solution is drawn off with a battery syringe or a siphon made of bent-glass tube, and water put in its place. If the upper parts of the cells are warmed and smeared with paraffin it will help matters. But the best plan of preventing evaporation and creeping of salts is to use a good quality of paraffin or lubricating oil, pouring on a layer about one-fourth inch thick as soon as the cells are set up. In cleaning cells after that, wet cotton waste dipped in sand will clean the zincs, etc., of the adhering oil. As soon as the blue solution goes down below the level of the copper more bluestone should be added. Corrosion of the connections of the zincs with their wires should be carefully looked after. It is better to have routine inspections of batteries made, and, if practicable, instrumental tests made with the voltmeters or voltammeter By thi. meai deterioration may be accurately noted and many annoyances breakdowns and delays which are frequently due to neglect and lack of regular inspection of the batteries may be avoided.

The internal resistance of a gravity cell in good condition will be found to be about 3 ohms, its E.M.F. 1 volt.

FULLER BATTERY

This belongs to the class popularly called "acid batteries." The cell has a high electromotive force, a comparatively low internal resistance (0.5 ohm), and is much used as transmitter battery on long-distance heavily worked telephones or local battery telephone switchboards. Its only disadvantage is that it uses a corrosive solution containing sulphuric acid, necessitating much care in handling. It consists of a glass jar about 8 inches high and 6 inches in diameter, with a wooden cover treated with asphaltum or P. & B. paint. Figure 5 illustrates this cell. The cover supports a carbon plate about 4 inches wide, 9 inches long, and one-fourth inch thick, with the top coated with paraffin to prevent the corrosion of the connection by the acid. In the jar stands an earthenware porous cup 7¼ by 3 inches, in the bottom of which is placed about 2 ounces of mercury. In this stands a conical zinc cast to a copper wire which extends out at the top. In the glass jar is placed the "electropion" solution, made by slowly adding 1 pound of strong sulphuric acid to 9 pounds of distilled water, and then stirring in 3 pounds of pulverized bichromate of potash or 2½ pounds of bichromate of sodium. This last is preferable, as the crystals formed in the action of the cell are not so hard and insoluble as those produced by the potash. In the porous cell with the zinc and mercury is placed water in which about a tablespoonful of salt has been dissolved. This cell will usually require little attention for three or four months. When the solution assumes a muddy bluish tint it is about exhausted.

If the copper wire at its junction with the zinc is covered with

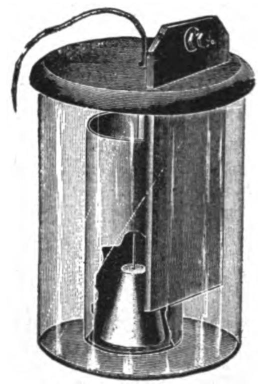


FIG. 5.—FULLER BATTERY CELL

paraffin or ozite, or if the copper wire is well amalgamated by rubbing with mercury after dipping it into acid, the wire does not tend to be eaten off at the junction, as it otherwise does under heavy service. The Signal Corps issues the materials for the solution in dry form, which when dissolved form the electrolyte. This is purchased under various commercial names as chromac, voltac, chromite, salts, etc., the first being the usual designation. It is packed in tin cans with thin cut-out top, containing 1 pound, which is the amount for one charge. Full directions for using are marked on each can.

The carbon of this cell lasts indefinitely, but should be soaked in warm water when renewals are made. The zinc may last through several renewals of the electropion fluid. The mercury should be saved and used repeatedly.

The following table, quoted from "Abbott's Telephony," indicates the effect of age on efficiency of transmission with the Fuller cell.

TWO-CELL FULLER BATTERY

Age	Volume of Transmission	Age	Volume of Transmission
Days	Per Cent.	Days	Per Cent.
20	92	60	76
30	88	70	70
40	84	80	62
50	80	90	54

From this it would appear that the cells must be renewed at

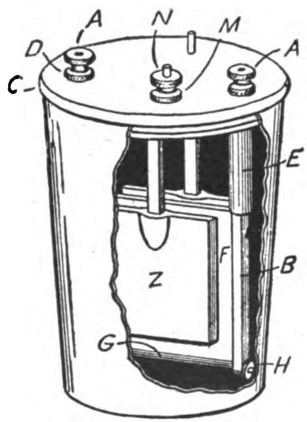


FIG. 6—TYPE V EDISON PRIMARY BATTERY CELL

least once in three months when used on a telephone transmitter.

EDISON PRIMARY BATTERY

The type **V** cell shown in figure 6 is the standard Edison cell. As previously manufactured for the Signal Corps, it has the same capacity as the old Edison La Lande cells, but its enamelled steel jar was slightly conical, enabling the cells to be nested together for transportation. The caustic soda and oil for each cell are issued in tin cans, so that there is nothing that will not stand transportation. This cell has a very low internal resistance (not exceeding one-eighth ohm) and will remain set up on open circuit for a long time with very little depreciation. It has a capacity of about 150 ampere hours, which means that it will furnish about 210 days' continuous service on a line where the current is 30 milliamperes and 40 days' service when the current is about 0.16 ampere. It gives but 0.67 volt E.M.F. in steady work.

The following complete directions for setting up, management, and renewal of these cells are furnished by the company manufacturing them:

DIRECTIONS FOR SETTING UP AND USING EDISON PRIMARY BATTERY, KNOWN AS EDISON CELL, TYPE V

TO CHARGE AND CONNECT BATTERIES

To make solution—Fill the cells with water to 1½ inches of the top. Add the caustic soda gradually to the water, stirring until the soda is entirely dissolved. When the solution cools, more should be added to bring it up to 1½ inches of the top. Then pour contents of bottle of heavy paraffin oil from bottle furnished for each jar on the solution. Note—The caustic soda will burn the skin and clothes. In stirring the liquid avoid splashing it.

To set up cells—Unscrew the nut N and the jamb nut M from the screw on the brass neck of the double zinc plate and remove the leather washer. Pass the screw from below through the central hole in the cover C. Replace the leather washer and the jamb nut M on the screw and tighten down the jamb nut until the zinc plate is rigid to the cover. The thumb nut N can then be screwed on.

Unscrew the nuts A A and jamb nut D from the screws on the two side pieces B B of the copper frame, leaving the flat leather washers in position on the screws, and pass the screws from below through the two round holes in the cover C. Replace the jamb nut on one of the screws and one of the thumb nuts on the other screw, and tighten both down until the frame sides are rigidly clamped to the cover. Replace the other thumb nut on the screw holding jamb nut. Then slip the hard rubber insulating tubes E E over the sides of the frame, one on each side.

To fill copper frames—(In this cell only one oxide plate is used.) (See figure 6.) Slide the oxide plate F sufficiently far into the frame to enable the copper bolt G to be passed underneath it through the slots in the bottom of the frame sides and the copper nut H tightened up on same. Be careful that the zinc plates do not touch the copper oxide plates or the cell will be short-circuited. The copper connection is made between the thumb nut A and the jamb nut D on one end of the copper frame and the zinc connection between the thumb nut N and the jamb nut M on the brass bolts suspending the zincs. After the oxide and zinc plates are properly connected to the cover, soak them in water and while still wet insert in jar filled with caustic solution. (Wetting the plates prevents the oil in jar from adhering to them.)

Important—In order to allow the cover on the jar to fit easily, it is advisable to wet the rubber gasket ring fitting into the grooved edge of the cover by placing it in water. This will cause the cover to slip on easily and will make the cell liquid tight. It is absolutely necessary that the upper edge of the oxide plates should be submerged at least 1 inch below the surface of the caustic soda solution in the jar; also on no account can the layer of oil on top of the solution be omitted.

RENEWING

When the cell becomes exhausted the solution and the remains of the zinc and oxide plates must be thrown away. The remaining parts can be used again.

TO TAKE THE CELLS APART

Lift the lids, unscrew the bolts, and remove the zincs and oxide plates. Wash off (with water) the copper frames, bolts, and rubber insulators, brightening up the metal where corroded with emery paper, especially the inside grooves of the copper frame sides. Pour away the solution carefully and set up cells with new caustic soda, oxide plates, and zincs according to directions.

Note—In taking the cells apart the parts that have been immersed in the caustic soda must be washed before they are handled.

TO ASCERTAIN IF THE OXIDE PLATES ARE EXHAUSTED

Pick into the body of the oxide plates with a sharp-pointed knife. If they are red throughout the entire mass, they are completely exhausted and need renewing. If on the contrary, there is a layer of black in the interior of the plate, there is still some life left, the amount being dependent entirely upon the thickness of the layer of black oxide still remaining.

COPPER FRAMES

When renewing the battery it is desirable to clean the inside grooves of the copper frames, where the copper-oxide plates make contact, so as to insure a good electrical connection. This is especially important where the batteries are required to give a heavy current for cautery or motor purposes. These frames can be easily cleaned by wrapping a small piece of emery paper around a stick which will just fit into the groove, or by immersing them in a diluted solution of 1 part of sulphuric acid and 4 parts water, and then carefully rinsing them in clean water to remove all traces of the acid.

Caution—The oxide plates should never be removed from the caustic soda solution and allowed to dry in the air, as, if this is done, the surface of the plates becomes oxidized by absorbing the oxygen from the air, and the oxide thus found is much more difficult of reduction than the original oxide of which the plates are formed. The internal resistance is consequently very greatly increased and the current materially diminished.

Note—Where batteries are placed in warm places they should be examined every two or three months to see that the solution has not evaporated, as this will gradually take place, in spite of the oil, if they are in a hot room. If the solution is found to have evaporated, add more water to bring it again to the proper height. It is of the first importance that all binding posts and connecting wires should be kept clean and bright at the points of connection.

The type V cell is excellent for use as an ignition battery or in lieu of small capacity storage batteries where no charging current exists. The Signal Corps uses this type of battery quite extensively in connection with the Alaska Military Cable and Telegraph System.

GROUPING OF CELLS

When it is necessary to cause a certain current to flow through a considerable resistance, as a long telegraph line, for instance, the necessary E.M.F. is obtained by connecting cells in series—that is, the copper of one cell to the zinc of the next, and so on until the requisite E.M.F. is obtained, the relatively small increase of the total resistance due to the internal resistance of the cells being of little effect. The total voltage is the sum of the voltages of all the units so connected. But when it is desired to get a certain current through a low resistance, another grouping must be made. The internal resistance of the ordinary gravity cell is about 3 ohms. And with its one volt E.M.F. the current through a short thick wire of no appreciable resistance connecting its poles will be one-third ampere. And if we have 100 cells in series and connect the terminals of the entire battery, we would get $\frac{100}{300}$ ampere, or one-third, as before. For any number of these cells in series, to obtain an increased current through low external resistance, we must cut down the internal resistance of our battery. This, with a given type of cell, may be done by linking them in parallel—that is, by connecting all the zincs together and all the coppers together and then connecting the multiple zinc and multiple copper thus obtained to the low external resistance. The E.M.F. of the battery remains the same as that on one cell, but the current output is now equal to the sum of the current capacities of all the units so connected.

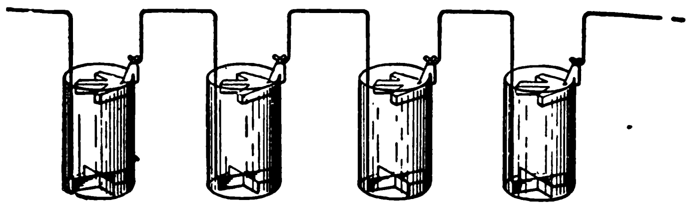


FIG. 7.—BATTERY CELLS CONNECTED IN SERIES

Figure 7 shows four cells of battery connected *in series*, and figure 8 shows four cells of battery connected *in multiple*, or parallel, as it is sometimes called. In the first case we should get a current of $(4 \div 12) = (1 \div 3)$ ampere through our short circuit; and in the second case $I = 1 \div \frac{3}{4} = (4 \div 3)$ ampere.

While in both figures the gravity cell is shown, the rule is applicable to any type, class, or make of primary or secondary battery cells.

Number and kind of battery cells required by various apparatus.

(Where more than one battery cell is indicated the cells are invariably connected in series.)

Instrument	Cell	Number of Cells
L. B. post-telephone switchboard[1]	Gravity Fuller	3 2
Camp switchboard	No. 6 reserve	2
L. B. telephone, post-telephone system.	do	2
Camp telephone	Type A tungsten	1 unit (2 cells)
Service buzzer	do	2 units (4 cells)
Induction telegraph set	do	do
Test buzzer for radio pack set	do	do
Flash-light	do	1 unit (2 cells)

[1]Either gravity or Fuller may be used for operator's transmitter circuit. In addition, 2 cells of No. 6 reserve may be used for night alarm.

SECONDARY BATTERIES

The storage battery differs from the primary battery in its action in that when it has given out all the energy the chemicals present enable it to supply, instead of requiring new elements, the cell can be completely regenerated or brought back to its original charged condition by passing a current into it in a direction opposite to that in which the flow took place on discharge.

Although there are many combinations which can be used for storage batteries, a large majority of those in commercial use and all those installed by the Signal Corps are of the lead-sulphuric acid type, which in its basic principle consists of two especially prepared dissimilar lead plates immersed in diluted sulphuric acid. Each cell of the lead-sulphuric acid storage battery has an E.M.F. of about 2.05.

The Edison storage battery, which has recently been developed and placed on the market, makes use of oxides of nickel and iron in the positive and negative electrodes respectively. The grids supporting the active material are made of nickel-plated steel. and the electrolyte is a solution of caustic potash and water. These cells when fully charged have a normal E.M.F. of 1.2 volts and are charged at about 1.7 volts. They stand abuse much better than the lead-sulphuric type of battery and are highly advantageous for vehicle purposes, as it is claimed the output per unit of weight is nearly twice that of lead cells. An idea of the ruggedness of this battery may be had when consideration is given to the fact that when the battery becomes unhealthy or impaired by lack of work. or too much work, short circuiting the battery for a moderate period will assist in returning the battery to a healthy condition.

Secondary batteries in the form of storage batteries or accumulators are used by the Signal Corps for supplying necessary current in connection with comparatively large telephone systems, signaling systems, and telegraph systems where a suitable charging circuit is available. When used for supplying current for the operation of post telephone systems, the systems are invariably

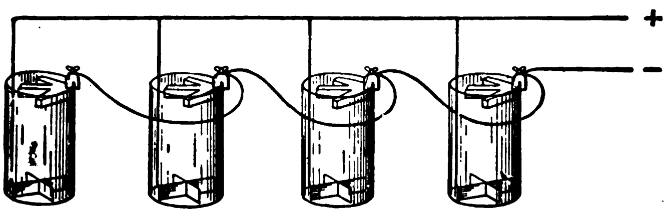


FIG. 8.—BATTERY CELLS CONNECTED IN MULTIPLE

what are termed "common-battery" or "central-energy" systems. With this type of system the current for operation of all apparatus is obtained from one battery. In a local-battery telephone system the switchboard and each telephone is equipped with a battery.

In fire-control systems at sea-coast defenses 15 cells of storage battery, connected in series, are installed for supplying current for operation of the telephone system of the fire-control system proper, and in a great many instances the same battery furnishes current necessary in the operation of the entire post telephone system. In emergency the same battery may also be used to supply all signal apparatus of the fire-control system, which normally is supplied by current obtained from a motor generator set, the motor generator set being used to charge the storage battery when operation of the system is not in progress.

Either a battery of 12 cells or a battery of 15 cells of storage battery, connected in series, are installed for supplying necessary current for operation of common-battery post telephone systems at interior posts.

GENERAL DATA CONCERNING THE STORAGE BATTERY

The elementary form of storage cell is made by immersing two lead plates in dilute sulphuric acid. The principle involved in the storage cell is the chemical action produced by a current which causes such changes of the lead plates in the acid that upon cessation of the current, if the two plates are connected together by a wire, a current will flow in the opposite direction from the original one and the plates will tend to return to their original condition.

The action of the current is to coat the plate that is connected with the positive pole of the charging dynamo with peroxide of lead, and to reduce to a spongy metallic condition the surface of the plate connected with the negative pole. When the plates are connected by a wire the peroxide coating tends to be reduced back to lead and the spongy lead on the other plate to become oxidized. The plates thus becoming alike the current will cease and the cell is said to be discharged. Various methods of manufacture are intended to give the plates more capacity; that is, to prepare more reducible peroxide on one and more spongy lead on the other. The means adopted are to make the plates up in the form of fine strips or grids of lead and fill in these interstices with the oxides of lead by various processes. These plates, being made up in sets, are then immersed in acid and given what is called a "forming charge," after which they may be used.

The plates as received from the manufacturer are of two kinds. The sets of plates of one kind are of a chocolate brown, while the other sets are of a grayish leaden color. When these are placed in the jars the sets of plates represent the zinc and copper, respectively, of a primary battery, the gray plates acting as zincs and the brown as copper. In connecting cells in series the brown set of one cell should be connected with the gray set of another, and so on. Care should be taken that no plates of different kinds touch on the inside of cells, and that the separators are properly placed, if these are furnished with the kind of cell used. The connecting lugs should all be brightened before they are bolted together, and after all connections are made it is well to go over them with a coating of cosmoline or asphaltum varnish. The cells should always be set up in a dry place, preferably where there is a good means of lighting and where there may be ample ventilation.

The first or initial charge of any storage battery takes a much greater length of time than the subsequent regular charges. The initial charge of any make of storage battery should be continuous if possible. With most batteries it takes from 50 to 60 hours to complete the initial charge, while the regular charge thereafter should be completed in approximately eight hours at the normal rate. The battery should be discharged below 1.70 volts per cell.

Purity of electrolyte is of first importance in storage battery operation, and all acid should be tested where a doubt as to its purity exists.

TELEPHONY—THE CAMP TELEPHONE AND THE BUZZER

MAGNETISM

A bar of steel or iron which has the properties of attracting other pieces of steel or iron is called a *magnet.* When freely suspended at its center it will point north and south. It can also impart these powers to another piece of iron or steel without losing any of its own.

The ends of a magnet are called its *poles.* The end which points toward the north is its north pole and the other end its south pole. The north end of any magnet will repel the north ends of all other magnets, but will attract all south poles. From this follows the law of magnetic attraction "like poles repel and unlike poles attract."

The force exerted by one magnet on another to attract or repel it is called *magnetic force.* If iron filings be spread on a paper laid over a bar magnet, the filings will arrange themselves about the magnet in curves which end at the poles. These curves are called *lines of force,* and the whole space occupied by the curves is the magnetic field of force, or *magnetic field.* It is assumed that the lines of force come out from the north pole of the magnet, pass through the air, re-enter the magnet at the south pole and pass through it to the north pole, thus completing the path. This path forms the magnetic circuit, and each of the lines of force completes it without crossing or combining with any one of the others in the field. A line of force always forms a closed loop so that as many lines enter the south pole as leave the north.

To make a magnet of a steel bar, place the bar flat on a table. Take the south pole of a magnet and stroke the bar with it several times, always from end to end in the same direction. The end of the bar first touched will then become a south pole and the end where magnet last touched a north pole. The bar will then be a magnet. Or wind a few turns of insulated wire around the bar and pass a current of electricity through the wire for a short time, gently tapping the bar with a hammer while the current is flowing. Upon removing the bar from the coil it will be found to be a magnet.

If a piece of iron, mounted on a pivot so it is free to swing about, be placed in a magnetic field of force, the iron will move so that the greatest number of lines of force of the field will pass through it. If the movable body be a magnet, for example, a compass, it will turn, under the influence of the field, so that not only the greatest number of lines of force will pass through it, but also that its own lines of force will be in the same direction as those of the field. Upon this fact is based the construction of many forms of electrical instruments.

If a bar of soft iron be placed in the field of a bar magnet, we will find on testing the soft iron bar that it, too, has become a magnet having two distinct poles. The iron bar is called the body under induction, the magnet the inducing body, and this phenomenon *magnetic induction.* Magnetic induction is defined as the action and reaction which occur when a magnetic field makes a magnet of a body placed therein.

Electromagnetism

Every wire through which a current flows possesses a magnetic field around it. This fact can be proved by bringing a compass near it. The magnetic field will act on the compass, and the needle will be deflected, showing not only the presence of a magnetic field but also the direction of the lines of force. These will be found to encircle the wire, always running from left to right, similar to the direction in which the hands of a clock move, assuming that the current is flowing directly away from the observer.

A *solenoid* consists of one or more layers of wire wound on a spool, usually of nonmagnetic material, the length being great as compared with the diameter. A magnet can be made of a solenoid by passing a current of electricity through the wire. One end of the coil will be the north pole and the other the south pole. If an iron bar be placed lengthwise through the coil while the current is flowing, it will be found that the magnetism has been increased. This is due to the fact that lines of force are much more easily set up in iron or steel than in a nonmagnetic medium. A solenoid with such an iron core constitutes an *electromagnet.* The current's magnetic field induces magnetism in a piece of iron placed within its limits.

If the iron core of a solenoid is pulled out while the current is flowing the attractive force of the solenoid will tend to pull the core back until its middle point coincides with that of the solenoid. This principle is made use of in many electrical devices, such as circuit breakers, ammeters, and telautographs. Electromagnets are used in many kinds of instruments—electric bells, telegraph sounders, telephone receivers and relays are examples. The strength of any electromagnet depends on the turns of wire and the strength of current passing through it.

Electromagnetic Induction

If a straight wire be moved across a magnetic field so as to cut lines of force, a difference of potential will be set up between its ends. If the ends of the wire be connected outside the field, a current will flow. This is called *electromagnetic induction,* and the currents so produced are *induced currents.* Upon the principle of induction is based the operation of all dynamos, transformers, induction coils, telephones, etc.

No distinction is made between the magnetic field of a permanent steel magnet and that of an electromagnet. Either the magnetic field or the closed circuit may be moved so long as the lines of magnetic force are made to cut the wire of the closed circuit. Usually a coil of wire with an iron core (electromagnet) is used to produce the induction. It is then called the primary coil, or simply "primary." The closed circuit, or the circuit under induction, is then called the secondary coil, or "secondary."

Current may be induced in the secondary by any of the following methods:

1. By moving either the primary or secondary while current is flowing in the primary.
2. By making or breaking the primary circuit.
3. By altering the current in the primary.
4. By reversing the direction of current in the primary.
5. By moving the iron core while current flows in the primary.

Electrostatic Induction

It has been found that an insulated conductor, such as a sheet of tin, an aerial-line wire, or a cable conductor, has the property of receiving an electrostatic charge when subjected to an electromotive force. If, for instance, a conductor of the type mentioned in the preceding paragraphs be thoroughly insulated and one terminal connected to one side of a battery, the other side of which is grounded, a certain amount of electricity will flow into the conductor and appear upon its surface as an electrostatic charge, and the potential of the conductor will be raised to that of the battery. The conductor in this condition is said to be *charged* and holds an amount of electricity depending upon its capacity. The charge is of the same polarity as the terminal of the battery to which the conductor is connected.

Experiment has determined that a charge can not exist on a conductor except there be an equal and opposite charge induced upon the bodies surrounding it, and this second induced charge is always of opposite polarity to that of the first charge. If now the conductor be connected to the ground it will lose its charge, but the charge of opposite sign on the surrounding bodies will still be held, although having no connection with the first body or with the source of electromotive force. This action by which bodies are charged through an insulating medium constitutes *electrostatic induction*, and the arrangement of two insulated conductors separated by an insulated medium constitutes a *condenser*. The most common type of condenser is the Leyden jar, in which the insulated conductors are sheets of tin foil, one placed on the outside, the second on the inside of the glass jar, the latter forming the insulating medium or *dielectric*, as it is commonly called. The capacity of the condenser, or its ability to receive an electric charge, varies in direct proportion to the area of its plates inversely as the square of the distance between the plates and directly as the specific inductive capacity of the dielectric. Where air is used as the dielectric, this latter quantity is unity. The substances, other than air, ordinarily used as dielectrics have a specific inductive capacity two to three times as great as that of air. Condensers used for telephone purposes where it is necessary to obtain considerable capacity in very limited space, are commonly built up of alternate layers of tin foil and paraffined paper tightly pressed, so as to bring the layers of tin foil which comprise the plates as close together as possible. The condenser is very extensively used in telegraph and telephone work as a means of allowing alternating or pulsating currents to pass while preventing the flow of direct currents. This is the direct opposite of the functions of an impedance coil, which imposes a very high resistance to variable currents while offering little resistance to the flow of direct current.

Principle of the Transformer

An induction coil, or transformer, consists of two independent coils wound on the same iron core and insulated from each other and from the core. Alternating or interrupted currents in one of the coils (called the primary) produce a variable number of lines of magnetic force in the iron core, and thus currents are induced in the other coil (secondary), so that any E. M. F. that may be applied to the primary may be changed to a higher or lower one in the secondary. The ratio of primary to secondary E. M. F. is equal to the ratio of the turns in the two coils. For example, if there are 10 turns in the primary and 100 turns in the secondary, the induced E. M. F. will be 10 times greater than that used in the primary. When a low E. M. F. in the primary is changed to a higher one in the secondary coil, the latter loses in current strength what it gains in pressure. For example, in this case, if there is 1 ampere current at 10 volts pressure in the primary and the E. M. F. of the secondary is 100 volts, only 0.1 of an ampere of current would be flowing through the latter. This assumes that there are no losses in the transformer. This principle is made use of to generate very high electromotive forces such as are used in wireless telegraphy.

Theory of the Telephone

In the act of speaking the vocal cords cause air vibrations, which, falling upon the drum of the ear, are recognized by the auditory nerves as speech. If, instead of falling on the eardrum, these vibrations should fall upon a diaphragm which is capable of changing them into electrical vibrations, and there is some means of transmitting them along a line and again reproducing them at the other end into similar air vibrations, we have the telephone. In order to understand the action of the telephone it is necessary to define lines of force and explain two simple laws of magnetic induction. Lines of force are imaginary lines which surround a magnet and indicate by their position and number the direction and strength of its action. The laws of magnetic induction referred to are: First, if a number of lines of force thread or pass through a coil of wire and this number is increased or diminished, a momentary current will flow in the coil; second, if a coil of wire be wound around a permanent steel magnet and a current of electricity be sent through the windings, it will, if in a certain direction, increase the strength of the permanent magnet, and if in the opposite direction will diminish its strength. To understand how articulate speech is transmitted by means of the telephone, let us take the simplest case of two telephone receivers, A and B, connected to the line as shown in figure 1.

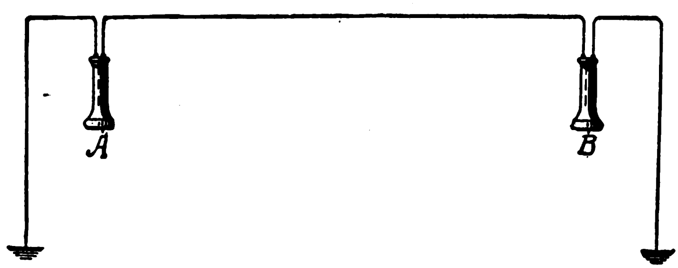


FIG. 1.—TELEPHONE CIRCUIT SIMPLIFIED, USING TWO TELEPHONE RECEIVERS

The telephone receiver (a more detailed description of which will appear later) consists of a soft-iron diaphragm placed close to a permanent magnet. Around the diaphragm end of this magnet is wound a coil of fine insulated copper wire. The air vibrations, caused by the act of speaking, upon striking the iron diaphragm at A cause it to vibrate. The vibrations of this diaphragm produce changes in the number of lines in force which thread through the windings of the coil. These changes, according to the first law, produce a current in the winding which will be of greater or less strength and in opposite directions, following the vibrations of the diaphragm. This varying current proceeds along the line, and when it arrives at B will increase and diminish the strength of B's magnet. The variation of the strength of B's magnet will produce a varying pull on B's diaphragm and cause it to vibrate in a manner similar to the diaphragm of A. The vibration of the diaphragm at B is recognized as sound coming from A. The simple circuit shown in figure 1 would permit a person to talk or hear, as the case may be. The first modification of the circuit (fig. 2) is to introduce two telephone receivers at the point A and two at the point B, all being in series, one serving as the transmitting and the other as the receiving instrument at each point.

For certain reasons this type of receiver just described does not make a good transmitter, and in practice is replaced by a battery transmitter.

A complete local battery telephone instrument consists of a receiver, local battery transmitter, induction coil, magneto generator, call bell, and certain switching devices which are contained in the magneto-generator box.

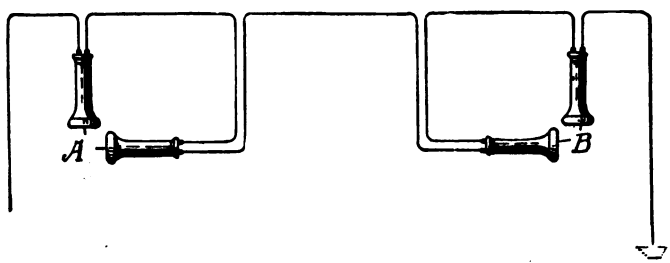


FIG. 2.—TELEPHONE CIRCUIT SIMPLIFIED, USING FOUR TELEPHONE RECEIVERS

A complete common battery instrument consists of a receiver, transmitter, induction coil, condenser, call bell, and hook switch.

Local Battery Transmission

The battery transmitter depends for its action on the fact that a varying pressure changes the resistance of carbon. The transmitter consists of a number of *carbon particles* or granules in a proper receptacle with a means of varying the pressure upon the granules in circuit with a battery and the coarse-wire winding of an induction coil. The induction coil consists of a bundle of soft-iron wires, surrounded by two windings of insulated copper wire, one being of coarse wire, with few turns and low resistance, called the "primary." and the other of fine wire, with a large number of turns and higher resistance, called the "secondary." The relative position of these various parts of a local battery instrument is indicated in figure 3, in which T is the transmitter that contains the carbon granules through which the current from battery B flows. T also contains a diaphragm which presses on the carbon granules, or is so connected with them as to vary the pressure between the particles as the sound waves fall on it. P is the coarse and S the fine wire winding of the induction coil which is connected to the receiver R and the line. The local battery circuit includes B, P, H, and T.

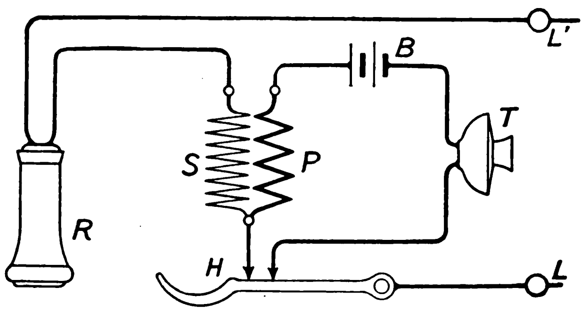


FIG. 3.—SIMPLIFIED LOCAL BATTERY TELEPHONE CIRCUIT

As the air vibrations fall on the diaphragm at T they produce a change in the resistance between the carbon particles in contact with it. This change of resistance causes the current flowing in the coarse-wire coil to fluctuate, thereby inducing an alternating current in the fine-wire coil, which goes to the line and receiver and reproduces speech, as has been explained before.

Common Battery Transmission

The common battery telephone operates similarly to the local battery telephone in its essential details. The principal point of difference lies in the fact that in common battery operation the current which flows through the transmitter is furnished by battery installed at the central exchange in place of local battery installed in the instrument, as in the case of the local battery telephone. In the common battery telephone, battery is supplied over the same wires that are used for transmitting speech. Figure 4 shows most of the essential parts of the common battery instrument. The induction coil for this type of instrument is usually provided with primary and secondary windings having more nearly the same number of turns and resistance than is found in the local battery instrument. The receiver and transmitter are practically identical with similar parts of the local battery telephone. The operation of a typical set is as follows (referring to Fig. 4):

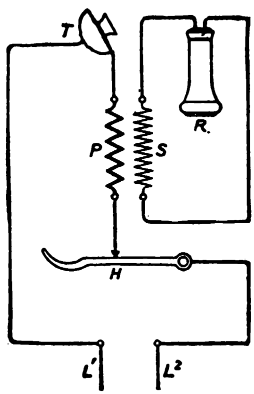


FIG. 4.—COMMON BATTERY TELEPHONE CIRCUITS, SIMPLIFIED

Direct current from the positive side of the battery at the central exchange enters the instrument over the line L,[2] passes through the hook H, primary winding P of the induction coil, transmitter T, and leaves the instrument by the line L^1. If the transmitter T is spoken into, the diaphragm, vibrating, produces a change in the resistance between the carbon particles placed near it. This varying resistance causes a corresponding variation in the current flowing, which is received at the distant station as speech. This varying current in the winding *P* acting upon the winding *S*, which is placed upon the same core, induces a current in the receiver circuit composed of the receiver *R* and the winding *S*. In the case of receiving from a distant station the voice current may be considered to follow the same course as that taken by the battery current. This current, however, is variable, and in passing through the winding *P* of the induction coil induces a current in the receiver circuit.

In the normal condition of the instrument when not in use the receiver *R* draws down the hook *H*, opening the contact, thus preventing the flow of battery when the instrument is not in use.

Owing to the fact that the common battery instrument depends for its operation on direct current in the line, the range of such operation is necessarily limited by the resistance of the line circuit. When the resistance of the line becomes so high as to materially cut down the strength of current, loudness of voice waves transmitted is correspondingly decreased.

Magneto

The magneto generator is largely used for producing the calling current. It is the simplest form of electric dynamo and consists of an armature wound with many turns of fine wire so mounted as to enable it to be rapidly revolved between the poles of a permanent horseshoe magnet. Its theory depends upon the principle that if the number of lines of force passing through a closed coil be varied a difference of potential will be developed between the terminals of this coil, and if an external circuit be connected electric current will flow, the direction of which will depend upon the relative direction of the lines of force and the movement of the coil.

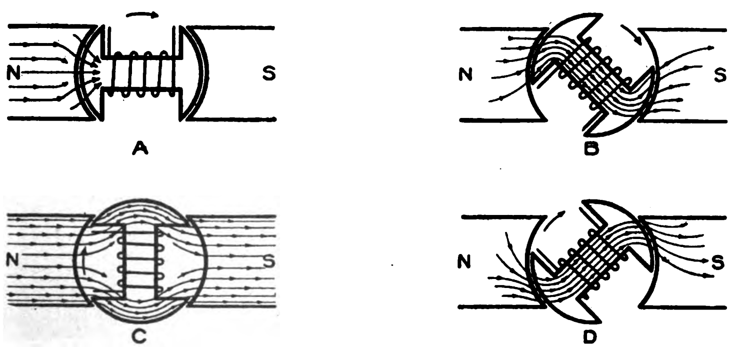


FIG. 5.—THEORY OF TELEPHONE MAGNETO GENERATOR

The following from "Telephonology," by Van Deventer, clearly explains the action of the magneto generator:

A magneto generator is shown in theory in figure 5. *N. S.* represents ends of the permanent magnets. The center opening is known as the "field." In this is placed the revolving armature upon which is wound many turns of insulated wire. The manner in which the current is generated will be understood from a careful study of the figures.

Magnetic lines of force are flowing across the field from the *N* to the *S* pole. To generate a current the wire must move across the lines of force, and in *A* the maximum number of lines are passing through the coil. The number of lines does not change until the armature has passed beyond the position shown in *B* and the voltage is 0. A little beyond *B* the lines begin to decrease, and current is generated until *C* is reached, when the remaining lines are shortened out of the coil and the rate of change of the lines is greatest and the voltage is at a maximum. This is the peak or highest point of the wave, shown in figure 6.

When the position shown in *D* is reached the lines of force pass through the coil in the opposite direction and the voltage drops to 0. This continues as long as the crank is turned.

While the wire is passing from the position of *A* to that of *B* a plus current, or, as it is termed, a positive current, is generated if the north pole of the magnet is on that side, while from that in *C* to *D* a minus or negative current is generated, because the wire is there subject to the influence of the south pole.

Plus current is represented by the sign + and minus current by the sign —. Current flowing first in one direction and then in another is called alternating current, and figure 6 illustrates waves

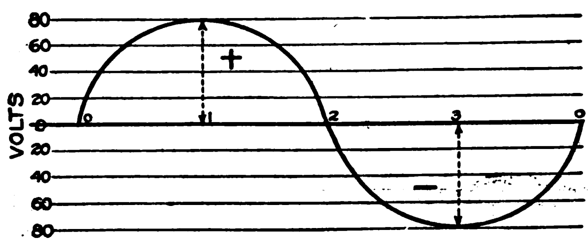


FIG. 6.—VOLTAGE CURVE OF TELEPHONE MAGNETO

of a current of this kind given by a magneto generator. On the left are figures representing the voltage, while the points O, 1, 2, etc., along the curved lines represent the different positions of the wire during one revolution and correspond to those in figure 5. Starting at line O where there is no current, we will suppose that the upper curved line represents plus current and the lower curved line minus current. From this it will be seen that current from the telephone generator flows first in one direction and then the other, the voltage increasing from 0 to 1, and then decreasing to 2, as the wire at this point (see B, Fig. 5) is no longer cutting across the lines of force. The current then increases to 3 in the opposite direction (see C, Fig. 5), and again decreases to 0 (D Fig. 5).

Magneto generators used by the Signal Corps are provided with an automatic device which opens the armature circuit when the armature is at rest.

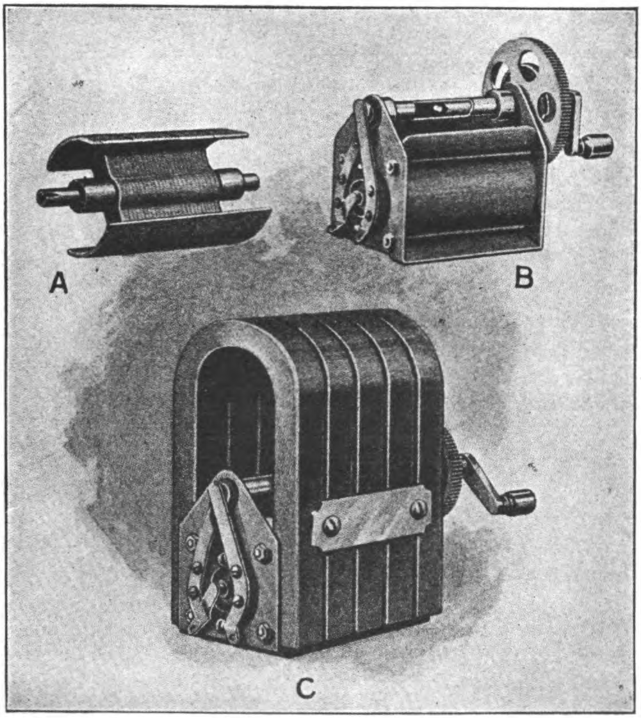


FIG. 7.—TELEPHONE MAGNETO GENERATOR

At the usual rate of turning the magneto generator by hand the voltage will be about 65 to 75 and the frequency about 15 complete cycles, or 30 alternations, per second.

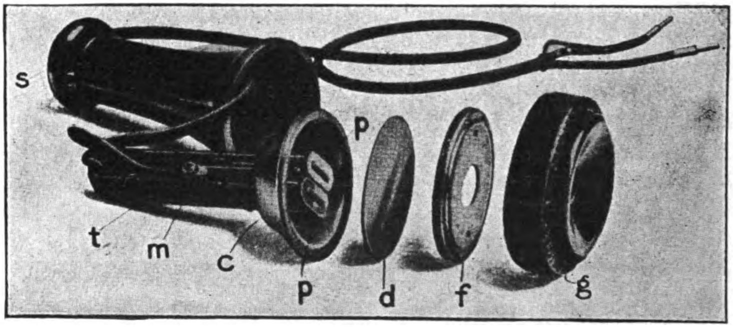


FIG. 8.—TELEPHONE HAND RECEIVER

In figure 7, *A* shows the generator armature on which are wound the many turns of fine wire which are revolved in the magnetic field referred to. It will be noted that this armature is made of a large number of thin stamped metal pieces which are assembled on the armature shaft as shown. In part *B* of this figure the generator armature, wound, has been placed within the generator frame. Contact pieces of the device for closing the generator circuit, mounted in place on end of the generator frame, are shown in the figure. On the other end a gear which meshes with a small pinion on armature shaft and a crank for revolving are shown. When crank is rotated in clockwise direction, the shaft, upon which is mounted the gear, automatically protrudes through end of frame, thereby closing the two contact pieces which automatically open when revolving of crank ceases.

C shows a complete generator of the 5-bar type, with horseshoe magnets in place.

Generators used by the Signal Corps are provided with 3, 4, or 5 bars, depending upon the class of service in which they are to be used.

Receiver

A hand receiver of the type now used in the Signal Corps is shown in figure 8.

It consists of a U-shaped permanent magnet *t*, to the ends of which are fastened soft-iron pole pieces *p p*. Over each pole piece is a coil of fine wire wound on a bobbin with nonmagnetic metal heads. These coils are connected in series in such a manner as to make the front end of one the north pole and the similar end of the other the south pole when current flows through both coils in a certain direction. The combined resistance of these coils connected in series is about 80 ohms. The pole pieces pass through the bottom of a metal cup *c*, which is thus secured firmly in place. The diaphragm *d*, of soft iron, tinned or enameled, rests on the rim of this cup. A clamping ring *f* screws on the metal cup *c*, thus holding the diaphragm *d* firmly in place. The receiver cords are connected to terminals *m*, a strain cord being attached to the loop of the magnet to provide against injury to the cord conductors. As thus assembled the receiver is operative and may be so used in case of accident to the containing shell and cap. This shell *s* slips over the working parts of the receiver and is held in place by the earpiece *g*, which screws on the shell. The separation of the diaphragm from the pole piece varies with the different types of receivers, the usual separation being about 0.014 inch.

The operation of the receiver is as follows:

The pole pieces *pp*, being attached to the ends of the permanent magnet *t*, have one a north and the other a south polarity, and the magnetic circuit is completed from one pole to the other through the soft iron diaphragm *d*, which is, therefore, drawn toward the poles and held in constant tension. If a current flows through the coils in such a direction that the lines of force due to it coincide with those of the permanent magnet, the diaphragm will be pulled closer to the pole pieces, due to the increased strength of the magnetic field. If the current flows in the opposite direction, the strength of the magnetic field, due to the permanent magnet, will be reduced and the diaphragm will spring farther from the poles. It will thus be seen that whether the lines of force due to the current in the coils assist or oppose those due to the permanent magnet, a varying pull is produced on the diaphragm that causes vibrations in the latter in unison with the changes in current. The movement of the diaphragm will thus set up vibrations in the surrounding air which may be perceived as sound.

Transmitter

The operation of the transmitter depends on the fact that the electrical resistance between two or more bodies, either in light or loose contact, varies with changes in the pressure between the bodies. The change in resistance is due to variation in the area of contact surface between the granules and electrodes and not to compression of the carbon granules themselves. In general, the transmitters used by the Signal Corps depend on this principle. A typical transmitter is shown in figure 9. A metal cup, *A*, forms the front electrode and is attached to the diaphragm for sending. The rear electrode is held rigidly in a metal bridge piece, *F*, which is in turn fastened to the frame which supports the mouthpiece *G*, and the remainder of the transmitter. This rear electrode consists of a hard, polished, carbon button, *M*, secured to a brass button between two parts of which is clamped a mica ring or diaphragm, *O*, the outer edge of which is clamped against the front electrode, *A*, by means of a metal ring, *S*, which screws over *A*. The space between the front and rear electrodes is partly filled with hard granular carbon of uniform size. Two dampening springs, *B* and *C*, are provided to prevent vibration of the diaphragm at its natural period.

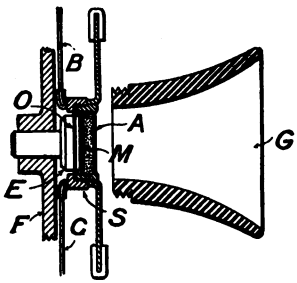


FIG. 9.—TELEPHONE TRANSMITTER

The operation of the transmitter is as follows:

Current from a battery passes from one terminal, *E*, to the carbon electrode through the granular carbon to the metal cup which forms the other electrode. If the transmitter now be spoken into, the diaphragm and cup vibrate in unison with the sound waves produced in the air, thus causing the pressure between the front and rear electrodes on the granular carbon to vary and thus change the resistance of the transmitter. Therefore, variations in the current are set up which correspond exactly with the voice vibrations which reach the transmitter diaphragm.

Ringer

The magneto generator is commonly used in connection with a polarized bell, or ringer, as it is usually called, by means of which audible signals indicate the incoming calls on the telephone instruments. The usual form of this piece of apparatus is shown in figure 10. In this figure *c c* represents soft-iron cores upon which are wound coils of fine wire connected in series with the line wires $l\ l^1$. *N S* is a permanent magnet, and *A* a soft-iron armature pivoted at its center. A slender rod terminating in a small metal ball is attached to the center of the armature. When no current is flowing through the coil the permanent magnet *N S* causes the upper ends of the cores to be north poles and the opposite ends to be south poles. In this condition the armature will be attracted by both cores and will rest against one or the other, as may chance to happen. If current passes through the coils in series in such direction as to increase the strength of the north pole *f*, and to make *e* south pole or weaker north pole, then *f* will attract the end

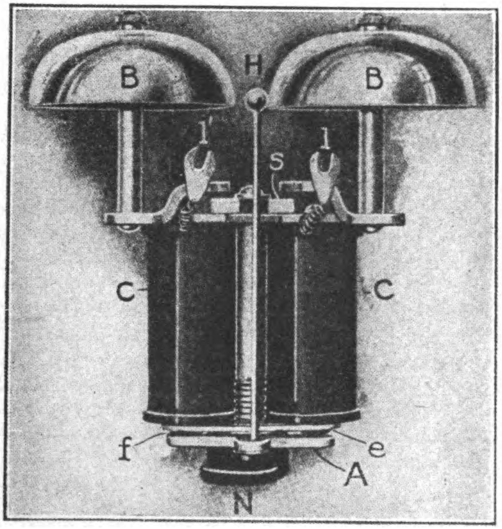


FIG. 10.—TELEPHONE RINGER

of the armature opposite it, while *e* will repel this end of the armature or attract it with smaller force. If the current is now reversed in direction so that *f* becomes a south pole or a weaker north pole and *e* a stronger north pole, the action will be reversed, *e* will attract its end of the armature and *f* repel its end or attract it with smaller force. With the ringer connected to the magneto generator as shown in this figure, the armature will vibrate between the two gongs with the same frequency as the current produced by the hand generator, and a practically continuous ringing sound will result. Practically all of the ringers used by the Signal Corps are wound to a resistance of 1,000 ohms.

Types of Instruments

The principles upon which depends the operation of the various parts of the telephones have been explained in the preceding pages.

The complete circuits of the instruments of the various types used by the Signal Corps will now be considered, and it will be assumed that the operation of the various parts as just explained is understood, and will not be discussed further. The instruments to be described have been selected as being typical of those now in use, and while slight modifications of the circuits shown may be encountered it is believed that if a person familiarizes himself with these circuits no trouble will be experienced in mastering any which are slightly different.

It will be noted that desk telephones of local battery and common battery types employ precisely the same principles as wall telephones, but that it is necessary to modify circuits and relative positions of component parts in order to meet requirements whereby the ringer (and magneto generator in local battery instruments) are stationary and the transmitter, receiver, and hook switch (as a unit) are movable. To accomplish this, all manufacturers employ the well-known desk stand and ringer box, connecting the two by means of a flexible cord consisting of two or more conductors. Some manufacturers place the induction coil in the ringer box and others in the base of the desk stand.

Circuits of the local battery telephone are as follows, reference being made to figure 11.

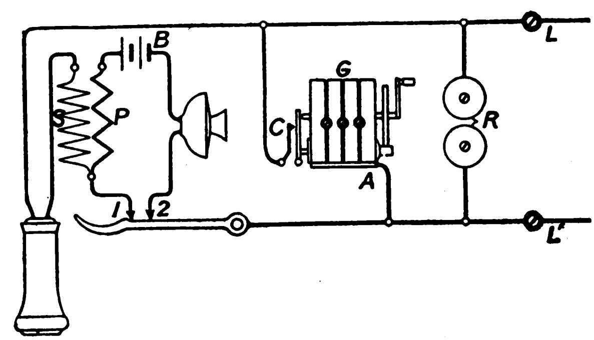


FIG. 11.—CIRCUITS OF LOCAL BATTERY TELEPHONE

Being Called.—Hook switch contacts shown in diagram as closed would be open, as receiver would not be removed from hook of hook switch. Magneto generator current enters at *L*, to ringer, to L^1.

Calling Distant Station.—Hook switch contacts shown in diagram as closed would be open, as receiver would not be removed from hook of hook switch. Revolving crank of magneto generator contact at C is closed and circuit is C to L, through one side of line, to ringer of distant station, through other side of line, L^1 to A.

It will be noted that ringer of station calling will also be operated. The reader will bear in mind that the windings of ringers are of high impedance, which, as previously explained, offers a very high resistance to the high frequency alternating currents transmitting the sound waves, and for this reason they can be connected direct across the line. The magneto generators are capable of operating forcibly under usual line conditions approximately ten ringers.

Listening.—Hook-switch contacts are closed as shown in diagram, as receiver should be removed from hook. A high voltage, high frequency alternating current from distant telephone enters at L, passes through receiver, secondary of induction coil, contact 1, hook of hook switch, and L^1.

Talking.—Hook switch contacts are closed, as shown in diagram, as receiver would be removed from hook. Direct current flows in primary circuit as follows: Battery, transmitter, contact 2, hook of hook switch, contact 1, primary of induction coil. Voice waves fall on diaphragm of transmitter, varying strength of current in primary circuit, thereby inducing in secondary of induction coil a high voltage and high frequency alternating current which is transmitted to distant receiver by means of the following circuit: Secondary of induction coil, contact 1 of hook switch, hook switch, L^1, one side of line, circuit of distant telephone, other side of line, L, receiver, connection to induction coil.

A few commercial standard local battery telephones are shown in figures 12 to 15 which follow:

Local Battery Wall Telephone

The circuits of the local battery wall telephone of the Sumter Telephone Manufacturing Co.'s make are shown in Figure 12.

This figure indicates the actual wiring of the instrument and the parts correctly placed with relation to each other as they are mounted in the instrument. The circuits of this instrument may be traced as follows:

1. Incoming signals enter at line L^1, pass to hinge C, to bell B, to hinge C^1, and return to line L. The hook switch is shown in its normal position with the hand receiver in place, all contacts being open.

2. Outgoing signals pass from one pole of the generator G to the line L, through the distant instrument and return on L^1 to hinge C, to the opposite pole of the generator G. In this instrument the bells B are permanently connected between the lines L and L^1, as is also the generator G. The latter, however, by means of its switching device, is open circuited when not in operation.

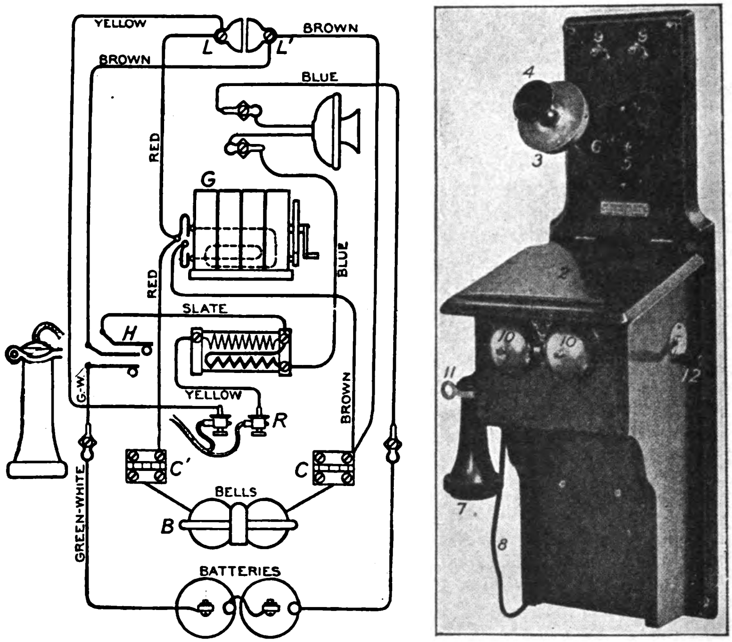


FIG. 12.—SUMTER LOCAL BATTERY WALL TELEPHONE AND CIRCUITS

Key to reference numbers:—1, backboard; 2, hinged shelf; 3, transmitter; 4, transmitter mouthpiece; 5, transmitter bracket; 6, bracket arm; 7, hand receiver; 8, cord of hand receiver; 9, binding post line; 10, gong for ringer; 11, hook for switch; 12, magneto crank handle.

3. The local battery and transmitter circuits pass from the battery through the transmitter and the coarse-wire winding of the induction coil through the hook-switch *H*, which now has all contacts closed, to the opposite pole of the battery. The receiving circuit passes from L^1 to the hook switch *H*, through the fine-wire winding of the induction coil, through the receiver *R*, to the line *L*.

Local Battery Desk Set

In figure 13 is shown circuits of the local battery desk telephone of the Sumter make, as furnished to the Signal Corps. The usual bridging circuit is used. The diagram shows the actual wiring as it is found in the instrument, and the various parts are shown correctly placed with respect to each other.

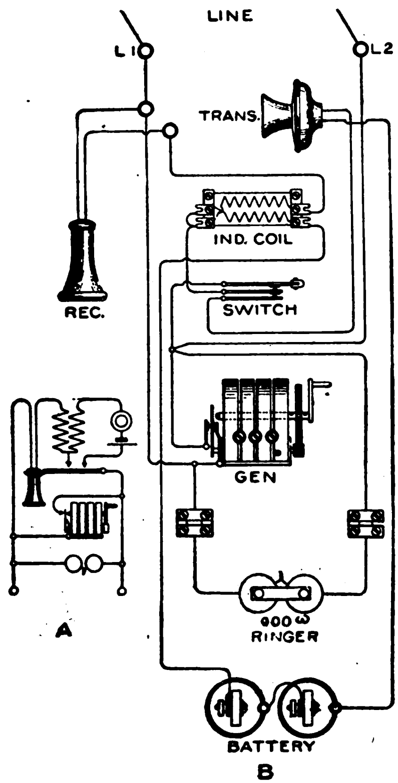


FIG. 14.—CIRCUITS OF GARFORD LOCAL BATTERY WALL TELEPHONE

The wiring of the Garford local battery wall telephone, which is furnished by the Signal Corps is shown in figure 14. In this figure, *A* shows a simplified circuit, and *B* the wiring as actually found in the instrument with the parts correctly located with respect to each other.

Figure 15 shows the Garford local battery desk telephone and the circuits employed with this instrument.

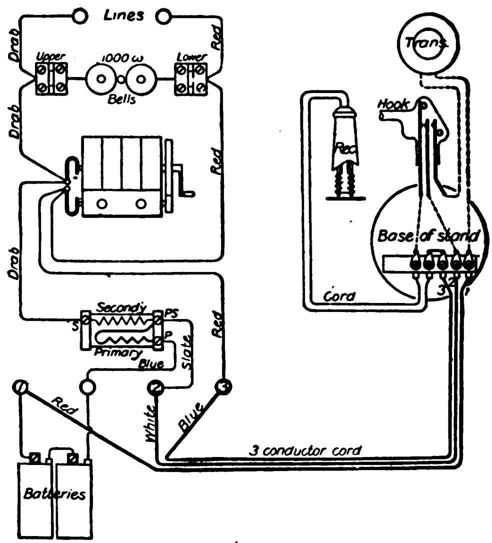


FIG. 13.—CIRCUITS OF SUMTER DESK LOCAL BATTERY DESK TELEPHONE

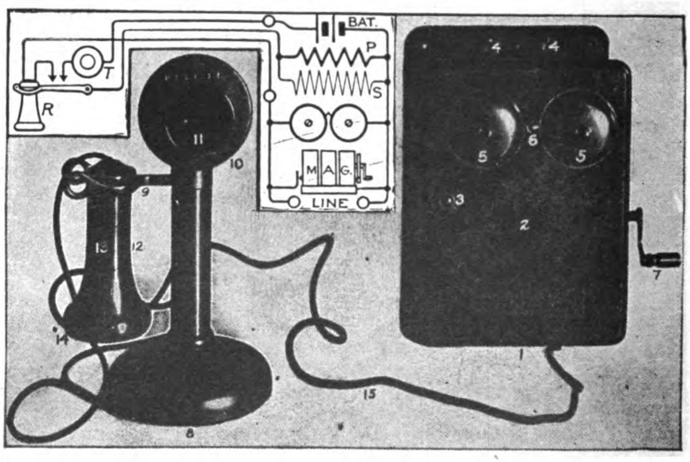


FIG. 15.—GARFORD LOCAL BATTERY DESK TELEPHONE.

Key to reference numbers:—1, ringer box; 2, door for ringer box; 3, screw fastener for ringer box; 4, line binding post; 5, gong; 6, hammer and armature; 7, magneto crank handle; 8, desk stand; 9, switch hook; 10, transmitter; 11, transmitter mouthpiece; 12, hand receiver; 13, shell for receiver cap; 15, main cord

Common Battery Telephone

In general it may be said that the parts used in the common battery wall telephones are similar to those used in the local battery.

It will usually be found that the primary of the induction coil used in the common battery instruments is of higher resistance, and that the ratio between the primary and secondary windings of the induction coils are quite different. The distinguishing difference between the commercial local battery telephone and common battery telephone is that the common battery instrument is not equipped with a magneto generator for calling, or batteries for furnishing current for transmitting sound waves, and is equipped with a con-

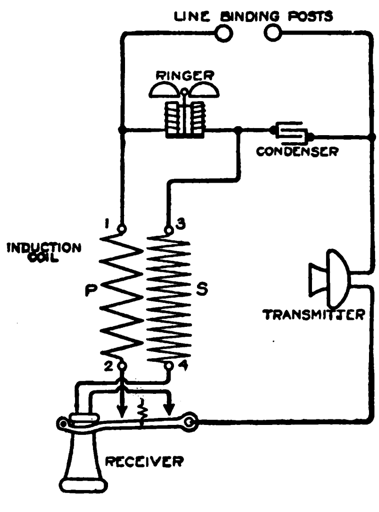


FIG. 16.—CIRCUITS OF WESTERN ELECTRIC CO. COMMON BATTERY WALL TELEPHONE

denser in series with the ringer. The secondary of induction coil in the local battery telephone is in series with outside line and receiver when receiver is removed from switch hook, while with the common battery instrument under similar conditions the secondary of induction coil is in series with receiver, transmitter and condenser, the primary of induction coil being in series with transmitter and outside line. By reference to figure 16, which shows circuits of the common battery telephone, it will be noted that the paths of both the current in primary of induction coil and current in secondary of induction coil traverse the same line through transmitter. They do not interfere with each other in any way, and the transmitter, being of low ohmic resistance and practically zero impedance, offers comparatively no resistance to either.

The reason for this rearrangement of component parts is due to the fact that battery for furnishing necessary current for operation is remote from location of telephone and is conducted to instrument by means of the line wires. The battery usually consists of 12 or 15 cells of storage battery having a voltage of 24 or 30. respectively.

While the ohmic resistance of the ringer is comparatively high, usually being 1,000 ohms, it will be seen that by connecting this direct across the line a considerable waste of current would ensue,

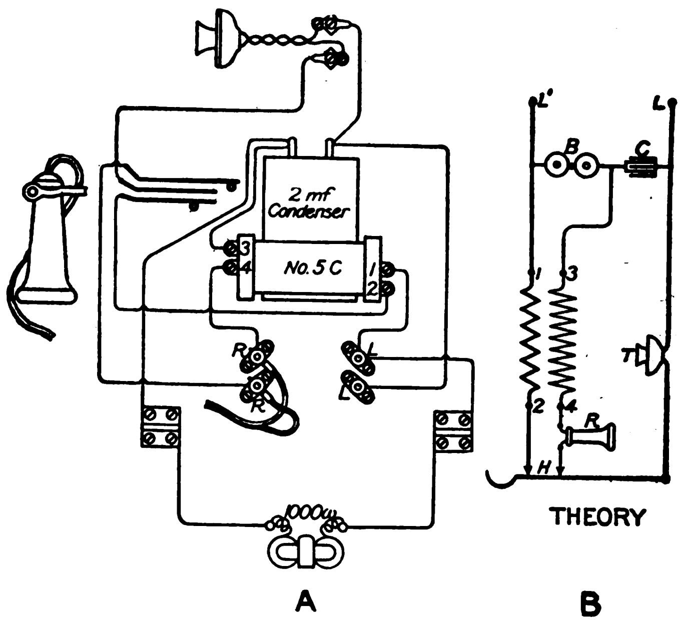


FIG. 17.—CIRCUITS OF SUMTER COMMON BATTERY WALL TELEPHONE

consequently the condenser which opens the direct current circuit is placed in series with the ringer across the line. Another reason for this condenser is that with the commercial common battery telephone the operator at switchboard is signaled by merely removing receiver from hook, thereby closing the direct current circuit through a magnetic device at switchboard. The devices are ordinarily of 200 ohms resistance and operate on approximately 0.01 of an ampere of current, so that by referring to Ohm's law in another chapter the reader can readily determine that this signal would be held closed if the 1,000-ohm ringer were connected directly across the ordina y line without condenser in series.

A few commercial standard common battery telephones are shown in figures 17 to 22.

The circuits of the common battery wall telephone of the Sumter Manufacturing Co. are shown in figure 17. *A* shows the wiring of the instrument and the parts with correct relation to each other,

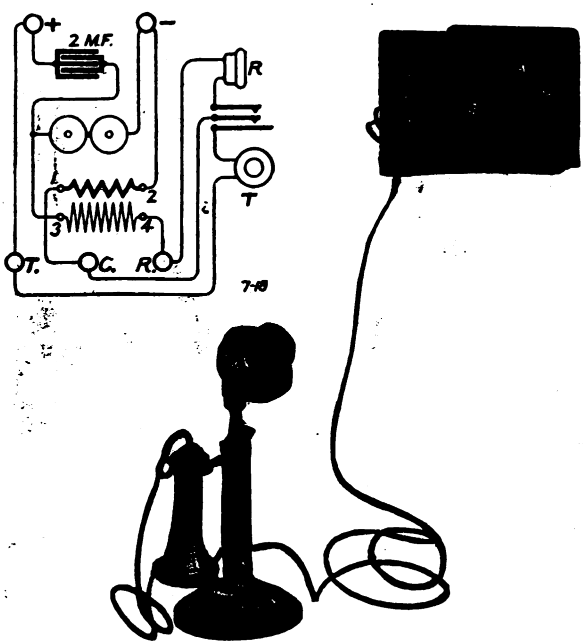
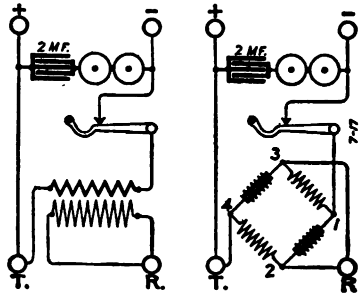


FIG. 18.—COMMON BATTERY DESK TELEPHONE

and *B* a simplified circuit diagram of the instrument. The operation of the instrument is as follows:

Assuming that the receiver is in place on the hook switch, the incoming ringing current will pass from the line L^1 through the



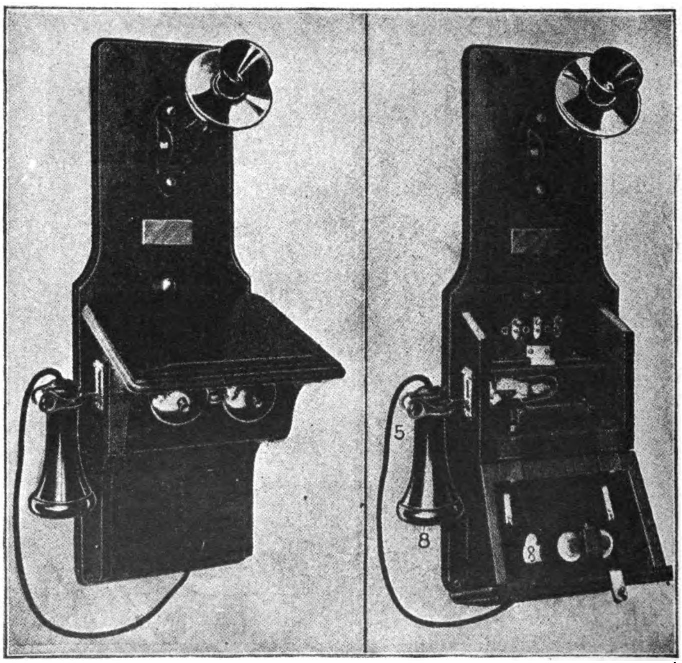


FIG. 19.—COMMON BATTERY WALL TELEPHONE

Key to reference numbers:—1, line binding post; 2, induction coil; 3, induction coil terminals; 4, condenser; 5, hook; 8, shell for receiver; 9, ringer bells B, condenser C, to the line L, ringing the bells B. The hand receiver being removed from the hook switch, the contacts at H are closed. In this condition the battery from the central exchange passes from L^1 through the coarse-wire winding of the induction coil, through the transmitter to the line L. Battery also passes from the bells B, secondary or fine-wire winding of the induction coil, receiver R, transmitter T, to the line L. The resistance of this second path is very much greater than that of the first path, so that the current flowing in this high resistance path may be considered negligible. If the transmitter be spoken into, the current flowing through the transmitter will vary by reason of the varying resistance of the transmitter caused by varying pressure between the carbon granules. These fluctuations in current result in a fluc-

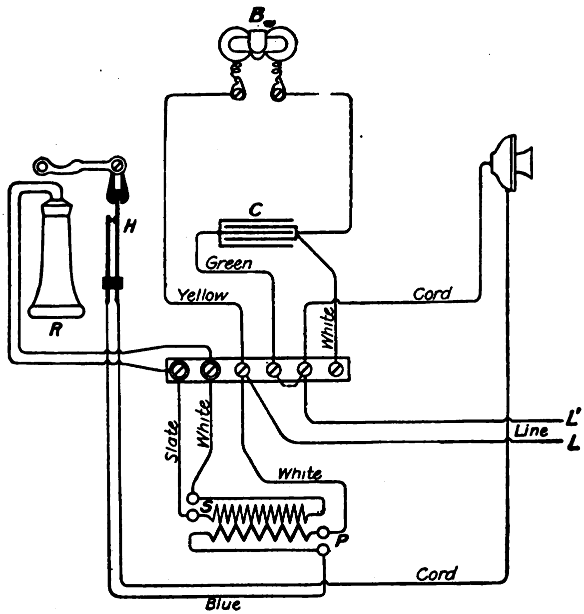


FIG. 20.—CIRCUITS OF NORTH ELECTRIC CO. COMMON BATTERY WALL TELEPHONE

tuating current in the primary of induction coil in telephone at distant station and induce in the secondary of same induction coil a high-voltage, high-frequency alternating current which affects the receiver, thereby reproducing speech. Incoming speech follows the same circuit as that taken by the battery from the central exchange. This voice current, however, being pulsating in character, induces a current in the fine-wire winding of the induction coil. This current passes through receiver *R*, hook switch, transmitter *T*,

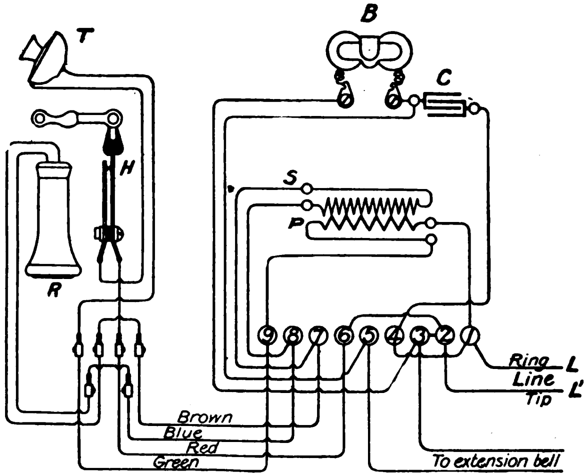


FIG. 21.—CIRCUITS OF N. E. CO. COMMON BATTERY DESK TELEPHONE

and condenser *C*, thus reproducing in the receiver *R* the sounds impressed on some distant transmitter. The condenser also serves to strengthen the effect of the induced current in *R* by reason of the varying potential across its terminals.

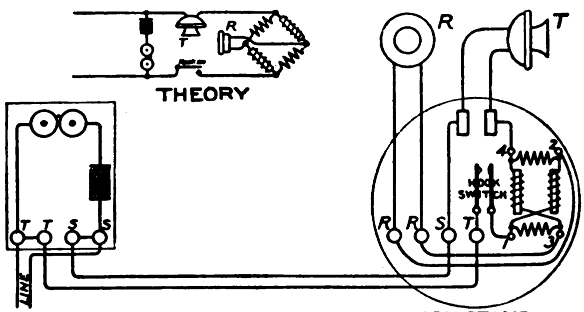


FIG. 22.—GARFORD COMMON BATTERY DESK TELEPHONE CIRCUITS

Figure 18 shows the general arrangement of a common battery desk telephone and figure 19 shows the general arrangement of the common battery wall telephone. The circuits shown or modifications of them are used by all manufacturers and the general appearance of the apparatus closely resembles that shown in the illustrations.

Figure 20 shows the circuits as installed of a North Electric Co. C. B. wall telephone. Figure 21 shows the circuits as furnished in the desk set type of the same instrument.

Figure 22 shows the circuits, as installed, of a common battery desk telephone, having the induction coil located in the base of the desk stand.

THE CAMP TELEPHONE

This telephone, which supersedes the field telephone, was developed by the Signal Corps for use in connection with camp tele-

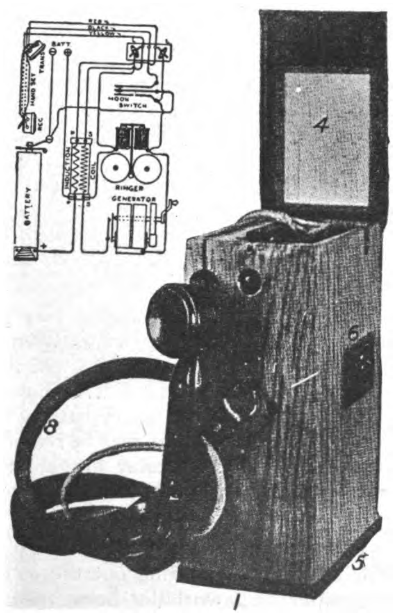


FIG. 23.—THE CAMP TELEPHONE AND ITS CIRCUITS

Key to reference numbers:—1, case; 2, hinged cover; 3, circuit diagram frame; 4, circuit diagram; 5, metal base for case; 6, wire netting frame; 7, wire netting; 8, carrying strap; 9, fitting and ring for carrying strap phone systems and small arms target range system, and may be installed in tents and structures, or considered a portable instrument for use in the field for testing lines or other purposes.

It is of local battery type. The battery employed is one unit of tungsten type A. Figures 23 and 24 illustrate this telephone, it being shown dismantled in Figure 24 to facilitate identification of parts in connection with the preparation of requisitions for renewals.

The first lot of these instruments was equipped with 2-bar magnetos and due to its limitations the instrument could not be used for long-distance work. The new model of this instrument will be equipped with a 3-bar magneto, employing a special high grade steel for permanent magnets, and while in other features there may be a slight deviation from the following description it is believed that figures 23 and 24 can be used in preparing requisitions, it being merely necessary to state "For Camp Telephone, 3-bar magneto type."

The instrument is made as compact as practicable and is contained in an oak case 4¼ by 7 by 10 inches high. The top consists of a metal hinged cover with circuit diagram on inside, held rigid when closed by a spring snap which can be released by depressing a button. The bottom of case is covered by a flanged piece of metal, the flange projecting approximately one-half inch up sides of case. Through one side of the case are six three-eighth inch holes which are covered on the outside by a close mesh metal screen held in place by a metal frame. These apertures allow the ringer to be distinctly heard. The case is equipped with a substantial, adjustable carrying strap, each end of which is fastened to case by means of hinged metal rings.

A small 2-bar magneto generator, small ringer, induction coil, aluminum chamber for the single unit of tungsten type A dry battery, hard rubber block upon which are mounted line binding posts, plug connections for the hand-set used with the instrument, hook switch and hook operating it and auxiliary battery binding posts are all mounted on a common base which may be readily removed from case after removing magneto generator crank, metal housing for it and three screws which extend through the case.

The instrument may be operated with cover closed, which is highly advantageous in inclement weather. To accomplish this there is a suitable opening for leading out the 3-conductor cord to receiver and transmitter, the two latter being mounted in the form of a unit, termed a hand-set. This hand-set consists of a transmitter and receiver mounted on a metal piece and is so designed that when the transmitter is normally placed to the mouth, the receiver is automatically adjusted to the ear.

The hook of the hook switch is so designed that it protrudes through case. When it is desired to transport the instrument or to remove the base upon which is mounted all the parts of the instrument, it is merely necessary to depress the hook and push it toward the base. By this arrangement the hook is not only held in the down position, thereby opening the battery circuit, but it is also protected.

The aluminum chamber for housing the single unit of tungsten type A battery is equipped with a spring catch so located that when

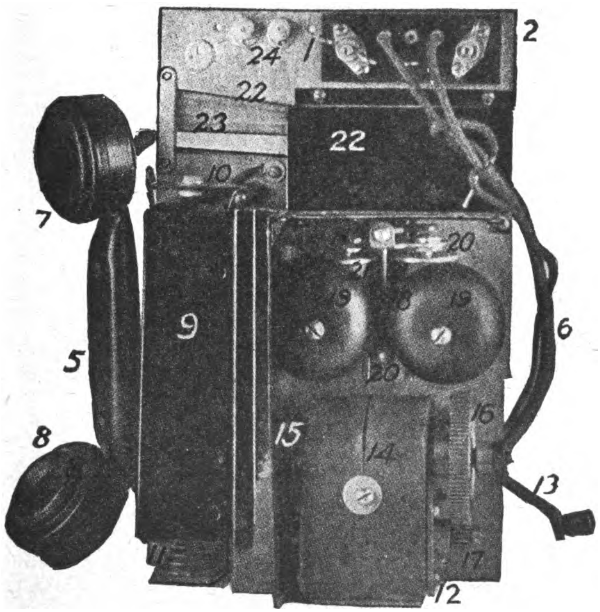


FIG. 24.—CAMP TELEPHONE, DISMANTLED.

Key to reference numbers:—1, base; 2, connecting block with binding posts; 3, binding post; 4, socket for hand-set cord; 5, hand-set; 6, hand-set cord; 7, hand-set receiver; 8, hand-set transmitter; 9, battery case; 10, battery-spring catch; 11, battery spring and support; 12, magneto; 13, magneto crank handle; 14, permanent magnet for magneto; 15, contact spring; 16, magneto gear; 17, magneto pinion; 18, ringer; 19, gong; 20, hammer and armature for ringer; 21, ringer coils; 22, case for hook switch; 23, switch hook; 24, binding posts for external battery

upper hinged piece is depressed to proper position the battery compresses a helical spring, thereby insuring continual contact. The base is equipped with two screw binding posts which may be used to connect leads to an outside battery in the event of there being no tungsten type A batteries available.

An aluminum frame, which is supported on the base previously mentioned, forms a compartment for the hand-set when instrument is being transported. When the instrument is installed for a temporary period, unless in actual operation, the proper place for the hand-set is hanging on the hook of hook switch, there being a ring on the hand-set for this purpose.

A small screw driver which will fit practically all screws used in the construction of the instrument is supported by the metal frame and is furnished with each instrument. The instrument complete weighs approximately 11 pounds.

The Service Buzzer

The buzzer is strictly a portable instrument and is issued to troops in the field for use in connection with all kinds of communication. It may be used as a telephone or for sending Morse or Continental Code signals, and for that reason it is specially adapted for field use.

When it becomes impracticable to transmit messages telephonically, due to the line becoming impaired or for other reasons, the usual telegraphic signals can be transmitted and are received in distant telephone receivers in the form of a high-pitched hum, somewhat similar to radiotelegraphic signals. These signals have been exchanged between two of these instruments after the wire line had been severed, both the ends, however, being slightly grounded.

The service buzzer, which is the latest approved instrument of this type of apparatus, replaces the field buzzer, the cavalry buzzer and the field artillery telephone and hereafter is the standard issue.

In the first part of this chapter it is explained how a circuit of high E. M. F. is obtained by means of two coils of wire wound on a soft iron core in connection with the telephone. This method may be termed mutual induction and is employed in the service buzzer. A high E. M. F. can be obtained by means of one coil of wire wound on a soft iron core, the latter method being termed self-induction. In order that operation of the service buzzer may be clearly understood, the theory of the field buzzer will first be explained.

The principle upon which the original *field buzzer* operates depends upon the effects of self-induction, i. e., the comparatively high self-induced voltage developed at the terminals of an electromagnet (coil with iron core) when the current through the circuit is suddenly interrupted. The interruptions are automatically produced by a circuit breaker, which is described later. During the interval of time required for the current to reach its maximum value, the field of force expands in direct proportion to the current strength until it also reaches maximum value. The current strength being kept constant, the magnetic field is of constant value. Any variation in current strength produces a corresponding variation in the strength of the magnetic field; therefore, when the circuit is broken and the current rapidly falls to zero the field of force also collapses and disappears. The energy furnished by the current and stored up in the magnetic field is thus returned to the circuit and tends to sustain the original current, as is noticed by a bright spark appearing at the point of break.

On "make," then, the whirls spring out from and cut the wire, inducing therein a current opposed in direction to inducing current. On "break" the whirls collapse, again cutting the wire and inducing therein a current having same direction as inducing current. The phenomena resulting from such cutting of a wire by magnetic lines of force is called self-induction.

When the circuit contains a coil, the effects of self-induction are much greater. If the coil contains an iron core the effects of self-induction are still more pronounced.

To make clear the action of the buzzer, let us consider the diagram, figure 25:

B is a battery of five dry cells; *K* is a key for making and breaking the circuit; *E* an electromagnet; *R* a telephone receiver.

When the key is closed there is a rush of current which reaches its maximum strength almost instantly. Simultaneously there is built up a magnetic field of force around the electromagnet. Now, if the key be opened, a pronounced click, of momentary duration, is heard in the receiver, which is caused by a self-induced current of high E. M. F. produced by the collapse of the magnetic field around the coil. This induced current would spark across the break at the key if there were not an alternate complete circuit through the receiver.

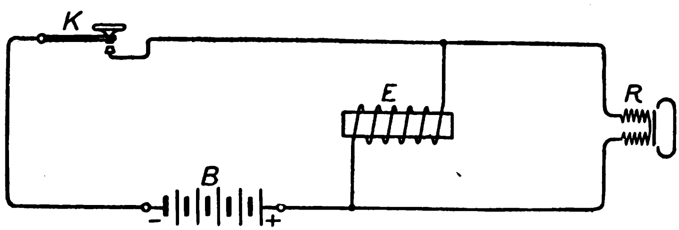


FIG. 25.—SIMPLIFIED CIRCUIT OF FIELD BUZZER

The more rapidly the circuit is made and broken by closing and opening the key, the greater the rapidity with which clicks in telephone follow one another, until, if the interruptions recur sufficiently often, the sounds in the receiver appear to be almost continuous.

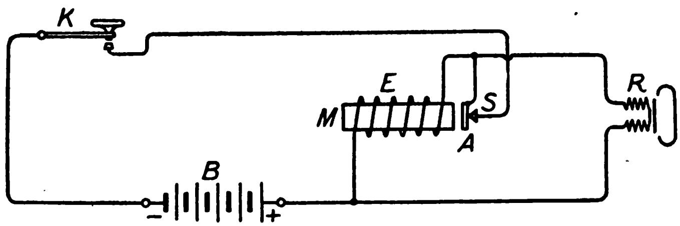


FIG. 26.—FIELD BUZZER SIMPLIFIED CIRCUIT WITH INTERRUPTER

If we introduce an automatic interrupter into the circuit (Fig. 26), a loud buzzing sound is heard in the receiver whenever the key is closed, and the dot and dash of the Morse alphabet are thereby produced by making short and long contacts with key.

The action of the interrupter or circuit breaker is as follows:

When the circuit is made by closing the key *K*, the current flows through coils of the electromagnet *E*, magnetizing the iron core *M*, which, in turn, attracts armature *A*. As soon as the armature is withdrawn from contact *S* the circuit is broken; as a result, the core becomes demagnetized and armature *A* springs back against *S*, thus again closing the circuit. The action continues so long as key *K* is kept closed.

If instead of the interrupter we substitute therefor a transmitter (Fig. 27), then when the key is closed current flows from + side of the battery through the coil to the lower disk (stationary) of transmitter, through loosely packed carbon granules to upper disk (movable), which is attached to the diaphragm, to key, to — side of battery.

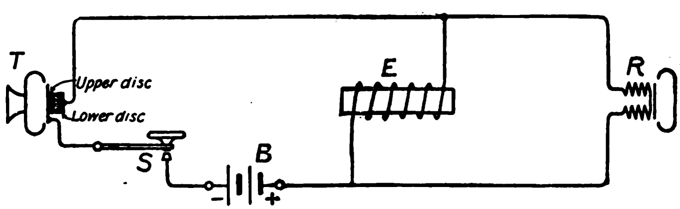


FIG. 27.—SIMPLIFIED CIRCUIT OF FIELD BUZZER WITH TRANSMITTER

Except when this circuit is first made, there is no evidence of self-induction in the circuit until the transmitter is spoken into, then the sound waves of the voice striking the diaphragm cause it to vibrate. The carbon granules between the carbon disks are thus subjected to varying pressure; this causes a variable resistance in the circuit, and the resulting current is a pulsating one (uniform in direction, but varying in strength). The effect of the varying current passing through the circuit is to increase and decrease the field of force built up around the wire. This changing field of force in turn produces the effects of self-induction, and these effects are particularly noticeable in coil *E*.

The inductive property of the coil is thus employed to augment the comparatively weak primary current to one of high E. M. F., which intensifies the vibration of the receiver diaphragm, these vibrations being received by the ear as articulate speech.

The sounds thus produced are not as loud as those produced by the interrupter, even though the same number of cells are used, for the reason that in the latter case the current is completely interrupted (circuit broken), whereas, in the case of the talking circuit, current is always flowing but is varied in strength; therefore the resulting field of force never reduces to zero, the cutting of the wire is consequently less, and the effects of self-induction are diminished.

If we now combine the two circuits described in one diagram we have the simplified buzzer diagram which is shown in Fig. 28.

An examination of this figure shows that the only change made is the introduction of two terminal binding posts, one of which is connected to the line, the other to the ground. If a similar instrument is connected at the distant stations, the currents traversing the home receiver also pass through the distant receiver.

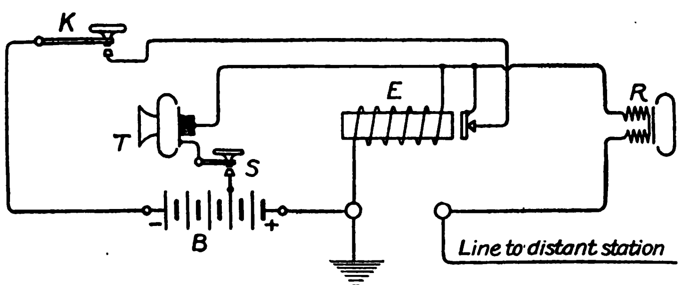


FIG. 28.—SIMPLIFIED CIRCUIT OF FIELD BUZZER WITH TRANSMITTER AND INTERRUPTER

The utilization of existing telegraph lines as a part or the whole of a circuit for buzzer and telephone working, at the same time not interfering with the use of the wire for Morse working, may be effected by using condensers interposed between the line and the buzzer. See Fig. 29.

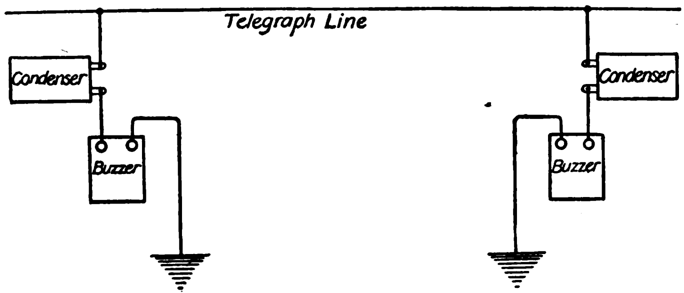


FIG. 29.—BUZZERS CONNECTED TO A TELEGRAPH LINE

The pulsations of the ordinary Morse sending are comparatively slow. The condensers, therefore, act as a very large resistance, and no appreciable effect will be noticed in the telegraph line.

The very rapid pulsations produced by the buzzer or transmitter, however, will permit of transmission from one buzzer to the other with little diminution of sound.

Figure 30 shows the circuits of the service buzzer. It will be noted that with the field buzzer if a line of low insulation resistance is utilized a heavy drain on the battery will ensue, due to the battery being connected to the line, while with the service buzzer under like conditions a heavy drain will not exist, due to the battery being connected in a local circuit which does not physically connect with the line. It will also be noted that a condenser which can be cut out by means of a short-circuiting switch is contained in the instrument and connected in series with the line. This condenser is for use when it is desired to use an existing telegraph line. (See Fig. 29.) Two units of tungsten type A dry battery are used with the service buzzer for furnishing the necessary primary current, both being in circuit when sending telegraphic signals, and one only being in transmitter circuit for telephone communication.

The circuits of the service buzzer may be classed as follows:

Primary sending circuit—telegraph.
Secondary sending circuit—telegraph.
Receiving circuit—telegraph.
Primary sending circuit—telephone.
Secondary sending circuit—telephone.
Receiving circuit—telephone.

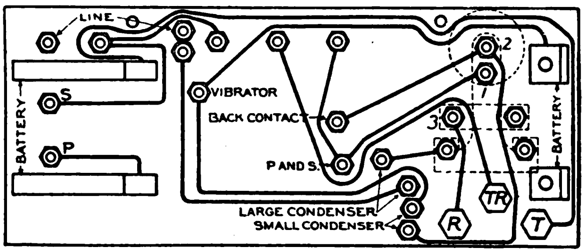
These circuits may be traced as follows, reference being made to figure 30:

Primary Sending Circuit—Telegraph

S. P. D. T. knife switch marked *"Sw"* must be closed on side marked "buzzer." Upon depressing key *K*, circuit is as follows: Positive end of battery, through primary of induction coil, to *A* to *B*, contact 1 of key, lever of key, contact 2, vibrator, to negative end of battery.

Secondary Sending Circuit—Telegraph

S. P. D. T. knife switch marked *"Sw"* is closed on side marked "buzzer." An A. C. current of high E. M. F. is induced in the secondary winding of the induction coil by interrupted current in the primary and its path is as follows: *G*, earth or one side of line (if metallic circuit is used); "receiving circuit, telegraph" of



BOTTOM VIEW OF BACKBOARD SHOWING WIRING

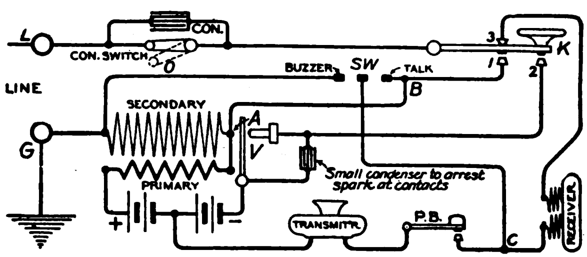


FIG. 30.—SERVICE BUZZER CIRCUITS

distant buzzer, other side of line, *L*, contact 1 of key (key is depressed), *B*, *A*, other side of secondary winding of induction coil.

Receiving Circuit—Telegraph

S. P. D. T. knife switch marked *"Sw"* is closed on side marked "buzzer." A. C. current of high E. M. F. reaches *L* from distant instrument by one side of line, contact 3 of key (key raised), receiver, *C*, switch marked "*Sw*," G, other side of line to distant instrument.

Primary Sending Circuit—Telephone

S. P. D. T. knife switch marked "*Sw*" is closed on side marked "talk"; from positive end of battery through primary winding of induction coil, to *A*, to *B*, through blade of switch marked "*Sw*" to *C*, through push-button switch marked "*PB*," through transmitter to negative side of one unit of the tungsten type A battery .

Secondary Sending Circuit—Telephone

S. P. D. T. knife switch marked "*Sw*" is closed on side marked "talk." When sound waves fall upon the diaphragm of the transmitter, an alternating current of high E. M. F. is induced in secondary winding of the induction coil. Starting with secondary of induction coil, to *G*, to earth or one side of line (if metallic circuit be used), through "receiving-circuit-telephone" of distant instrument, returning on other side of line, to *L*, through contact 3 of key marked "*K*" (key raised), to receiver, to *C*, to switch marked "*Sw*," through blade of this switch to *B*, to *A*, to other side of secondary winding of induction coil.

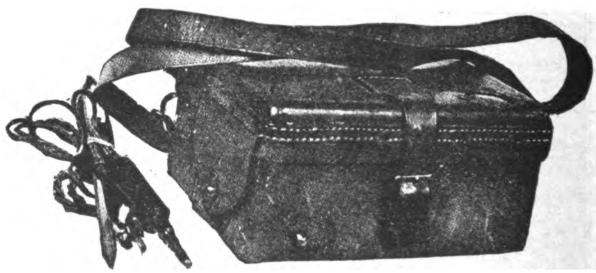


FIG. 31.—SERVICE BUZZER

Receiving Circuit—Telephone

S. P. D. T. knife switch marked "*Sw*" is closed on side marked "talk." An alternating current of high E. M. F. induced in the secondary winding of induction coil in distant instrument reaches the buzzer over outside line, to *L*, thence to contact 3 of key marked "*K*," to receiver, to *C*, to switch marked "*Sw*," through blade of this switch to *B*, to *A*, through secondary winding of induction coil to *G*, to earth or line (if metallic circuit be used), to distant buzzer.

When an existing telegraph line is utilized, the switch marked *"con sw"* should be thrown to the "O" position in order that the condenser *"Con"* will be placed in the circuit.

The service buzzer is shown in accompanying Figures 31 and 32, it being shown dismantled in figure 32 to facilitate preparation of requisitions for renewal parts.

The instrument is contained in an aluminum case fitted with a hinged cover, both of which are covered externally with a russet-colored, smooth-finish leather which is neatly sewed and riveted in place. The overall outside dimensions of the case are approximately 3¾ by 5¼ by 7½ inches. The two units of tungsten type

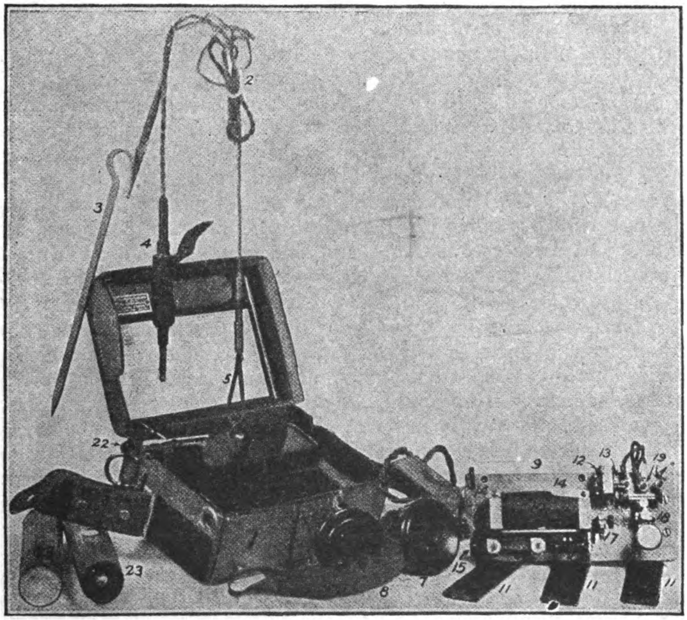


FIG. 32.—SERVICE BUZZER, DISMANTLED

Key to reference numbers:—1, case; 2, main cord with terminals; 3, ground rod, type D; 4, plug; 5, connector, type A; 6, transmitter; 7, receiver; 8, head band; 9, base; 10, induction coil; 11, condensers; 12, condenser connecting blocks; 13, short-circuit switch; 14, holding clip; 15, jack plug; 16, transfer switch; 17, vibrator; 18, sending key; 19, binding post; 20, large screw driver; 21, small screw driver; 22, handle for screw drivers and wrench; 23, tungsten battery, type A.

A battery are contained in a chamber located in the bottom and are accessible without opening the main cover, there being an additional small hinged cover in one end of case which is fastened securely, when closed, by a substantial spring clip, and by a flap of leather.

The instrument may be operated with both covers closed, which is highly advantageous in inclement weather. To accomplish this there is a suitable opening for leading out the cords to the receiver and transmitter, and in main cover, directly over the sending key, is a round aperture which is made moisture-proof by means of a covering of extremely flexible pigskin. The sending key can be readily operated through this flexible pigskin.

The sending key, induction coil, condensers, plug jack, transfer switch, vibrator, and binding posts for transmitter and receiver cords are mounted upon a common base of hard rubber. Wiring to the component parts is routed in the under side of this base, which is mounted in the front of the case above the battery chamber previously mentioned. In the rear of the instrument is a compartment of leather for containing the transmitter, receiver, and cord for connecting them. At one end of this chamber, neatly mounted on a hard rubber strip, is a socket wrench for adjusting the nuts which secure the transmitter and receiver terminals, also two screw drivers—one large and one small—which are so constructed that the shanks may be inserted in the end of socket wrench, thereby using the socket wrench as a handle.

Invariably there is furnished with this instrument a two-conductor cord, approximately 5 feet long, one end of which is equipped with a substantial plug similar to those used in connection with telephone switchboards. At other end one of the conductors is equipped with a Williams test clamp for connection to line, the other conductor being equipped with a Signal Corps type D ground rod. The Williams test clamp is so constructed that to attach it to the line, it is merely necessary to compress the two principal parts, releasing them when the line has been inserted in space provided. One side of this clamp is equipped with an 11-point stud securely threaded to test clamp. These points make excellent contact on line, regardless of whether the line be insulated or not. By this means a quick connection can be made to buzzer wire or field wire which is insulated, and when the clamp is removed the abrasion to insulation is negligible. There is an opening in the case of the buzzer through which the plug is inserted when connection is desired, and when plug is so inserted it makes a positive connection by means of a substantial jack mounted on the base as previously indicated.

The case has an adjustable carrying strap, one end of which is equipped with a snap connection, the other end being sewed to hinged fitting on case. The instrument, including carrying strap, type D ground rod, Williams test clamp, plug and 5-foot cord, weighs approximately 5 pounds, and full directions for operation, together with a circuit diagram, are attached to the inside of the main cover.

Figure 33 shows the circuits employed in sending and receiving Morse signals by means of service buzzers. It will be noted that a single conductor is used to connect the two instruments, and that the earth is used for other conductor of the circuit. This is the customary manner of connecting two or more service buzzers in the field.

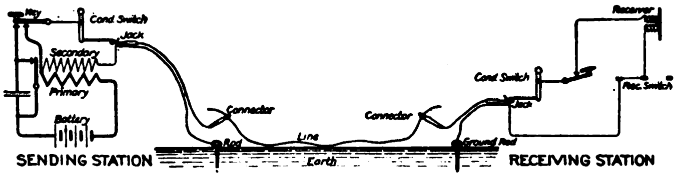


FIG. 33.—CIRCUITS EMPLOYED IN SENDING AND RECEIVING MORSE SIGNALS WITH SERVICE BUZZER

INDUCTION TELEGRAPH SET

The induction telegraph set (figure 1) is strictly a portable field instrument which was developed by the Signal Corps. It is designed for sending Morse signals over field lines of communication and other lines where it is difficult to supply the large amount of battery required for ordinary telegraphic work. It can also be used for the transmission of speech by making certain modifications. The instrument comprises a wooden case, the dimensions of which are 11½ by 7¾ by 6 inches, outside. The top of the case contains instructions for operating and a diagram of circuits. A baseboard, which is removable by means of four screws, has on its underside the wiring and on its upper surface a battery case of aluminum to hold two tungsten batteries; an induction coil of the closed magnetic circuit type; a double contact telegraph key of standard pattern; a polarized sounder, which will be described later; a double-pole double-throw switch for reversing the connections to l e, and three binding posts numbered 1, 2, and 3. In addition, authority has been issued by the Chief Signal Officer to install a fourth binding post on all instruments in service, to be connected to the contact of the bottom battery. This is for the purpose of attaching external battery to this instrument and for this purpose the batteries in the case must be removed and external battery connected to binding posts 3 and 4. The line is connected to binding posts 1 and 2 as usual. This set can be used for ordinary Morse telegraphy, in which case the line is connected to binding posts 2 and 3, and the small blocking screw which prevents the switch of the key from being closed should be run down with a screw driver so that the switch may be kept normally closed when not sending.

Previous models of the field induction telegraph set used a polarized relay of a well-known commercial form, and, in addition, required a local battery and local sounder to be connected to the relay tongue. The model 1912 set contains what is known as a "polarized sounder." It consists of a regular local sounder frame, underneath which is mounted a strong permanent magnet, the cores of the coil forming the pole pieces of the magnet. The coils are so wound that a current in one direction tends to increase the strength of the magnet and in the other direction tends to decrease the strength of the magnet. The armature is adjusted by means of a spring, so that it remains in either the up or down position when no current is flowing. When an instantaneous current comes over the line due to the depression of the key at the distant station, the direction of winding is such that the magnetism is suddenly increased and the armature is drawn to the down position. It remains there after the instantaneous current has

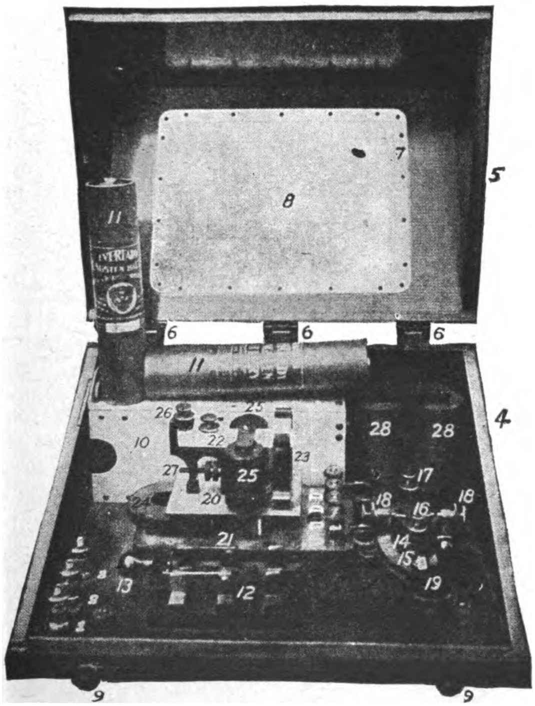


Fig. 1.—Induction telegraph set. Key to reference numbers: 1, 2, 3, binding posts; 4, case; 5, cover; 6, hinge; 7, circuit diagram frame; 8, circuit diagram; 9, cover fastener; 10, battery case; 11, tungsten, type A, battery; 12, D.P.D.T. switch; 13, switch handle; 14, key; 15, spring for key; 16, spring adjusting screw for key; 17, rear adjusting screw for key; 18, key trunnion screw and lock nut; 19, key handle; 20, sounder; 21, sounder base trunnion screw and lock nut; 19, key handle; 20, sounder; 21, sounder base; 22, sounder armature; 23, sounder armature supports; 24, sounder permanent magnet; 25, coils for sounder; 26, armature movement adjusting screw; 27, spring tension adjusting screw; 28, induction coil.

ceased. When the key at the distant station is opened and an instantaneous current in the opposite direction flows through the instrument, the magnetism of the cores is suddenly decreased with the result that the armature lies to the up position and there remains. If the line is not too long nor too high a resistance, and particularly if there are not too many instruments in series on the line, the sound made by this instrument imitates very closely that made by a local sounder. It may be that the pulses from the distant station will come in reversed, and for this purpose the double-pole double-throw switch is provided which reverses the connection of the sounder to the line. If the signals come in reversed, it is only necessary to turn the switch over when they will come in, in the proper direction.

Theory

Figure 2 shows the theory of operation of the field induction set. Circuit A comprises a key, primary of an induction coil, and battery. Circuit B comprises the secondary of the induction coil

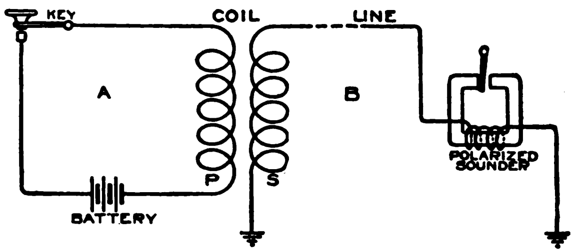


FIG. 2.—THEORY OF OPERATION, INDUCTION TELEGRAPH SET

and a polarized sounder or relay. When the key is closed in circuit A there is an instantaneous electromotive force induced in the secondary of the induction coil which causes an instantaneous current to flow through the polarized instrument and to bring its armature to a certain position in which it will remain after the instantaneous current has ceased. When the key in circuit A is opened there will be a similar instantaneous electromotive force tending to make a current flow in the opposite direction in circuit B. This current will bring the armature of the polarized instrument to its other position, in which it will remain after the current has ceased. As this secondary electromotive force may be very high, and as polarized instruments can be made to operate on extremely small currents, this induction telegraph arrangement will operate over lines of high resistance, although the battery in the primary circuit may be one of only a few volts.

Instructions for Operating

To install batteries—Open door of the battery case by releasing spring, at the same time placing the forefinger against the inside of the door through the small aperture in metal case. Insert top battery unit, negative or flat end, first and lower unit, positive or bottom end, first.

To use as an induction telegraph set—Connect line to binding posts 1 and 2. Lock circuit closing lever in the open position by unscrewing small setscrew in key base until it projects sufficiently to lock the lever. If the sounder fails to respond, change the direction of the current through the sounder by throwing the reversing switch.

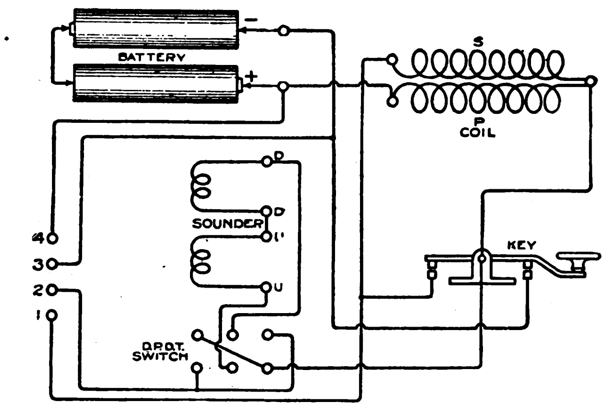


FIG. 3.—CIRCUITS OF INDUCTION TELEGRAPH SET

To use as a closed-circuit telegraph set—Remove batteries from case. Connect line to posts Nos. 2 and 3; release circuit-closing lever by screwing locking screw down until it is flush with the base.

Circuits—As an induction telegraph; when the key is depressed current from + of battery flows through primary of coil, key, front contact to — of battery. The instantaneous secondary current flows from secondary of coil, through switch, polarized sounder (operating it), to binding post 2, line, distant station, ground, binding post 1, secondary. The instantaneous secondary current on opening the key follows the same path in the opposite direction. Incoming impulses through line to binding post 2 go through the switch, polarized sounder, key, back contact of key, binding post 1, ground. The purpose of the back contact of the key is to short-circuit the secondary of the induction coil and so remove its impedance from the circuit when receiving. It is not essential and the key may be replaced by one having no back contact.

As a closed-circuit telegraph; external battery one pole to ground, the other to binding post 3. Batteries in instrument removed. Circuit, binding post 3, front contact of key, key, reversing switch, sounder, binding post 2, line. Note that circuit closing lever on key must be closed when not sending.

The resistance of the primary of the induction coil installed at present in these instruments is very low, and the batteries run down very quickly in service. All officers in charge of installations using these instruments should keep this in mind and keep constant requisitions for new batteries going forward. Wherever possible, as in permanent or semi-permanent stations, external battery should be installed. The type of external battery is immaterial, about 6 to 10 volts being a good E.M.F. to use.

Duplex Operation

The field induction telegraph set may easily be duplexed, following the simple principles of the differential polar duplex system. The only additional equipment required is an artificial line which can be adjusted to have the same resistance and, with long lines, the same capacity as the line itself. For duplex operation the line must be connected to binding post No. 2. The green wire normally connected to outside binding post U on the polarized sounder must be shifted to inside binding post U, and the connecting bar joining inside U to inside D must be in place. The artificial line goes between outside U and binding post No. 1, and the ground is attached to binding post No. 1.

Artificial line for duplex—Any resistance box, sliding rheostat, or other variable resistance whose maximum value is equal to or greater than the resistance of the line and distant instrument. If the line has appreciable capacity, as in the case of a long line or one in cable or laid on the ground, a balancing capacity can be constructed of the 2 m.f. condensers used in common battery telephones. They are cheap and easily obtained. Fractions of 2 m.f. can be obtained by putting condensers in series. Close static balance is rarely necessary.

Installation—In large offices the operators should have in front of them only the local sounder and key. All other apparatus should be in a separate room under charge of an expert. This plan is especially necessary where duplex and repeater sets are installed. In small offices the circuits should be well installed without unnecessary complication, and full instructions for operating and adjusting should be furnished. Operators put in charge of such stations should receive special instruction before assuming charge, as the induction telegraph system is not used commercially at present, in spite of its many advantages.

RADIOTELEGRAPHY

Electric Charges and Static Fields of Force

Electrical phenomena may be grouped in two general classes. One of *static* electricity, when the electrical charges are at rest, and the other of *dynamic* or current electricity, when the charges are in motion along a conductor.

When an insulator, such as sealing wax, is rubbed with fur, or a glass tube with silk, it acquires the property of attracting light bodies near it, and is said to be *charged*. This action shows that forces exist in the adjacent space, and there is said to be an *electrostatic*, or, more briefly, a *static field of force* about the charged body. When two bodies are brought near together they may be either attracted or repelled, depending on the nature of the two charges. If the rubbed glass is brought near particles touched and charged by the rubbed

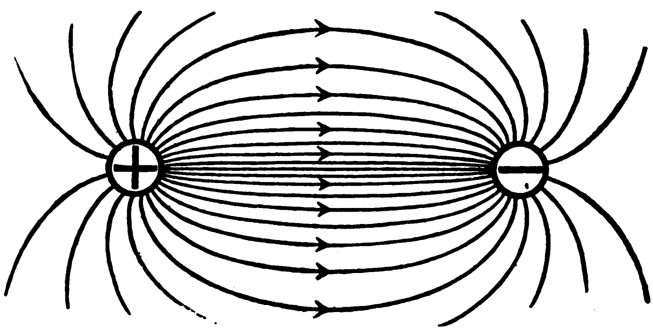


FIG. 1.—A FIELD OF FORCE BETWEEN CHARGED BODIES

sealing wax they will be attracted to it, and similarly if the rubbed sealing wax is brought near particles charged by the rubbed glass they will be attracted; but two bodies, both of which have been charged by either the glass or the wax, will repel each other. Hence *like charges repel each other* and *unlike charges attract.* The names *positive* (glass) and *negative* (sealing wax) have been given, respectively, to these charges. By means of a delicately suspended insulated body the static forces can be mapped out along directions in general perpendicular to the charged surfaces. In figure 1 is shown in section the static field of force between a positively charged and a negatively charged body in which the direction of the field at any point is indicated by the direction of the arrows at that point, and the intensity or strength of the field in any area is indicated by

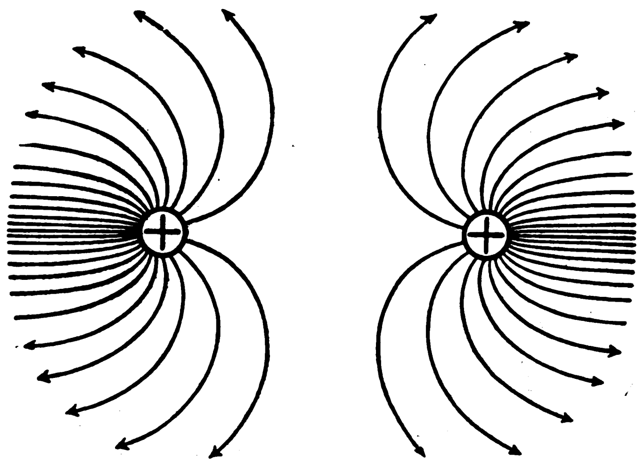


FIG. 2.—STATIC LINES BETWEEN TWO POSITIVELY CHARGED BODIES

the number of lines in that area. It is seen that most of the lines are crowded together between the two as though there was an actual pull along their length, thus suggesting attraction. Similarly in figure 2 are shown the static lines between two bodies with positive charges which are apparently driven

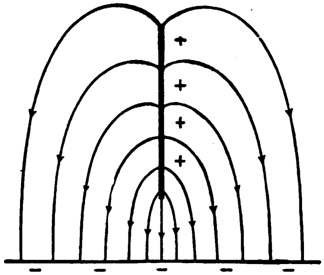


FIG. 3.—STATIC LINES FROM A POSITIVELY CHARGED WIRE

apart, thus suggesting repulsion. If both charges were negative the direction of the arrows would be reversed, but the static lines would have the same shape as before. In figure 3 are shown in elevation the static lines from a positively charged wire near the surface of the earth. If the wire were negatively charged, the signs of the charges and the direction of the arrows would be reversed.

Currents and Magnetic Fields of Force

If a wire connects a charged body with an uncharged or oppositely charged one, the static charge will flow through the wire from the charged to the uncharged body, or from the positively charged body to the negatively charged one, and become a *current* while so flowing, that is, a *current* is a moving charge or succession of charges. If the same charge is continuously renewed there is a *steady* or *direct current*,

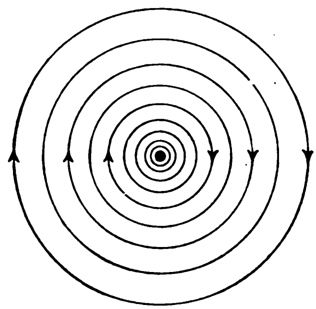


FIG. 4.—MAGNETIC FIELD OF PERPENDICULAR WIRE

often abbreviated as D.C. If the charges are continuously varying in intensity and sign and the variations are periodic in character, there is an alternating current or A.C.

While the current is flowing in the wire it has been found that there exists around it a field of force of another kind. If a horizontal magnetic needle is brought near a vertical wire in which a direct current is flowing, the needle will be deflected and the direction in which it will point depends upon the direction in

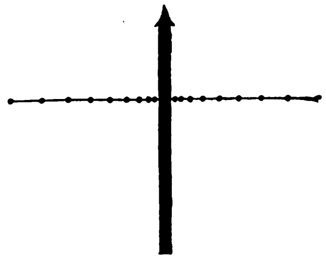


FIG. 5.—MAGNETIC FIELD OF HORIZONTAL WIRE

which the current is flowing. This action shows that magnetic forces exist in the adjacent space, and the wire carrying the current is said to have a *magnetic field* about it. The lines of magnetic force may be mapped out with iron filings or a

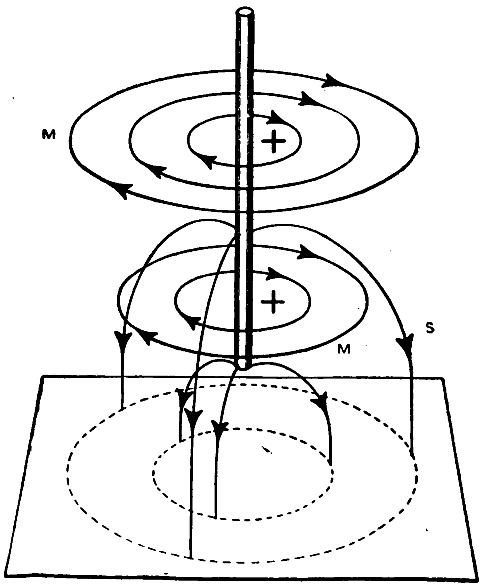


FIG. 6.—STATIC FIELD OF POSITIVELY CHARGED WIRE

magnetic compass. Thus, if the compass is moved in the direction indicated by the deflection of its needle it will trace out circles around the wire at a center and in planes perpendicular to it.

In figure 4 is shown a section of wire, perpendicular to the paper and carrying a current downward through it, surrounded by circles, which by the direction of the arrows indicate the direction of the magnetic field at any point, and by the number of lines in any area indicate the intensity of the magnetic field in that area. If the direction of the current in the wire were reversed so as to flow up through the paper, the direction of the arrows would have to be reversed. Similarly, in figure 5 the wire is shown lying on the paper and the current flowing toward the top of the page, with the magnetic lines (appearing as dots) going down through the paper on the right of the wire and coming up through on the left.

Static and Magnetic Fields Near a Wire

If a long wire is placed vertically, and positive and negative charges are alternately applied at the bottom and flow along the wire, there will be near the wire alternately opposite *static* fields, due to the charges; and at the same time alternately opposite *magnetic* fields, due to the alternating currents. Figure 6 shows in perspective the wire with a positive charge,

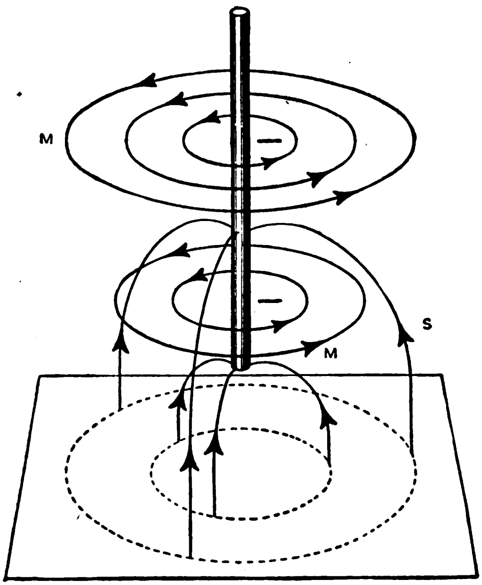


FIG. 7.—STATIC FIELD OF NEGATIVELY CHARGED WIRE

surrounded by its vertical static field S and its horizontal field M, and figure 7 the wire with a negative charge and both its fields reversed in direction. Figure 8 shows both the static and magnetic lines as seen when projected on the plane below the wire where the magnetic lines are circles, as in figure 4, and the static lines are straight, being radial with respect to the circles.

Radiation of Electromagnetic Waves

These two fields of force changing their direction and intensity with great rapidity and traveling outward from the

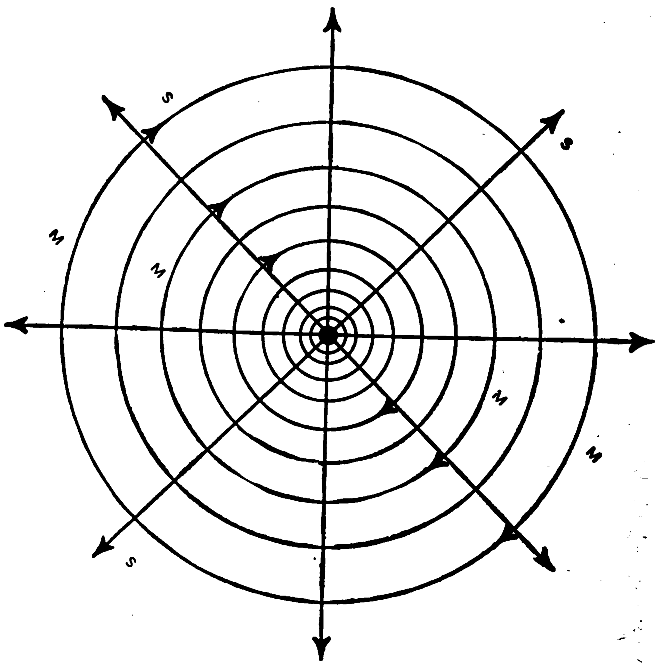


FIG. 8.—STATIC AND MAGNETIC LINES ON THE PLANE BELOW THE WIRE

wire in the medium called the *ether* with the velocity of light, 300,000,000 meters or 186,000 miles per second, are the *electromagnetic* waves of radio-telegraphy. They spread simultaneously radially outward and upward from the vertical wire or *antenna* as it is called. The energy of the varying electric charges and currents is thus imparted to the medium, or is *radiated*.

The two fields constituting the wave and their outward motion in radiation are shown in a general way in figure 9, where the electric field is indicated as lines and the magnetic field is perpendicular to the plane of the paper. At great distances from the transmitting antenna the static lines become straight and perpendicular to the surface of the earth and the magnetic lines straight and parallel to the surface.

These static and magnetic lines of force, moving with the velocity of light, sweep across the antenna at the receiving

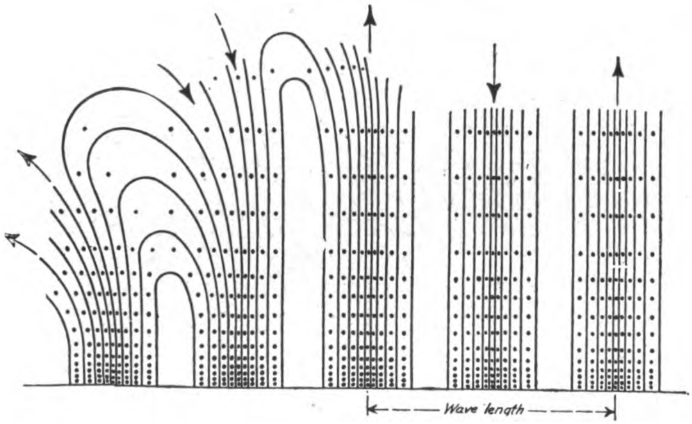


FIG. 9.—THEORY OF THE ELECTRO-MAGNETIC WAVE TRAIN

station. The vertical *static* lines in the wave are directed alternately upward and downward and produce in the antenna moving charges of alternately opposite signs; that is, an alternating current. At the same time the horizontal *magnetic* lines are directed alternately to the right and left, and when cutting across the antenna produce an alternating current in it. The resultant current generated by these two fields gives an alternating current in the receiving antenna quite similar to that in the transmitting antenna, although of course much weaker. It is these alternating currents which produce the signals in the receiving apparatus.

Measurement of Potential by Spark Discharge

If large charges of opposite signs are given to two insulated bodies close together, a spark will jump between them and the *potential* is said to be high. The distance between the points of two needles mounted in the same line may be used to measure this potential. The distance between two brass balls each 2 centimeters (about 25/32 inch) in diameter also may be used. It will be found that the needle points are more useful at low voltages, as from 5,000 to 15,000, and the brass balls

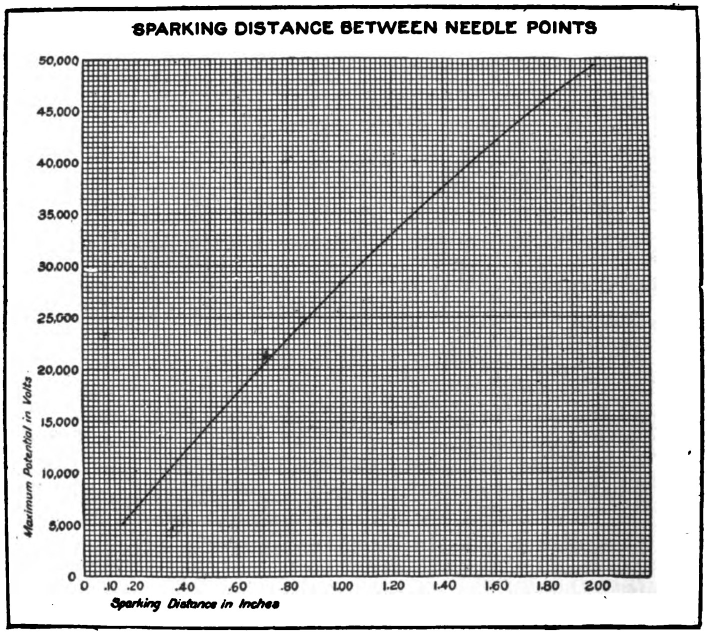


FIG. 19.—VOLTAGE CURVE FOR MEASURING POTENTIAL BETWEEN NEEDLES

more useful at the higher values. In figures 10 and 11 are given the voltage curves for the needle and the ball gaps. Thus, if the discharge occurs between needle points one-half of an inch apart the potential is 15,000 volts. In Tables 1 and 2 are given the values from which the curves are plotted in which the potential is the *maximum* or *peak* value, and not the value which would be indicated on a high voltage voltmeter.

TABLE I.—NEEDLE POINTS

(Adapted from the table of the American Institute of Electrical Engineers)

Sparking Distance in inches	Maximum potential in volts
0.15	5,000
.20	6,400
.30	9,300
.40	12,200
.50	15,000
.60	17,700
.70	20,500
.80	23,100
0.90	25,700
1.00	28,300
.10	30,700
.20	33,000
.30	35,300
.40	37,500
.50	39,700
.60	41,900
.70	43,900
.80	45,800
1.90	47,600
2.00	49,500

The potential is the maximum or peak value.

TABLE II.—BRASS BALLS 2 CENTIMETERS IN DIAMETER

(Adapted from Prof. Fleming's book, "The Principles of Electric Wave Telegraphy.")

Sparking Distance in inches	Maximum potential in volts
0.05	5,700
.10	10,000
.20	17,700
.30	25,000
.40	31,700
.50	36,700
.60	40,600
.70	44,300
.80	47,700
.90	50,800
1.00	53,400

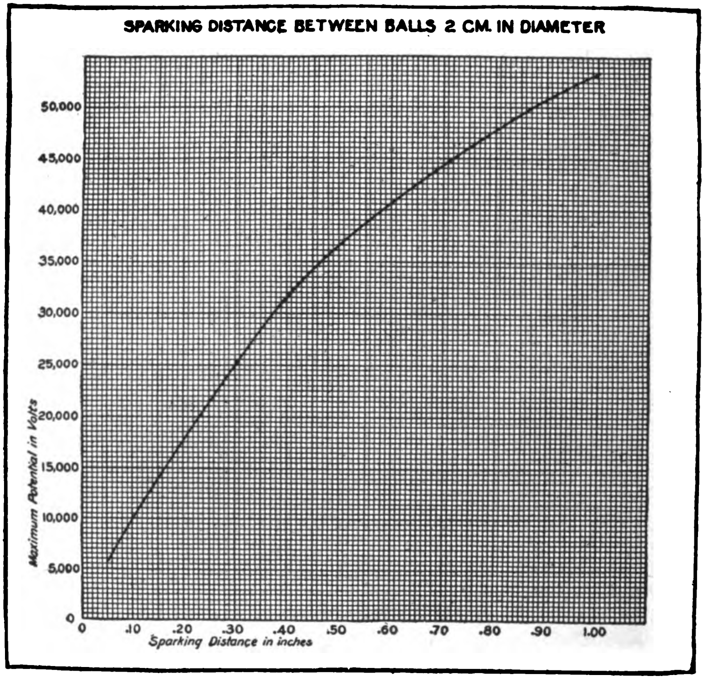


FIG. 11.—VOLTAGE CURVE FOR POTENTIAL BETWEEN BALL GAPS

Systems of Units

Inductances and capacities are essential elements in the circuits for generating and detecting electromagnetic waves. Their definitions and the units in which they are measured will be briefly given in the following paragraphs:

A condenser is said to have *capacity,* which may be defined as its property of storing the energy of electric charges in the form of an electrostatic field.

A coil is said to have *inductance,* which may be defined as its property of storing the energy of electric currents in the form of a magnetic field.

Capacity and inductance, as well as the other electrical quantities, can be measured in three different *systems of units,* the *electrostatic, electromagnetic,* and *practical.* From some points of view it is unfortunate that three different systems have come into use, but it is now impossible to abandon any one of them. The relations between the systems may be briefly explained as follows:

The units of the electrostatic system may be considered as based on the value of a unit quantity or charge of electricity such that if two bodies are charged with it they will repel each other with a unit force when placed at a unit distance apart. If this charge flows along a wire it becomes a current, and if the unit charges are renewed at the rate of one every second the current so obtained is called a *unit current in the electrostatic system.* The units of the electromagnetic system may be considered as based on the value of a unit current of electricity such that its magnetic field will exert the same unit force as mentioned on a body with a unit magnetic field when placed at a unit distance from a unit length of wire carrying this current. The current so defined is called the *unit current in the electromagnetic system.*

The strength or intensity of these two unit currents is not the same; in fact, it is very different, that of the current in the electromagnetic system being 30,000,000,000 times stronger than the unit current in the electrostatic system. The units of the other electrical quantities, as capacity, inductance, resistance, etc., are likewise nearly all different in the two systems, in some cases the units being larger in one system than in the other, and vice versa. Owing to the inconvenient size of the units in the two previous systems, suitable fractions or multiples of these units have been chosen as the units of the *practical* system. The numerical relations between the units of the three systems are given in textbooks, so that only a few of the more useful ones will be included in the table which follows.

It is sometimes convenient to abbreviate the words "electrostatic" and "electromagnetic" to "static" and "magnetic," as has been done in the table, and also to write more shortly E.S. and E.M.

When capacity is measured in the *practical* system the units are the *farad* and the one-millionth part of a farad, called the *microfarad,* and in the *electrostatic* system the unit is the *centimeter.* The relation between the two as shown in the table is as follows:

$$\frac{\text{Number of static units of centimeters}}{900{,}000} = \text{number of practical}$$

units or microfarads; thus,

$$1{,}000 \text{ cms.} = \frac{1{,}000}{900{,}000} \text{ mfd.} = \frac{1}{900} \text{ mfd.} = 0.00111 \text{ mfd.}$$

Similarly 900,000 × number of microfarads = number of centimeters.

The unit of capacity in the electromagnetic system has received no name, but if a capacity is measured in the units of this system, they can be converted into those of the other systems by means of the table.

When inductance is measured in the *practical* system the unit is the *henry* with its fractional parts, as the one-thousandth part, called the *millihenry,* and the one-millionth part, called the *microhenry*. Thus, 1/1,000 henry = 1 millihenry, and 1/1,000,000 henry = 1 microhenry; 1 henry = 1,000 millihenrys = 1,000,000 microhenrys. In the *electromagnetic* system the unit of inductance is the centimeter. It is to be noted that the *name* of this unit is the same as that of the unit of capacity in the electrostatic system, an unfortunate choice which can not now be changed. The relation between the units of inductance of the two systems is as follows:

$$\frac{\text{Number of magnetic units or centimeters}}{1,000,000,000} = \text{number of practical}$$

units, or henrys; and similarly 1,000,000,000 × number of henrys = number of centimeters; 1,000 cms. = 1 microhenry = 1/1,000,000 henry = .000,001 henry; 1,000,000 cms. = 1 millihenry = 1/1,000 henry = .001 henry; 1,000,000,000 cms. = 1 henry. Thus

$$\frac{1}{500} \text{ henry} = \frac{2}{1,000} \text{ henry} = 0.002 \text{ henry}.$$

$$= .002 \times 1,000,000 \text{ microhenrys} = 2,000 \text{ microhenrys}.$$

$$= .002 \times 1,000 \text{ millihenrys} = 2 \text{ millihenrys}.$$

$$= .002 \times 1,000,000,000 \text{ cms.} = 2,000,000 \text{ cms.}$$

The unit of inductance in the electrostatic system has received no name but can be converted into units of the other systems by the table.

Table for changing some of the more common units from one system to another.

CAPACITY.

Electrostatic units (in cms.).		Electromagnetic units (no name).		Practical units (in mfd.).	
To magnetic.	To practical.	To static.	To practical.	To static.	To magnetic.
Divide by 9×10^{20}	Divide by 900,000	Multiply by 9×10^{20}	Multiply by 1×10^{15}	Multiply by 900,000	Divide by 1×10^{15}

(Table continued on next page)

(Table continued from preceding page)

INDUCTANCE.

Electrostatic units (no name).		Electromagnetic units (in cms.).		Practical units (in henrys).	
To magnetic.	To practical.	To static.	To practical.	To static.	To magnetic.
Multiply by 9×10^{20}	Multiply by 9×10^{11}	Divide by 9×10^{20}	Divide by 1×10^{9}	Divide by 9×10^{11}	Multiply by 1×10^{9}

CURRENT.

Electrostatic units (no name).		Electromagnetic units (no name).		Practical units (in amperes).	
To magnetic.	To practical.	To static.	To practical.	To static.	To magnetic.
Divide by 3×10^{10}	Divide by 3×10^{9}	Multiply by 3×10^{10}	Multiply by 10	Multiply by 3×10^{9}	Divide by 10

POTENTIAL.

Electrostatic units (no name).		Electromagnetic units (no name).		Practical units (in volts).	
To magnetic.	To practical.	To static.	To practical.	To static.	To magnetic.
Multiply by 3×10^{10}	Multiply by 300	Divide by 3×10^{10}	Divide by 1×10^{8}	Divide by 300	Multiply by 1×10^{8}

RESISTANCE.

Electrostatic units (no name).		Electromagnetic units (no name).		Practical units (in ohms).	
To magnetic.	To practical.	To static.	To practical.	To static.	To magnetic.
Multiply by 9×10^{20}	Multiply by 9×10^{11}	Divide by 9×10^{20}	Divide by 1×10^{9}	Divide by 9×10^{11}	Multiply by 1×10^{9}

It will be noted that in many cases the units have received no name in some of the systems in which they are expressed, so that the name of the system must be given; thus a current of 1 ampere is a current of 3,000,000,000 units of current in the electrostatic system, or 3,000,000,000 electrostatic units of current.

Owing to the large numbers which must be used in converting units from one system to another it is usual to abbreviate as in algebra; thus, 3,000,000,000 is written 3×10^9, where the number 9 indicates the number of times that the cipher or zero must be written after the number 3, and similarly 900,000,000,000,000,000,000 is written 9×10^{20}.

The table may be used to convert from one system to another, as follows: A potential of 2.5 units in the E.S. system is equal to 2.5×300 units in the practical system, or 750 volts; current of 1.0 ampere in the practical system is equal to $1.0 \div 10$ units of current in the E.M. system, or 0.1 unit in the E. M. system; an inductance of 1/500 henry is equal to $1/500 \times 10^9$ E.M. units of inductance or centimeters, or $1/500 \times 1{,}000{,}000{,}000 = 2{,}000{,}000$ cms.

Mechanical and Electrical Oscillations

The following illustrations and explanations of oscillatory discharges and their occurrence in resonant circuits are introduced here so as to give a clear understanding of these most important principles.

OSCILLATORY DISCHARGES

If a strip of steel is clamped at one end and the free end is pulled to one side and released, this end will not only return to its normal position but will swing past it, and returning it will swing past in the opposite direction, but not so far as before and will thus execute a series of oscillations, each of which takes place in the same length of time expressed in fractions of a second, which will gradually die down to zero, or are said to be *damped*. The free end returns to its normal position because of the elasticity of the metal, and swings beyond it because of its inertia. The energy stored up in the spring in pulling it to one side is thus gradually wasted in friction, etc. In a similar way in electrical circuits we have to deal with *capacity*, which corresponds to the elasticity, and inductance, which corresponds to the inertia.

If a condenser of considerable capacity C, such as a number of Leyden jars or condenser plates in parallel, is connected in a circuit with a coil L and spark gap S, as shown in figure 12, and the potential on the condenser gradually increased, quite a large charge may be stored in it before the potential

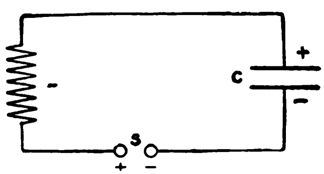


FIG. 12.—CIRCUIT FOR DAMPED OSCILLATIONS

rises high enough to cause a spark at the gap. When, however, the gap breaks down, the charge in the condenser discharges through the gap and the coil, and on account of the inductance (inertia) in the circuit it overshoots in the same

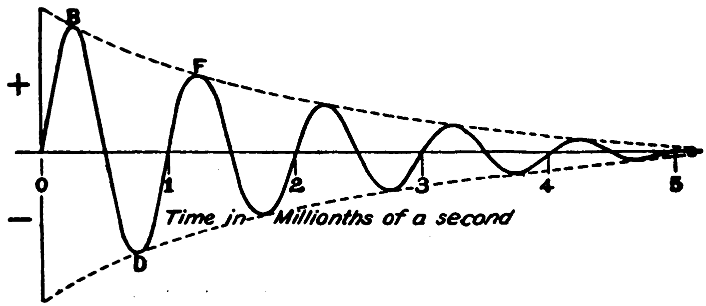


FIG. 13.—HIGHLY DAMPED WAVE TRAIN

way as the spring, then discharges in the opposite direction, etc., so that the charge may oscillate many times back and forth across the gap before it is so used up in heat that not enough charge remains to jump across again. The charged condenser, as C of figures 12 and 16, is thus the immediate source of the energy of the electrical oscillations. Its rapid oscillatory discharge through the gap S and the inductance L takes place in the form of a series of decreasing oscillations, called a *train of damped oscillations* or a *damped wave train.*

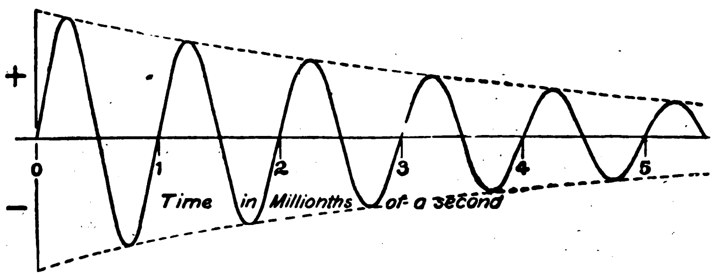


FIG. 14.—SLIGHTLY DAMPED TRAIN OF OSCILLATIONS

In some circuits there may be twenty, thirty, or even more such oscillations in a wave train. Figure 13 represents discharges in which the oscillations die down quickly, and are said to be *strongly damped* or *highly damped.* Figure 14 represents discharges in which the oscillations die down gradually and are said to be *feebly damped* or *slightly damped*. Figure 15 represents discharges in which the oscillations do not lie

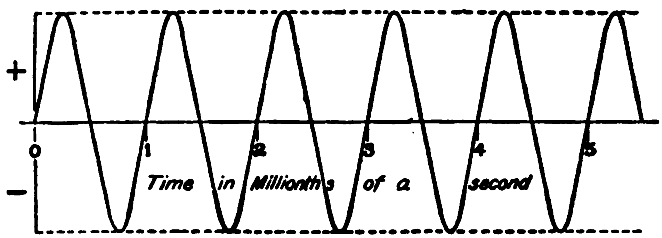


FIG. 15.—WAVE TRAIN OF UNDAMPED OSCILLATIONS

down and are said to be ***undamped oscillations, continuous oscillations,*** or ***sustained oscillations.*** These undamped oscillations can not be generated by the discharge of a condenser through an ordinary spark gap, but may be developed by means of a special type of direct-current arc with metal or metal and carbon electrodes, or by special high-frequency alternators. Both the arc and alternator methods of the generation of undamped oscillations are now in use.

FREQUENCY

The rate of vibration of the steel spring or number of vibrations per second depends upon the weight, distribution, and elasticity of the metal. Similarly in the electrical circuit, when the condenser discharges across the gap and through the inductance, the rate of the electrical oscillations, or *frequency* in number of oscillations per second, depends upon the capacity of the condenser and the inductance of the coil. The larger the product of the capacity and inductance, the slower is the rate of the oscillations; that is, the fewer the number of oscillations per second and the lower the frequency, and vice versa, the smaller the product of the capacity and inductance the more rapid is the rate of the oscillations per second and the higher the frequency. The formula for the number of oscillations per second is $n = \frac{1}{2\pi\sqrt{LC}}$ where L is the inductance in circuit and henrys and C the capacity in farads; thus, if C is 0.000,000,004 farad (0.004 microfarad) and L is 0.001 henry

(1,000,000 cms. or 1 millihenry), then the oscillations are taking place at the rate of about 79,600 per second.

$$n = \frac{1}{6.28\sqrt{0.001 \times 0.000{,}000{,}000{,}004}} = \frac{1}{6.28\sqrt{0.000{,}000{,}000{,}000{,}004}} = 79{,}600$$

Resonance

The principles of resonance can be illustrated by the steel spring, preferably in the form of two tuning forks. If a loud note from one tuning fork is sounded near another fork, the latter will be set in vibration slightly, even if the pitch of the note or number of vibrations per second is not the same as that which the latter itself would give. If, however, the note is of the same pitch, then each successive vibration of the prongs will be re-enforced by air waves of the same frequency as its own, and stronger vibrations will be produced by this note than by any other. Under these conditions the two forks are said to be in *resonance*. Similarly if a circuit containing a coil l, condenser c, and very small spark gap s, all in series, is brought near another circuit LCS, as shown in figure 16, in

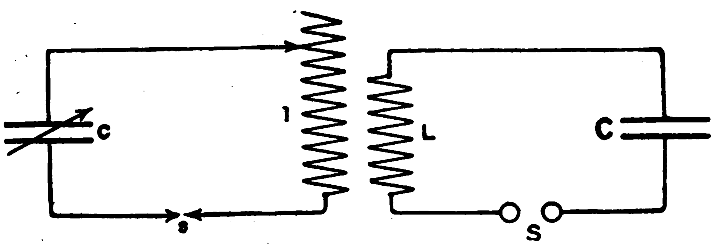


FIG. 16.—CIRCUITS IN RESONANCE

which oscillations are taking place, then small sparks may be seen passing across the gaps of the first circuit, showing that currents are being induced in it. If, however, adjustments are made in the number of the Leyden tubes in circuit or in the number of turns of inductance by means of the sliding contact, then generally the size and brightness of the sparks will be increased up to a certain point, and any further changes in either the inductance or the capacity will make the sparks smaller and fainter. At the adjustment which gives the largest and brightest sparks the induced oscillations are the strongest and of the *same frequency* in the two circuits; that is, the two circuits are *sytonized*, or *tuned*, or are in *resonance*.

Power Circuits

TRANSFORMERS

After each oscillatory discharge the charge in the condenser is renewed at regular intervals by an induction coil, or *alternating current transformer*. The former is but little used now, and will not be described here. The transformer is an apparatus for increasing the comparatively low voltage of an alternating current dynamo or generator to the high voltage necessary to cause the condenser charge to jump across the spark gap. The details of transformer construction are described in textbooks on electricity. It will suffice to say here that it consists of a *primary* winding of a comparatively few turns of heavy wire, wound on but insulated from a laminated iron or iron-wire core, which carries the current fom the alternator; a *secondary* winding of many turns of finer wire wound in sections and well insulated from all other parts of the transformer, which delivers a smaller current, but at the necessarily higher voltage, to the condenser that is charged thereby. In general the transformer increases the alternator of primary voltage in the same proportion as the number of secondary turns is increased over the number of the primary turns. The voltage of the alternator impressed on the primary of the transformer is usually 110 or 220 volts; the voltage of the secondary which is impressed on the condenser depends upon the size of the radio set and varies between, say, 10,000 and 30,000 volts.

In the case of quenched spark sets a transformer is generally used in which by a proper choice of the capacity connected to its secondary circuit, the secondary voltage is increased by

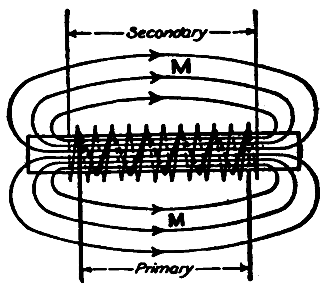


FIG. 17.—FIELD OF TRANSFORMER OPEN MAGNETIC CIRCUIT

resonance to perhaps twice as many times as the ratio of the primary and secondary turns would indicate. Such a transformer is called a *resonance* transformer.

Transformers may be divided into two classes, depending on the type of the laminated core, whether with the *open magnetic circuit,* as shown in figure 17, or with the *closed magnetic circuit,* as shown in figure 18. These terms apply to the iron as a path for the magnetic field. Thus in figure 18 it is seen that the magnetic lines M have a continuous path or circuit through the iron, or, as it is said, a closed magnetic circuit, whereas in figure 17 the path of the lines is partly through the space outside, or, as it is said, an open magnetic circuit. In both figures the direction of the field as it exists at one instant is indicated by arrows, but it must be remembered that the field is continually reversing its direction as the alternating current changes its direction. Both types of transformers are in general use, although it is probable that the closed magnetic type is now being used more than the other. There is no essential difference in efficiency of operation. Practical experience has shown, however, that in general it is not always possible to interchange transformers of the two types in any one set, particularly in quenched spark sets, where the alternator, transformer, and condenser of the closed oscillating circuit must be designed as a whole to secure the best results.

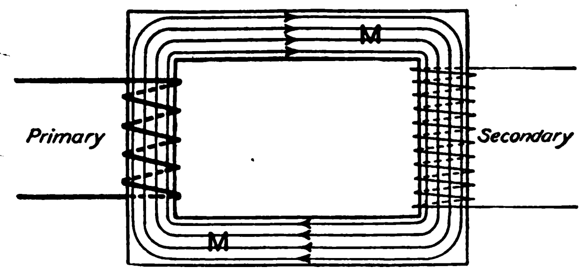


FIG. 18.—CLOSED MAGNETIC CIRCUIT

Transformers may be divided into two types, depending on the nature of the insulation, whether *oil insulated* or *dry insulated.* In the first the transformer is completely immersed in a suitable insulating oil, such as transil oil, in an iron tank provided with a cover to keep the oil from spilling, through which the terminals extend, strongly insulated, as with porcelain for example. In the second type strong insulating fabrics or materials are used around and between the windings which are saturated with a nonfluid insulating compound. In the higher voltage transformers of both types, the secondary coils are often heated in a vacuum to remove the air and moisture, dipped in an insulating varnish or compound, and baked until they are hard so as to protect the windings, exclude moisture, etc.

The connections of the transformer, etc., are shown in figure 19 where A is the alternating current generator, K the

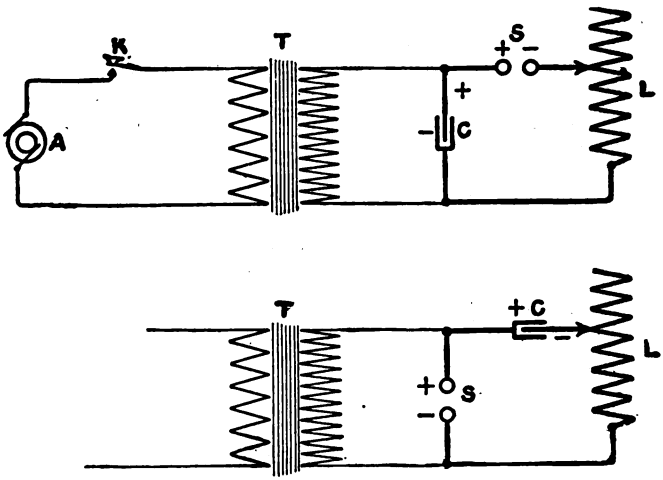


FIG. 19.—THE TRANSFORMER CONNECTED IN CIRCUIT

telegraph key, T the transformer with primary and secondary windings, C the condenser, S the spark gap, and L the inductance. There is no essential difference in operation of the two kinds of connections, the choice generally being made on account of some convenience of wiring.

ALTERNATORS

The transformer receives its power from an *alternating current generator*, or *alternator*, as it is often called, which is either belt or chain driven from an engine or electric motor, or directly driven by electric motor, in which case the two machines are mounted on the same bedplate and the shafts connected by a flexible coupling, the set being called a *motor-generator set.* The two essential parts of an alternator from an electrical point of view are the fields and the armature. A direct current is supplied to the former and an alternating current is delivered by the latter. Alternators are built in three general types, with *revolving field, revolving armature,* and of the *inductor* types, the last two being generally used in radio work. In the revolving armature type the fields are stationary and the armature rotates, its wires thus cutting the magnetic lines from the field windings and generating the alternating current which is brought out by brushes bearing on two *collector rings,* or *slip rings,* as they are called. In the inductor type both the field and the armature are stationary, the rotating part being simply an iron form with projecting pole pieces, the rotation of which carries the magnetic lines from the fields in and out of the fixed armature, the wires of which thus cut the magnetic lines and generate the alternating current. In this type of machine there are no revolving wires or moving contacts of any kind. The moving part, as armature, field, or inductor, as the case may be, is called the *rotor.* The stationary part is called the *stator.*

The alternator fields require a direct current for their energizing, which may be furnished either by an outside direct-current source, such as the direct-current mains that supply the power to run the direct-current motor of a motor-generator set, or by an *exciter,* which is a small direct-current machine that may be mounted on the alternator shaft or may be a separate machine independently driven by any convenient means.

RHEOSTAT AND REACTANCE CONTROL

In order to control the power delivered to the transformer a variable resistance or *rheostat* is sometimes inserted in series in the circuit of the alternator armature and transformer primary; in other cases a variable inductance called a *reactance* or *reactance regulator* is used, consisting of coils of heavy wire, with taps brought out at different points, wound on a laminated iron core. The rheostat and the reactance may serve a similar but not necessarily the same purpose; thus increasing the resistance in the rheostat *always* decreases the power delivered to the transformer, and increasing the reactance *may* do likewise. In these cases the rheostat or reactance may normally be cut out of circuit and introduced only as needed to cut down the power, as for example, when it is desired to decrease the range of a set so as not to cause interference at a distant station or when, as required by law, a ship station reduces its power as it comes within fifteen miles of a naval or military station.

Increasing the reactance does not always cut down the power; in fact, in some circuits of the quenched-spark type it may actually increase the power delivered to the transformer, and hence to the antenna, where it causes an increase in the antenna current. The reason for this is that there is a combined adjustment of the inductances in the transformer primary and secondary circuits and of the capacity of the closed circuit condenser which is best adapted for the charging of this condenser at regular intervals. In some cases more inductance is required than that in the alternator armature, and the transformer primary, and it is then added as a reactance in the primary circuit. In other cases the inductance may be added as a reactance in the secondary circuit, where evidently the coil must be designed to withstand high potentials. In a few cases reactances are added in both circuits so as to secure the desired results. When the best adjustments have been attained it is often found that the transformer primary current drops to a minimum value, the antenna current rises to a maximum, and at the same time the note of the spark is the clearest.

KEYS

In the smaller sizes of radio sets the current from the alternator to the transformer can be controlled by ordinary types of Morse keys, with either silver or platinum contacts, without troublesome sticking, trailing, or arcing even at fast sending. In the larger sizes, however, special means of cutting down the arc at the breaking of the circuit must be used, such as shunting the key by a resistance, condenser, reactance, etc., so that the key does not break the whole current. In the largest sets a *relay key* is generally furnished, which consists of an electromagnet, the windings of which are in series with an ordinary Morse key and a source of direct current, and the armature of which carries the heavy contacts necessary to break the current in use. Such a key may be used to break a current of 50 or 60 amperes or more without injurious sparking. In some cases a single large key with contacts an inch or so in diameter and a handle a foot long has been used.

Another type of key is coming into use, known as a "break key," which permits the receiving operator to break the transmitting operator as on a wire line. Among other ways this may be accomplished by providing the ordinary key with an extra set of contacts which, just after the current has been broken in making a dot or dash, and just as the key handle comes up to its final position, automatically connects the receiving circuit to the antenna and ground without the necessity of throwing a special switch. At any time that the receiving operator misses a word or desires to "break" the transmitting operator he holds his key down or calls "bk," and the transmitting operator with the telephones on his head and with his detector in adjustment will hear the call between the dots and dashes of his own sending and thus be broken. For most successful use both operators should be provided with break keys. It is essential that the receiving circuits in general and the detector in particular be protected from sparks from the transmitting circuits, and that the operators be not bothered by the sounds from their spark gaps or machinery.

Definitions of Alternating-Current Terms

For a proper understanding of some of the points on the following pages, definitions and explanations will be given of the more common terms in use in the employment of alternating currents.

The frequency with which the charges in the condenser C of figure 19 are renewed by the transformer depends, among other things, upon the rate at which the voltage and current

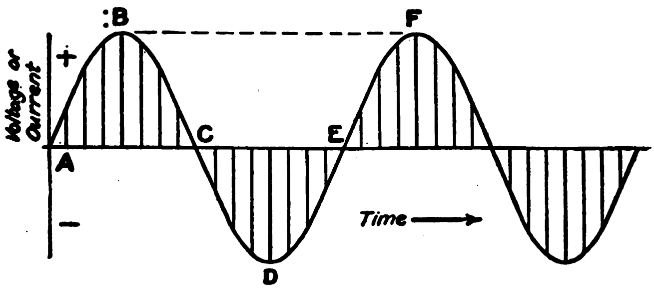


FIG. 20.—SINE CURVE OF CURRENT FROM ALTERNATOR

delivered by the alternator is varying. Figure 20 represents the manner in which these quantities vary, where the set of values ABCDE, half of which is positive and half negative, is called a *cycle* of voltage or current, the symbol for which is often thus written ~. The number of cycles per second is called the *frequency* and the letter "n" or "f" is often used as its symbol. In commercial alternators used in radio telegraphy the frequencies are generally 60, 120, 480, or 500 cycles per second; that is, there are 60, 120, etc., complete sets of values, such as ABCDE of figure 20 per second, or $n = 60$, 120, etc. Half a cycle, such as the set of values ABC or CDE of figure 20, which may be either positive or negative, is called an *alternation*. There are always twice as many alternations per second as there are cycles. The frequency of an alternating current is sometimes given in alternations per minute instead of cycles per second, thus a current of 60 cycles per second is of the same frequency as one of 7,200 alternations per minute. The time taken to complete one cycle is called the *period,* and the letter T is often used as its symbol, thus if there are 500 cycles per second, the time to complete one cycle is 1/500 second or 0.002 second; that is, $T = \frac{1}{500}$ second, or $T = 0.002$ second. Similarly the time for one alternation of a current of the same frequency is 1/1,000 second or 0.001 second. The relation between the frequency in cycles per second and the period in fractions of a second is given by the formula $T = \frac{1}{N}$ or

$$N = \frac{1}{T}$$

The highest value of the current or voltage in any alternation, as at points B, D, etc., of figure 20 or the corresponding points in figures 13, 14, and 15, is called the *amplitude,* or sometimes the *peak* of the curve.

It will be noted that there is a similarity between the sustained oscillations as represented in figure 15 and the alternating current or voltage as represented in figure 20. The two curves have the same shape or form, being known in trigonometry as *sine curves,* but they differ in the greatly increased frequency of a hundred thousand or million per second in the radio circuits (the closed and open oscillating circuits), as compared with that of 60 to 500 per second in the power circuits (the alternator and transformer circuits). It is the general practice to speak of the number of oscillations or of cycles per second in radio circuits, but only of the number of cycles per second in power circuits.

If the voltage or current varies as a sine curve, as in figures 15 and 20, the voltmeter or ammeter will not read the peak or amplitude value, because this value lasts for only a short part of the total time, but a fractional part, $0.707 = \frac{1}{\sqrt{2}}$ of the peak value. Similarly if the voltmeter or ammeter reading is given, the peak value or amplitude can be found by multiplying by

$$1.41 = \frac{1}{\sqrt{2}}$$

The frequency of the alternating current is sometimes indicated by a *frequency meter,* which in one type consists of a series of flat steel springs or reeds, each with a different period of mechanical vibration which is marked on it, the whole series covering a range of frequency of from, say, 470 to 530 vibrations per second. Behind the springs is an electromagnet carrying the alternating current, the frequency of which is to be measured. When the frequency of the electromagnetic impulses is the same as that of any one of the reeds it is set into vibration by resonance with these impulses, and the frequency of the current is then the same as that marked on the reed in vibration.

High-Frequency Circuits

CLOSED OSCILLATING OR PRIMARY CIRCUIT

The circuit of coil L, condenser C, and spark gap S, as shown in heavy lines in figure 19, is called the *closed oscillating* or *primary circuit,* as distinguished from the open, radiating or secondary circuit to be described later. These three elements are always connected in series to form the circuit, which is found in all spark excitation types of radio stations. There are two different methods of connecting the transformer secondary leads to this circuit for the charging of the condenser, one of which is shown in the upper part of figure 19, where the condenser is seen to be directly across the transformer secondary leads, and the other in the lower part where the spark gap is so connected. In this latter case the condenser is charged through the inductance L, but its resistance and inductance are so small as compared with that of the transformer secondary as to have no effect in the charging. There is no essential difference in the operation of the two types of connections.

The actions taking place in the closed circuit as a whole are as follows: The condenser begins to get its charge at the beginning of each alternation, as at points A, C, E, etc., of figure 20, and reaches such a potential as to cause its discharge across the gap and through the inductance at the peaks of the curve, as at points B, D, etc. The condenser is, so to speak, a reservoir which is filled and discharged 1,000 times per second in a 500-cycle alternator set. In figure 21 the upper curve represents the 500-cycle alternating current delivered by the transformer secondary to the condenser which is charged thereby; the lower curve represents the discharge of the condenser, producing damped *wave-trains* of perhaps 20 or 30 oscillations, each train lasting a few millionths or hundred thousandths of a second, as shown in figures 13 and 14. In order to be able to show the wave trains at all in figure

21 their duration must be shown much exaggerated as compared with the intervals between them. Thus, if the period of each complete oscillation in the train were $\frac{1}{500{,}000}$ second and there were twenty-five oscillations in the train, each train would persist for $\frac{25}{500{,}000}$ second, or $\frac{1}{20{,}000}$ second, or the duration of each wave train is only one-twentieth of that between successive trains.

It must be noted that although the transformer secondary is connected to the closed oscillating circuit, as shown in figure

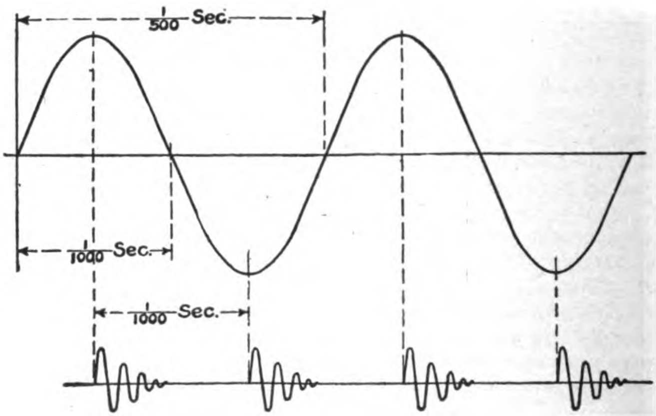


FIG. 21.—A DAMPED WAVE-TRAIN

19, it takes no part in the oscillations of this circuit. The reason for this is that the period of the circuit of the transformer secondary and closed circuit capacity is so long (in fractions of a second) on account of the large secondary inductance that the wave train in the closed oscillating circuit has been completed before the transformer secondary circuit has had time to complete a part of one of its own slow oscillations. The period or frequency of the oscillations of the closed circuit is thus independent of the transformer circuit.

In the preceding example it has been assumed that there was one discharge in each alternation or two discharges per cycle; that is, 1,000 wave trains per second. In some cases, however, the circuit may be arranged so that there is a charge and discharge in every other alternation—that is, only one discharge per cycle—which, with a 500-cycle alternator, would give only 500 wave trains per second. In both cases, however, the wave trains are thus *separated by equal intervals of time.* When the wave trains are thus separated by equal intervals of time the *note* of the spark is said to be *pure.* In some cases, however, it is possible to charge the condenser two, three, or even more times per alternation, and hence four, six, or even more times per cycle, and then it is said that these are *multiple discharges.* Under these circumstances the intervals of time between the wave trains will not in general be all equal and the note will not be pure. The pure note is often very desirable, although not always necessary in practical work.

WAVE TRAIN OR SPARK FREQUENCY

The number of wave trains per second is called the *wave-train frequency* or the *spark frequency.* If the alternator frequency is 500 cycles per second and there is a discharge once in every alternation, or 1,000 discharges per second, the spark frequency is 1,000 per second. It must be noted that in general the alternator frequency and the wave-train frequency are not the same; in fact, they may be very different, as in the case of multiple discharges mentioned in the preceding paragraph.

If the spark frequency is, say, 120 per second, as from a 60-cycle alternator, it is said to be *low,* but if it is 1,000 per second, as from a 500-cycle alternator, it is said to be *high.* There are certain advantages in a high spark frequency which appear both at the transmitting and at the receiving stations. If the closed circuit condenser is charged 1,000 times per second to a certain potential, it is evident that more energy will be required than if charged only 120 times, the formula for the energy being $\frac{1}{2} C V^2 N$, where C is the capacity, V the potential, and N the number of times per second. If the same amount of energy is available in the two cases—that is, if $\frac{1}{2} C V^2 N$ is constant—the smaller the value of N the larger must be the value of V, other conditions being constant, and, vice versa, the larger the value of N the smaller may be the value of V. The earlier practice was to make N small, as 120 per second from a 60-cycle alternator, and V large, as 30,000 volts. The modern practice is to make N large, as 1,000 from a 500-cycle alternator, and V small, which in this example must be about 10,800 volts. It is evident, then, that the transformer secondary and the closed oscillating circuit condenser do not need to be built to withstand the high voltages formerly used, and that, therefore, they may be lighter and more compact; also that the oscillation transformer and antenna, to be described later, do not need the very high insulation which was formerly necessary.

The advantages of the high spark frequency at the receiving station will be mentioned later under that heading. If suitable constants are used in the formula for the energy, it is possible to determine the capacity, peak voltage, etc, for any size of set. Let K. W. be the number of kilowatts that the transformer secondary must deliver to the closed oscillating circuit condenser; M. F. the capacity of this condenser in microfarads; V. the peak value of the voltage to which the condenser is charged and then discharged as the spark gap breaks down; and Cycles the number of cycles per second of the alternator in which there are two discharges per cycle, then—

$$\text{K. W.} = \frac{(\text{M.F.}) \times (\text{V}^2) \times (\text{Cycles})}{10^9}$$

Thus if M. F. is 0.012 mf.; V. 18,250 volts, peak value; and the Cycles 500, with two discharges per cycle, then K. W. will be 2.0. As it is impossible to build a transformer with an efficiency of 100 per cent. it is evident that the armature of the alternator must deliver a larger number of kilowatts to the primary of the transformer than is given by the above formula. The actual number will be found by dividing the secondary kilowatts by the efficiency of the transformer. Thus, if the efficiency were 93 per cent., or 0.93, then the alternator armature output or the transformer primary input would be $\frac{2.0}{0.93} = 2.15$ K. W. By simple changes in the above formula it is evident that when any three of the quantities are known, the fourth can be found.

Transmitting Condensers

A brief description of the three elements, condenser, coil, and spark gap, will be given.

The functions of the condenser are, by virtue of its capacity, to store the charge delivered to it by the transformer secondary circuit until its potential reaches the desired value as determined by the spark gap, and then to discharge through the gap and the inductance. An ideal condenser would be one that was perfectly insulating, could not be punctured, and showed no heating or losses of any kind during charging and oscillatory discharging.

There are several different types of transmitting condensers used in the Signal Corps radio stations, varying widely in capacity, size, voltage, etc., from the small mica ones of the field radio sets to the 4½-foot jars or compressed-air types in the permanent stations. All types consist essentially of two conducting surfaces, as tin or copper foil, separated by an insulator or *dielectric,* as it is often called, which can withstand without puncturing the high voltage required to break down the spark gap. Probably the most efficient condenser is the compressed-air type, which consists of a large number of circular metal plates mounted on two sets of supports with a small air space between each plate, the top plate and every alternate plate being connected together as one set and the remaining plates as the other set. The whole is contained in an air-tight tank, one set of plates being connected to the tank as one terminal and the other set to a terminal brought out through the cover in a porcelain insulator sealed air-tight by a lead gasket. Air is then pumped into the tank until a pressure of about 240 pounds per square inch is reached, or about 16 atmospheres of 15 pounds per square inch, as shown by a pressure gauge on top of the tank. At this pressure it has been found that air has an insulating strength many times greater than at ordinary pressures. Condensers of this type will withstand a maximum or "peak" voltage of about 20,000 volts under service conditions. The most serious objection is the excessive weight, a tank of about 0.006-microfarad capacity weighing about 300 pounds. There are many types of condensers using glass as the dielectric, such as plates or jars covered with foil or plated with copper. When these condensers are used at high potential, such as 25,000 volts or more, there is developed at the sharp edges of the foil or plating a discharge (sometimes called *brush discharge*), which spreads out over the surface of the glass, is accompanied by a hissing sound and considerable heating of the glass close to the edges, and in a dark room shows a pink light at the edges. The puncturing of the glass and the breaking down of the condenser often takes place close to the edges, due probably to the brush discharge and the local heating of the glass. These discharges represent losses which, in part at least, can be prevented by covering the edges of the foil with an insulating coating, such as asphaltum, and more completely by immersing the condensers in an insulating oil, such as castor oil, etc.

The capacity of these condensers and the voltage which they can withstand depend so much on the quality of glass, the manner in which it was annealed, its thickness, etc., that it is impracticable to give figures except for condensers that have actually been tested. The capacity of one glass plate about 3-16 inch thick and with the foil 15 inches square, is about

0.0020 to 0.0025 microfarad. The capacity of a jar with glass ⅛ inch thick, 4¾ inches in diameter, and height of foil of 10 inches is about 0.002 M. F. In the case of a good grade of plate glass about $\frac{3}{16}$ inch thick, free from scratches, bubbles, etc a potential of 20,000 volts, peak value, can be safely used.

In figure 22 is shown a closed oscillating circuit with three condenser jars connected in *parallel;* that is, the three outside coatings are connected together as one terminal and the three inside coatings as the other, and with a potential of 20,000

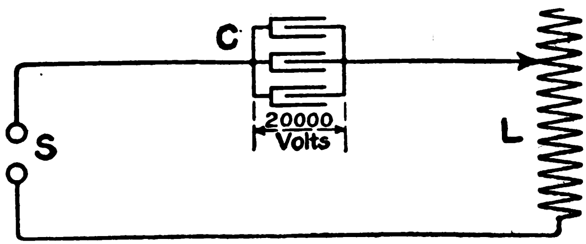


FIG. 22.—CLOSED OSCILLATING CIRCUIT WITH CONDENSER JARS CONNECTED IN PARALLEL

volts between the terminals. When condensers are thus connected in parallel the total capacity is the sum of all the capacities; if the condensers are all of equal capacity, the total capacity is the capacity of any one condenser multiplied by the number. Thus in figure 22 if each condenser were a jar of capacity 0.002 M. F., the total capacity would be 0.006 M. F., or three times 0.002 M. F.

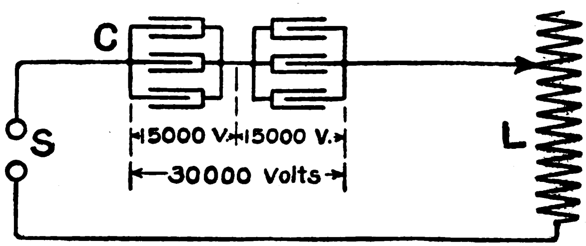


FIG. 23.—CONDENSERS CONNECTED IN SERIES

If the condensers break down at this potential or if higher potentials, such as 30,000 volts, are to be used, two banks, each of three jars in parallel should be connected in *series,* as shown in figure 23. It is to be noted that this connection requires twice as many jars as before, but if the total potential is 30,000 volts, the potential across each jar is now only 15,000 volts instead of 20,000 as before. Whenever condensers are connected in series, the total capacity is always reduced; if two equal condensers are so connected, the total capacity is one-half the capacity of either; if three equal condensers are so connected, the total capacity is one-third, etc. As the connections shown in figure 23 reduce the capacity to one-half the desired value in figure 22, two banks each of six jars must be connected in *series-parallel,* as shown in figure 24, thus requiring four times as many jars as the first circuit.

Another type of condenser having some advantages is the *Moscicki jar,* which consists essentially of a glass tube or jar with inside and outside coatings, as in the other types, but at the edges of the coatings where the puncture usually takes place the glass is thickened to give increased strength, and at the same time the edges are covered with an insulating liquid

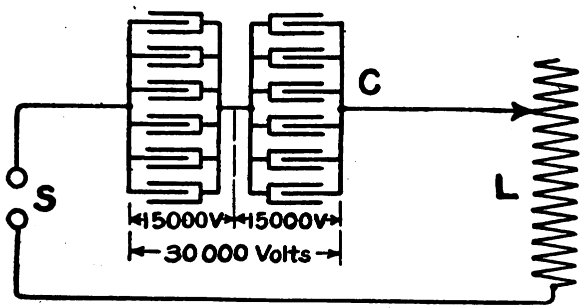


FIG. 24.—CONDENSER JARS IN SERIES PARALLEL

to stop the brush discharge. The whole is contained in a brass tube to which the outside coating is connected, the inside coating being brought out to a binding post through a sealed porcelain insulator. The case and the binding post thus become the two terminals. These tubes are made in two sizes, the larger of which is in more general use, has capacity of about 0.005 M. F., and is capable of withstanding 20,000 volts.

There are many other types of condensers using such dielectrics as mica, paper, and various molded insulating compounds. In a few cases oil is used as the dielectric, in which case metal plates are mounted on insulating supports a short distance apart in tanks filled with a suitable insulating oil, such as castor oil, etc.

TRANSMITTING INDUCTANCES

The function of the inductance is to form one of the two elements, the condenser being the other, necessary for developing and maintaining the oscillations, and to serve as a means of transferring energy from one circuit to another. An ideal coil would be one having the desired inductance but with a zero resistance to the oscillating currents.

The inductance coil L, which has been shown in the various figures, may be any one of several different types, such as a helix of heavy copper wire, thin-walled copper tubing, or flat strips, or a *flat spiral* of copper ribbon, such as the linking coil of the early Signal Corps field radio sets, etc. These are generally provided with clips so as to be able to vary continuously the number of turns, and hence the inductance in circuit. In any single coil, the fewer the number of the turns the less will be the inductance, and vice versa, the larger the number of

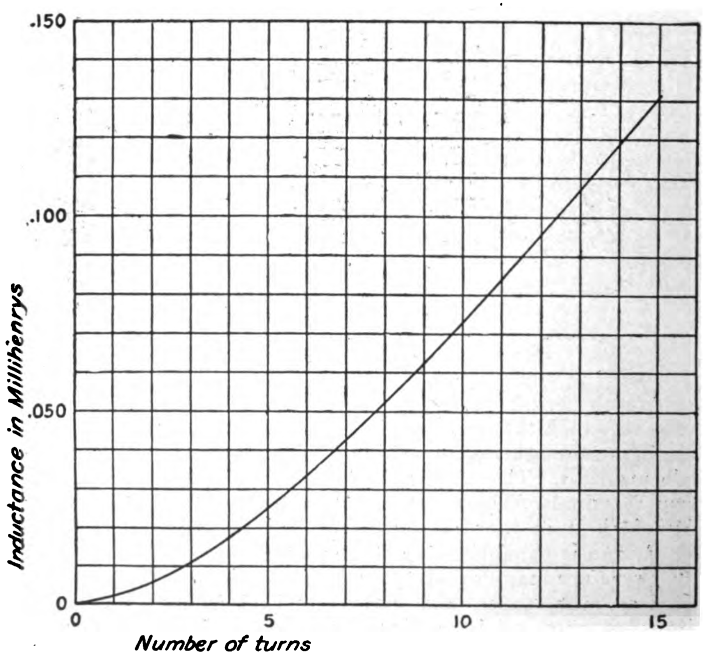


FIG. 25.—CALIBRATION CURVE OF THE INDUCTANCE OF A SQUARE HELIX

turns the greater will be the inductance. In some cases the coil may be provided with plugs and sockets to vary the inductance by steps and other means provided elsewhere in the circuit to get all adjustments between the steps.

Curves showing how the inductance of a coil varies with the numbers of the turns in circuit is called a *calibration curve* of the inductance. In figure 25 is shown such a curve for a helix, with square turns wound with copper tubing about one-fourth inch in diameter, the length of each side being 21½ inches and the spacing of the turns being 1 inch between centers. In figure 26, A and B, are shown two calibration curves of a flat

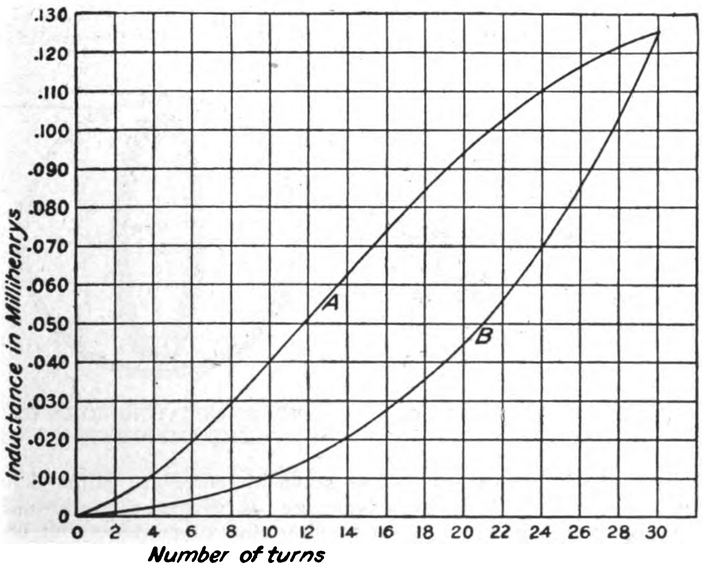


FIG. 26.—CALIBRATION CURVES OF A FLAT SPIRAL

spiral, similar to the one used in the field radio sets, in the first of which (A) the turns are counted from the outside inward, and in the second (B) they are counted from the inside outward. Thus it is seen that in using different numbers of turns in a flat spiral care must be taken to state how the turns are counted. The explanation of the difference between the two curves is that, other things being equal, the greater the diameter of the turn the larger will be the inductance and hence the inductance will be the larger for a few turns in that curve in which the turns are counted from the outside inward.

There is another useful type of inductance called the *variometer,* which consists essentially of two coils connected in series or parallel, as desired, one of which is movable with respect to the other. In some cases one coil is arranged to slide past the other in a plane parallel to its windings, as indicated in figure 27; in other cases one coil is rotated inside the windings of the other, as indicated in figure 28. In the second type, when the coils are in the same plane and the windings are connected so that the current is circulating through them in the same direction, the two magnetic fields are helping each other and the inductance is a maximum; if, now, one coil is rotated through an angle of 180 degrees the two fields are opposing and the inductance is a minimum; for intermediate

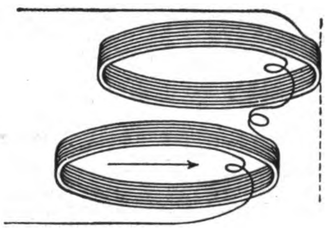


FIG. 27.—SLIDING COILS OF THE VARIOMETER

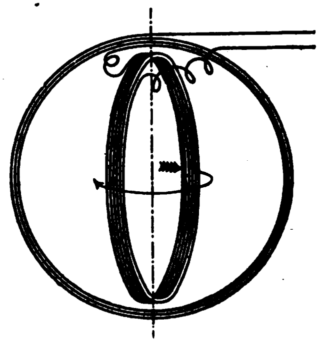


FIG. 28.—ROTATING COILS OF THE VARIOMETER

angles the inductance will have some intermediate value. The variometer thus has the advantage of giving a continuous change of inductance without moving clips or contacts, but has what *may be* under certain conditions the disadvantages of not giving zero inductance at its minimum position and of always having the resistance of all its wire in circuit. A variometer is generally used in connection with a helix or coil, variable only by steps, to give intermediate values of the inductance as mentioned above.

The earlier types of closed circuit inductance were wound with wire or tubing, the resistance of which to direct current was very low. Both theory and experiment have shown, however, that the resistance to high-frequency currents may be comparatively large. The explanation is that these high-frequency currents tend to travel almost wholly on the surface of the conductor and do not penetrate to any considerable distance into the wire. Thus a thin-walled tube will have practically the same resistance to high-frequency currents as a solid wire of the same diameter, the inside of the wire carrying no current at all.

This tendency of the current to flow only on the outer surface is sometimes called the *"skin effect"* and the distance to which the current penetrates the thickness of the skin. The higher the frequency the more marked is the skin effect and

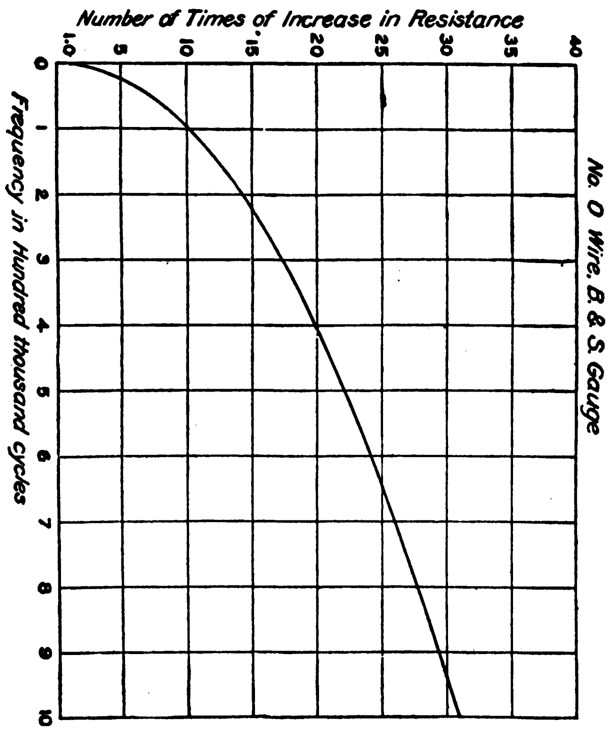


FIG. 29.—RESISTANCE CURVE OF NO. O, B. & S. COPPER WIRE

the thinner is the skin; in other words, the higher the frequency the larger will be the resistance for the same size and length of wire. In figure 29 is given the curve showing the increase in resistance for No. 0 copper wire, B. & S. gauge (about 325 mils in diameter), as the frequency changes from zero or a steady current up to 1,000,000 cycles per second. Thus at 500,000 cycles it is seen that the resistance has been increased about 22 times the D. C. value. The scale of such a curve will differ with the different sizes of wire, the increase being greater than here shown for wires larger than No. 0 and less for smaller sizes. In figure 30 is given the curve showing the increase in resistance for the various sizes of copper wire in the B. & S. gauge at a frequency of 500,000 cycles per second. Thus a wire as small as No. 35, B. & S., has very nearly the same resistance at this frequency as at a steady current, or,

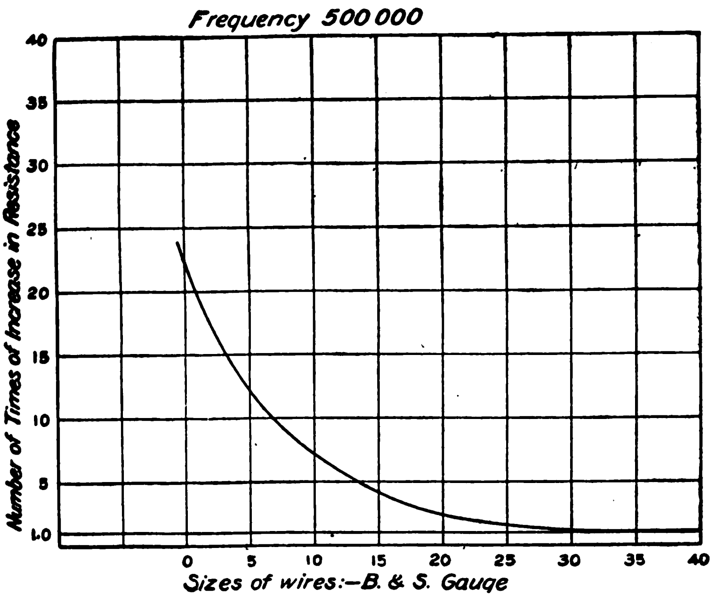


FIG. 30.—RESISTANCE CURVE SHOWING INCREASE FOR THE VARIOUS SIZES OF COPPER WIRE IN THE B. & S. GUAGE

in other words, the thickness of the skin at this frequency is about equal to the radius of the wire. In order to be able to include all sizes of wire at all frequencies it is evident that a large number of curves or an extensive table of resistance and frequency would be necessary.

If a large number of wires, the diameter of which is such that the current just penetrates to the center at any given frequency, is used in parallel in the form of a compactly stranded wire or cable it is evident that *all* the copper is in use and that the current-carrying surface of such a cable is very much greater than that of a *solid* wire of the same outside diameter, and hence the resistance is very much lower. Each wire must, however, be separately insulated, as otherwise the current will immediately seek the outer surfaces of the outer wires on account of the skin effect, and the resistance will not be much decreased from that of a solid wire. Such a stranded wire or cable, with its individual wires separately insulated, as with enamel, is sometimes called *litzendraht,* from the German word. The size of the insulated wire depends upon the frequencies at which it is to be used. If the highest frequency should be 500,000 cycles per second, then from figure 30 it is evident that there would be but little gain in using a wire smaller than No. 34 or No. 35 on B. & S. gauge. The number of wires depends upon the current to be carried and the resistance desired. For small currents it is generally a multiple of 7, as 7×7, or 49 wires, but for heavy currents the number may be in the hundreds or even in thousands.

It is evidently impossible to get a continuously variable inductance by a sliding clip or contact on all the wires of a litzendraht coil, so that when such an inductance of *low resistance* is desired it is generally made in the form of a variometer wound with litzendraht.

The use of litzendraht is not confined to transmitting coils, but is also used in receiving sets to get low-resistance circuits.

Spark Gaps

The function of the gap is to serve as a trigger in starting the oscillations and to limit the potential applied to the condensers by the transformer secondary. An ideal gap would be one having an infinite resistance during the charging of the condensers and a zero resistance during each wave train of the discharge.

The types of spark gaps in use differ nearly as much as the other parts of the closed-circuit elements. In small-sized sets the electrodes or terminals are generally made of zinc or brass, the sparking surfaces being either balls of one-half inch diameter or more, or else rounded surfaces. Sharp points are not used, as at small separations the potential required to break down the gap is too small to allow any considerable power to be used, and if the gap is opened to increase the potential and power the gap resistance becomes too high. As the power delivered to the transformer is increased it is soon found that the discharge at the gap becomes flaming in character and has a hissing sound, seeming to be more like an arc than a spark, and the gap terminals become very hot. The reason for this is that, owing to the great quantity of electricity discharged across the gap, the resistance becomes so low that a high-potential alternating-current arc, which is almost a short circuit, is maintained at the transformer secondary terminals. This arc is formed in the heated air and the vapor of the metals forming the gap terminals. Experiment has shown that a blast of air across or through the gap will blow out the arc but not the spark. By thus removing the short circuit the condenser can be charged to the full potential of the secondary and the power of the set increased—in some cases it may be nearly doubled.

The air blast may be obtained from a blower or compressor driven, for example, by an electric motor or directly by the rotating of the gap terminals themselves, in which case it is known as a *rotating gap*. There are two general types of rotating gaps, in the first of which the rotation is simply a convenient means of giving the necessary ventilation and cooling. It is not necessary that it be provided with rotating terminals, although it may be so provided. In one of the early types used in the Signal Corps, shown in figure 31, a rotating disk is used

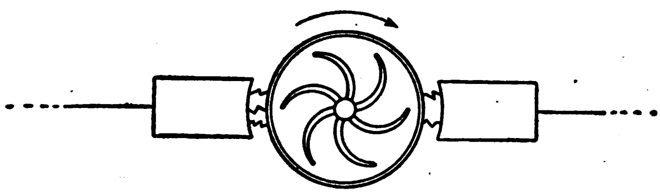


FIG. 31.—NON-SYNCHRONOUS ROTATING SPARK GAP

between two fixed terminals. In this case the sparks shift from place to place on the edges of the disk as it turns, the ventilation being by means of fans on the face of the disk, which blow the air away from the gaps. As no attempt is made to secure any special time relation between the discharges and the alternator frequency this type of gap is often called a *non-synchronous gap*.

In the second type of rotating gap one set of electrodes is attached to the alternator shaft, preferably insulated from it, and thus rotates at the same speed as the armature; the other terminal is mounted so as to be capable of adjustment, both in the direction of rotation and in a radial direction. If the spacing of the revolving terminals is such that as many terminals pass the fixed terminal per second as there are alternations per second, and, further, if the adjustments of potential, etc., are such that the discharge is at the peak of each alternation, then there will be as many sparks per second as there are alternations, and the gap is called a *synchronous gap*.

In order to secure the correct adjustments of a synchronous gap the fixed terminal should be adjusted radially to give only a small clearance, as 1/32 inch or less, and then adjusted in the direction of rotation as follows: If the rotating terminals are watched by the light of the sparks themselves, they will appear either to be wavering back and forth or else to be nearly fixed in position. In the former case the discharge does not occur at the peak of the wave, but perhaps before the peak in one alternation and after in the next, and hence the wavering appearance; in the latter case the discharge is at the peak of the wave as shown by the apparent steadiness of position. At the same time that this correct adjustment is secured the note of the spark as heard either in the station itself or at a distant receiving station will become much clearer, the advantages of which will be mentioned later.

As it is generally best not to have long leads from the spark gap to the other elements of the closed circuit, it may be necessary to have all of the closed circuit as well as the open circuit in the room with the alternator, in which case the operator and the receiving set should be in another room. In some cases it may be possible to mount the alternator and gap so that short leads can be brought out from the latter through well-insulated bushings into the next room, which should be sound proof, and thus all the circuits be contained in the same room with the operator for convenience and promptness in making changes in wave length and other adjustments, etc.

QUENCHED SPARK GAPS

Most modern sets use the quenched spark gap, a brief description of which will be given here and the theory of the quenched spark transmitter later. The gap is essentially a

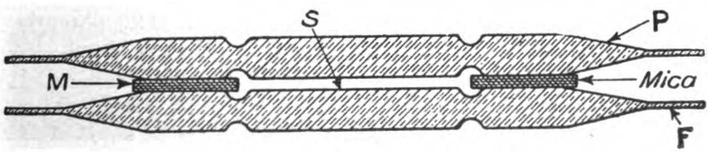


FIG. 32.—SECTION OF PLATES OF QUENCHED GAP

series gap consisting of a number of plates with small separations between the sparking surfaces, which are inclosed in air-tight chambers formed between the plates themselves.

In figure 32 is shown a section of a gap where P are the plates, often made of copper, which, on account of good conductivity for heat, will carry off the heat of the spark; F are the flanges, which help the cooling by exposing a large area to the air or to the air blast to be mentioned later; S are the sparking surfaces between which the sparks pass, which may be of the same copper stock as the rest of the plate or of heavy silver plate fastened in place at S; M the separators or insulating rings, also called gaskets, between the plates, often made of mica, about 0.010 inch thick (10 mils), the thickness of which determines the distances between the sparking surfaces. In some cases the separators are made of rubber or other insulating materials which are somewhat compressible, and then the bearing surfaces are often corrugated, as shown in figure 33, so that the material may be pressed down into the annular spaces. Whatever the type of separator, the gap as a whole must be put under strong mechanical pressure so that the air shall be excluded from the sparking surfaces, the reason for which seems to be that these surfaces are roughened with free exposure to air, and an arc is formed at some point which behaves as a short circuit between the plates and lowers the efficiency

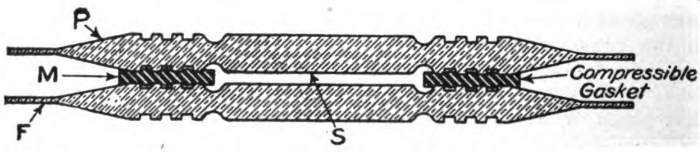


FIG. 33.—QUENCHED GAP PLATES WITH CORRUGATED SURFACES

of the gap. Gaps with mica separators should not be compressed as tightly as the others because the mica will be injured by the excessive pressure and the heat from the gap and will soon crack and puncture. In order to keep the gap cool the flanges of the plates are generally blackened, as a black body will cool more quickly than a polished body, other things being equal. In the larger-sized sets it is necessary to cool the gap by means of a blower driven by a motor similar to the type used in blowing out the arc of an open gap. The potential between each plate of a gap assembled as above is about 1,000 volts. This may be measured by finding the potential across several gaps by means of the needle gap and the values in Table 1, and then dividing this potential by the number of the gaps.

Under service conditions a quenched gap should be taken apart only when it is absolutely certain that trouble in the radio circuits has been located in the gap itself, as shown, for example, by one or two of the plates becoming much hotter than the others, or by an actual puncture of a gasket or separator. The reason for not taking the gap apart frequently seems to be that after a certain time, depending on the amount of use, the oxygen of the air contained between the plates becomes inactive and there is no tendency of the sparks to roughen the sparking surfaces and form local arcs, but rather that these surfaces are worn smooth and kept bright by the sparking action. If, however, the gaps are continually being taken apart air will be admitted each time, and the gap may not give the results that otherwise would be attained. There are cases where quenched gaps have been used handling heavy traffic daily for six months or more without the necessity of being taken apart once during that time, and in one of the Signal Corps sets such a gap has now been in service for nearly three years without having a plate or gasket replaced or even the gap taken apart. If, however, it becomes necessary to clean the plates, they should be laid face down on fine emery cloth or paper on a *flat surface* and the roughness carefully smoothed off. When mica is used as a separator, the bearing surface is generally flush with the sparking surface, and particular care must be taken to keep the two plane and parallel as shown by a straightedge. Any irregularities on the bearing surface will admit air and injure the gap, no matter what pressure may be put on the plates. Almost all gaps are provided with more plates than should be used under service conditions, the extra gaps being short-circuited by clips for that purpose, so that when any one gap becomes bad it can be temporarily cut out of circuit without the necessity of taking the whole gap apart.

Connection of Closed Oscillating or Primary Circuit with Antenna Circuit

In the original transmitting arrangement of Marconi the spark gap was inserted between the antenna and ground, the transformer secondary terminals being connected, one to the antenna and the other to the ground, as shown in figure 34. This circuit is often known as the *plain Marconi antenna* or *aerial.* As the antenna has both inductance and capacity it forms in this case the oscillating circuit, taking the place of the circuit CSL of figure 19. The values of the inductance and the capacity vary with the size, shape, etc., of the antenna; thus for a small antenna, as on an artillery tug or in a portable field set, the capacity may be between 0.0006 and 0.0009 mf., and the inductance between 20,000 and 30,000 cms., or 0.02 and 0.03 millihenrys; and for a "T" or inverted "L" antenna on 180-foot masts, the capacity may be as large as 0.0015 or 0.0020 mf., and the inductance 30,000 to 60,000 cms. or 0.030 to

0.060 millihenrys. Only in the largest stations is the capacity of the antenna as large as 0.01 mf.

From its position and shape the antenna circuit is often called the *open* or *radiating circuit,* as distinguished from the closed oscillating or primary circuit. It is a good radiator of the electrical energy imparted to it by the transformer, but its small capacity makes it impossible to store a large charge in it, and consequently at each discharge across the gap there is comparatively little energy available for radiation. For this

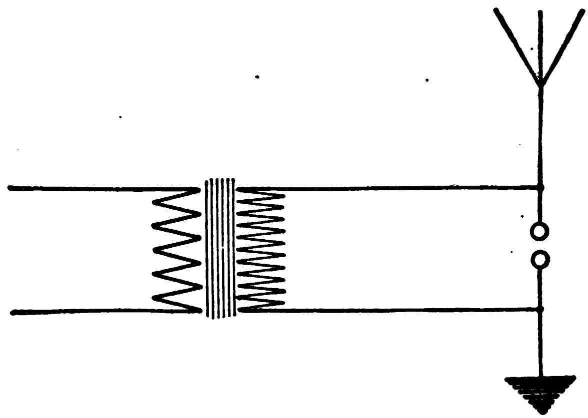


FIG. 34.—CIRCUIT OF THE PLAIN MARCONI AERIAL

and other reasons to be mentioned later this circuit is not now used in practical radiotelegraphy.

COUPLING

By means of the arrangement shown in figure 35 a large charge may be stored in condenser C, much larger than that which can be stored in antenna of figure 34, and the discharge of this condenser through the gap S and the inductance L will produce powerful oscillations in the closed oscillating or primary circuit. On account of its position and shape, however, this closed oscillating circuit is a poor radiator of electrical energy. There are two general ways in which the energy of this circuit can be transferred to the antenna circuit; or, as it is said, two ways of *coupling* the circuits. One is shown in figure 36, where the ground and the antenna circuits are directly connected to the inductance coil of the closed circuit, and the circuits are said to be *directly connected, directly coupled,* or *conduc-*

tively coupled. From its position in the circuit the coil is often called the ***antenna coil or helix.*** The other is shown in figure 35,

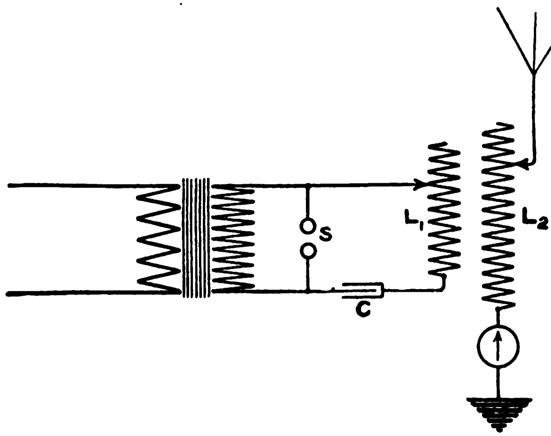


FIG. 35.—INDUCTIVELY COUPLED CIRCUIT

where a number of turns in the antenna coil L_2, connected between the antenna and ground, is brought near enough to a number of turns of the coil L_1 in the closed oscillating circuit to have oscilla-

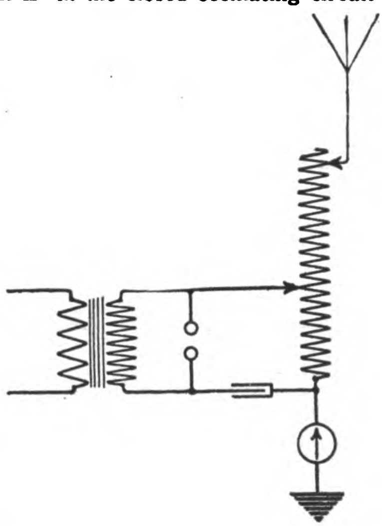


FIG. 36.—DIRECTLY COUPLED CIRCUIT

tions induced in the antenna coil and circuit, and the two circuits are said to be *inductively coupled* or *connected.* The two coils L_1 and L_2 form an *oscillation transformer,* as it is usually called, the coil L_1 being the *primary* and coil L_2 the *secondary.* Hence the antenna circuit is sometimes called the *secondary circuit* as well as the open or radiating circuit, as previously mentioned. There is no essential difference in the operation or efficiency of the transfer of energy in the two *types* of coupling, but rather that each may have advantages in certain cases. Thus the directly connected set is somewhat more compact and the inductively coupled set somewhat more easily adjusted under certain conditions.

In direct connected sets when nearly the same turns are connected in both the primary and the secondary circuits—that is, when most of the turns in use are common to both circuits, as shown in figure 37—the coupling is said to be *close* or *tight.*

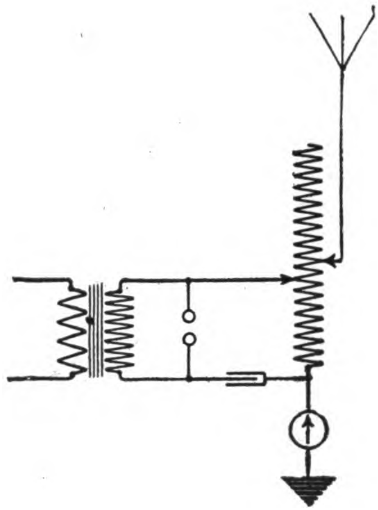


FIG. 37.—CLOSE COUPLED CIRCUIT

When only a comparatively few turns are common to the two circuits, as shown in figure 38, the coupling is said to be *loose.* Similarly in inductively connected sets, when most of the turns in use in the two circuits are near together, as when one coil is moved inside the other, as shown in figure 39, the coupling is close. When the turns in use are not near together, as shown in figure 35, the coupling is loose. In the case of inductively coupled sets it is evident that moving the coils of the oscillation transformer nearer together will tighten the coupling or make it closer, and vice versa, moving the coils further apart will loosen the coupling. If the turns in use in either circuit of a directly connected set are moved so as to have few or even no turns at all in common, as shown in figure 38, the coupling

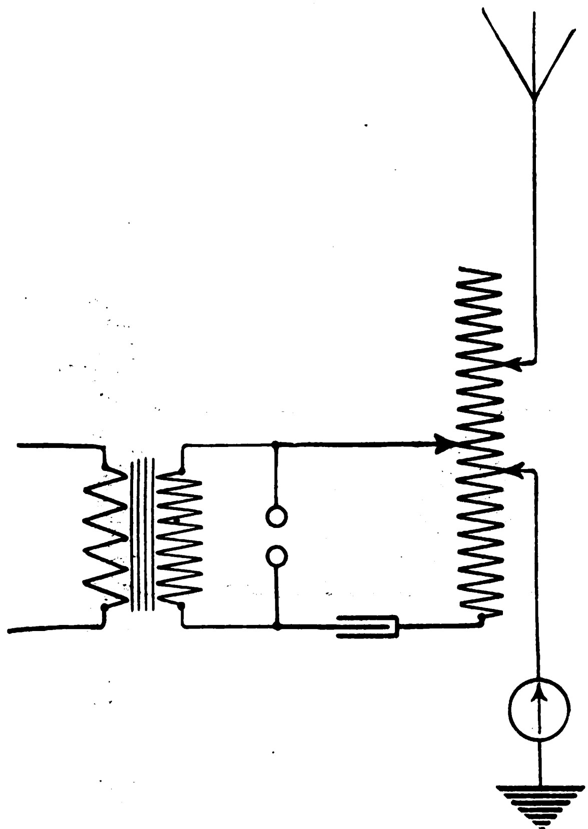


FIG. 38.—LOOSE COUPLED CIRCUIT

is loosened. The coupling may be made loose in other ways, one of which is illustrated in figure 40, where the coil L′₂ often known as a *loading coil*, is inserted in the antenna circuit, thereby adding inductance *not* coupled with the primary circuit. Similarly in the case of inductively connected sets the coupling may be loosened by inserting the loading coil L'_2 in the antenna circuit, as shown in figure 41. In both these cases it is to be noted that the result is practically the same as though the turns in use in the two circuits

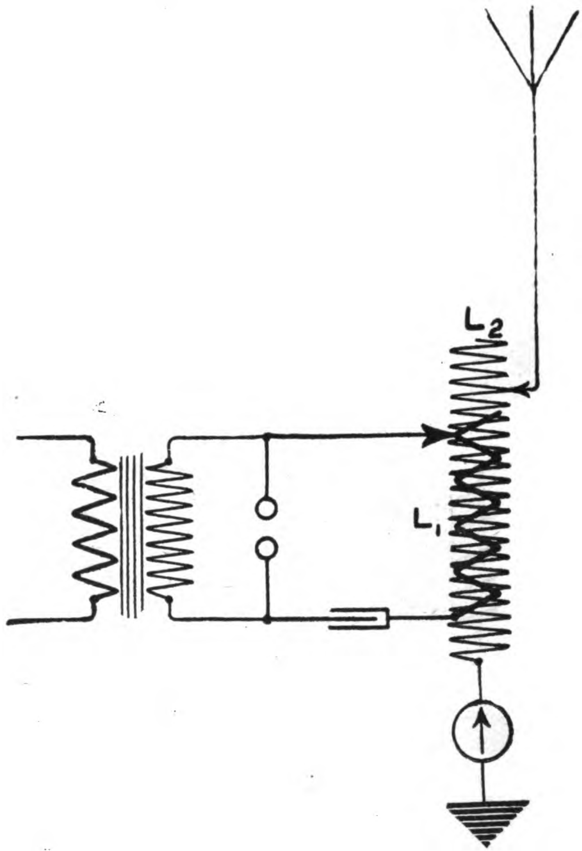


FIG. 39.—CLOSE COUPLED CIRCUIT

were moved farther apart as a whole. In both the directly connected and the inductively connected sets the coupling may also be loosened by inserting a loading coil in the primary circuit, as shown in one case in figure 42. By means of these loading coils a directly connected set can thus be made as loosely coupled for practical work as an inductively connected set. In such a circuit as that in figure 40, the coil which is common to both circuits and serves to transfer the energy from one to the other is sometimes called the *coupling coil.* At the

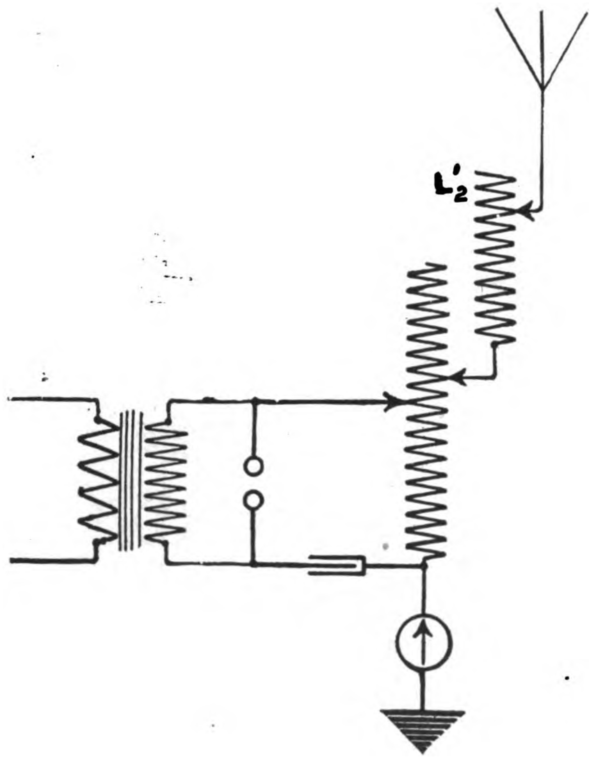


FIG. 40.—LOADING COIL IN ANTENNA CIRCUIT

present time most of the sets in use in the Signal Corps are loosely coupled and all of the various methods of obtaining loose coupling here described are in use, each one having advantages in its particular radio set.

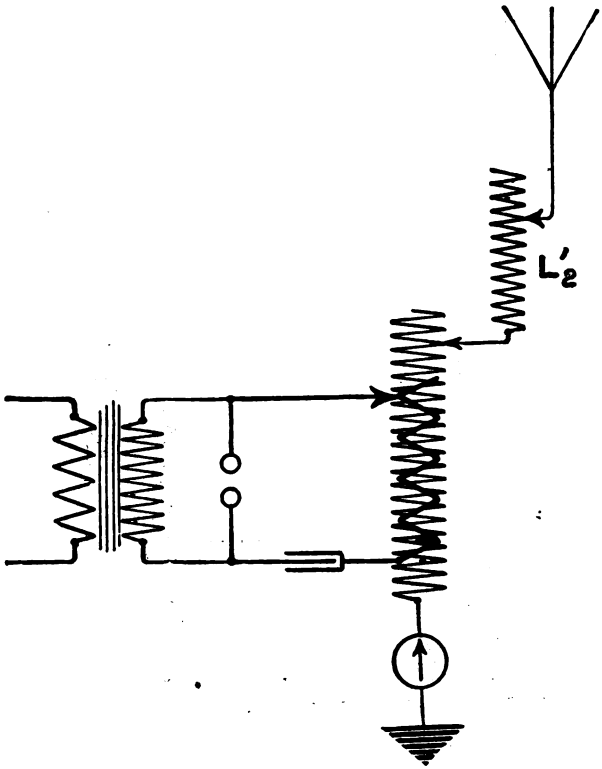


FIG. 41.—ANOTHER HOOK-UP OF FIGURE 40

ANTENNA

The open or radiating circuit has its own natural period of oscillation expressed, as in the case of the closed circuit, in fractions of a second. The most energy can be delivered to it from the closed oscillating circuit when by adjusting the inductance or capacity, or both, of the latter the oscillations in it have the same frequency as in the open circuit; that is, until the two circuits are *in resonance.* Then the strongest oscillations or the greatest current will be flowing in the antenna as shown by the maximum reading in a *hot-wire ammeter* of figures 37 to 42, inclusive. The ammeter is usually connected between the ground and the secondary of the oscillation transformer, but may be connected between the secondary and the antenna.

These powerful damped high-frequency oscillations in the antenna or open circuit produce corresponding periodic disturbances in the surrounding medium, which spread outward in the form of electromagnetic waves, as has already been explained.

In general the higher the antenna, the greater the energy

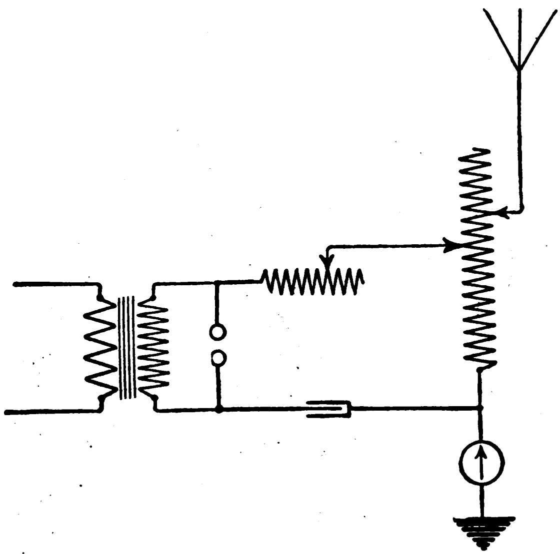


FIG. 42.—LOADING COIL IN PRIMARY CIRCUIT

in the form of electromagnetic waves which it can radiate and receive; in other words, the greater the distance to which it can send and receive signals. In most cases a large capacity is also desired, which can be secured by putting up a number of wires, but there is little gain in capacity unless the wires are at least a foot apart. Additional capacity and increased efficiency in radiation can be secured by using a flat top or horizontal spread of wires at the top of the mast, which becomes, as it were, one plate of a condenser, the earth being the other plate, with the air as the insulator or dielectric. Antennæ are often divided into *three types*, depending on the way in which the wires are arranged at the top, such as umbrella, inverted L, and T, where the names are sufficiently suggestive as not to require a description. The umbrella is best adapted for short stations having a single mast or tower with several acres of land around the station, and has largely been used by the Signal Corps.

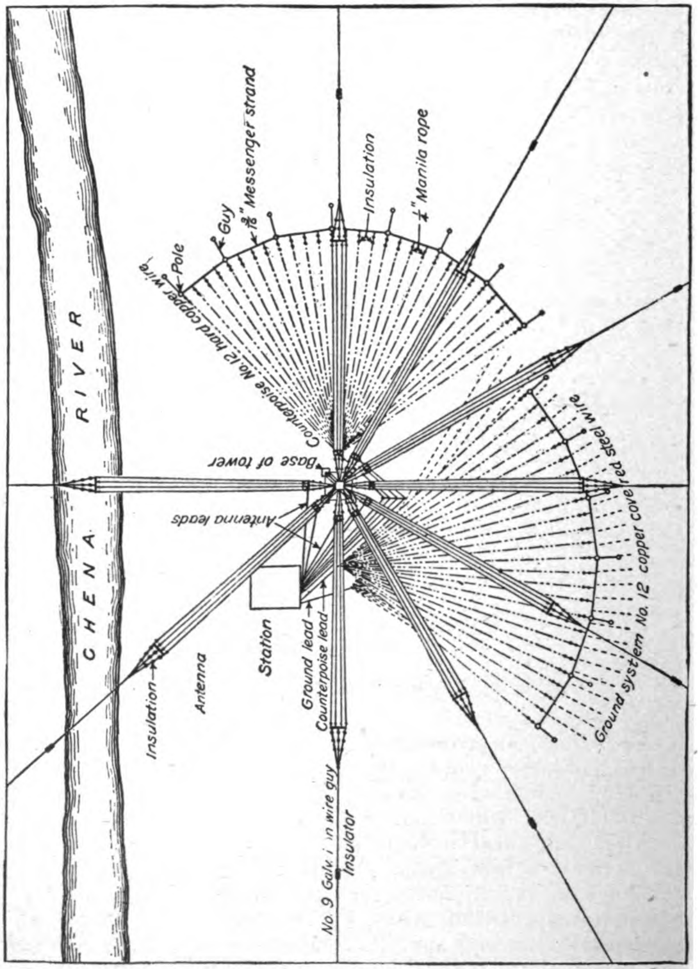


FIG. 43.—THE SIGNAL CORPS AERIAL INSTALLATION AT FAIRBANKS, ALASKA

The inverted L and the T can be installed on shipboard or at shore stations, but require two masts or towers. In the case of the umbrella antenna, the wires extending outward from the mast should be kept as nearly horizontal as possible and as far away from tree tops, buildings, roofs, etc., as circumstances will permit. The distant ends are dead-ended at high-potential insulators attached to long guys carried out to stub masts or deadmen. These guys should have insulators inserted every

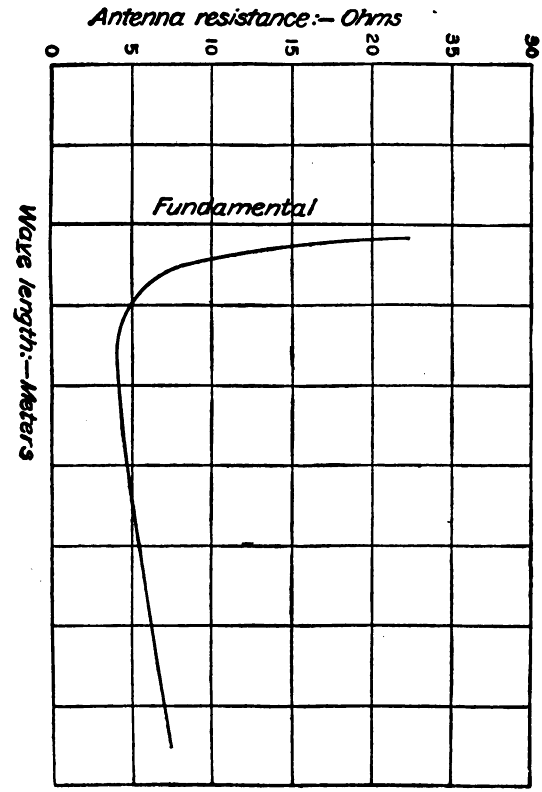


FIG. 44.—WAVE CURVE OF TYPICAL ANTENNA RESISTANCE

50 or 100 feet to prevent them from serving as extensions to the antenna wires and thereby bring the antenna too near the ground. It is not necessary that the antenna wires be symmetrically arranged around the tower, it being far more

important that advantage be taken of the configuration of the ground and that the outer ends be kept well elevated. This is shown in the plan of the Signal Corps radio installation at Fairbanks, Alaska, figure 43, where, on account of swampy land along the river near the station, a symmetrical arrangement is practically impossible.

The antenna must be well insulated, particularly at the outer ends of the horizontal wires, as otherwise there will be leakage to ground in damp weather or rainy seasons, which will cause a serious loss in efficiency when the station is transmitting. High-tension insulators of electrose or porcelain are usually furnished for use at these points of the circuit.

The antenna wires are generally stranded, thus giving somewhat greater strength than a solid wire of the same weight. For permanent stations a phosphor-bronze or silicon-bronze wire is generally used consisting of seven strands of either No. 20 or No. 14 B. & S. gauge, and for the portable stations, such as the Signal Corps field-pack sets, an antenna cord made up of 42 phosphor-bronze wires stranded around a hempcord center. A very low resistance in the antenna wires is not as nesessary as it might seem to be, as it has been shown by theory and proven by experiment that the radiation of electromagnetic waves introduces a resistance, sometimes called the *radiation resistance,* which in general is many times the high-frequency resistance of the wires themselves. This radiation resistance rarely falls below 2 ohms on a ship set and may be as high as 20 or 30 ohms in a shore station. When the *antenna resistance* is measured under service conditions it includes that of the wires at the given frequency, the resistance of the ground, and that due to the radiation of energy, the latter being generally the larger part. A typical antenna resistance is shown in figure 44, where it is to be noted that the resistance is greatest near the fundamental wave length of the antenna and is least at a wave length about one and one-half or two times the fundamental. It is at or near this point that many stations work most efficiently.

ARTIFICIAL ANTENNA

In many cases it is convenient to make station tests without using the actual antenna, particularly where such use would cause unnecessary interference. A local circuit of a coil L and condenser C having the same inductance and capacity as the antenna and called an *artificial antenna* is often used, thus serving the same purpose as an artificial line or cable in telegraph tests. When a resistance R is inserted in this circuit to give the same current as actually flows in the antenna this resistance is approximately equal to the antenna resistance. The circuit for making these measures is shown in figure 45, where the circuit of L, C, and R, which replaces the antenna when the switch is thrown to the right, is the artificial antenna.

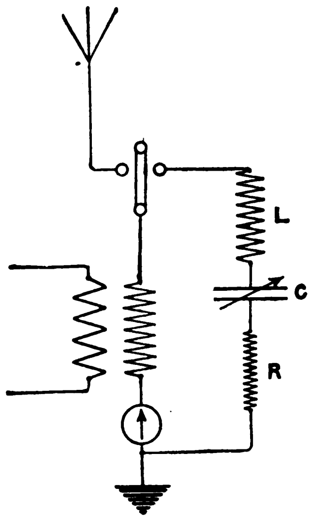


FIG. 45.—ARTIFICIAL ANTENNA CIRCUIT

The antenna inductance L and capacity C can be easily measured with the help of a wave meter and thus a suitable coil and condenser selected for use in the artificial antenna which will then closely represent the actual antenna.

Efficiency of Radio Set

The antenna resistance, the radiation resistance, and the antenna current all change as the frequency or wave length changes. If at any one frequency or wave length the square of the antenna current in amperes is multiplied by the antenna resistance in ohms, the product, I^2R, is in watts, and represents the power delivered by the closed oscillating circuit to the antenna; that is, it is the *antenna input,* as it is sometimes called, or the *watts in the antenna.* If the number of watts delivered by the alternator is known, the *efficiency* from alternator to antenna can be found by finding the quotient of the watts in antenna divided by the watts from the alternator,

$$\text{thus } \mathfrak{E} = \text{efficiency} = \frac{\text{watts in antenna}}{\text{watts from alternator.}}$$

In the early types of spark sets this value was as low as 10 or 20 per cent, whereas in modern quenched spark sets, it may be as high as 50 per cent or even higher. If a motor-generator set is used and the number of watts delivered to the motor is known, the over-all efficiency can similarly be found by dividing the antenna watts by the motor watts, thus over-all

$$\mathfrak{E} = \frac{\text{antenna watts.}}{\text{motor watts.}}$$

The percentage so obtained will of course be lower than before, as it allows for losses in the motor-generator which were not considered in the previous case.

The rating of the earlier radio sets was given as the output of the alternator, but in modern sets it is often given as the number of watts delivered to the antenna. In the latter case the artificial antenna may be used and its inductance, capacity, resistance, together with the current and watts at a given wave length must then be specified.

When steel towers are used they are generally heavily insulated at the base, but provided with switches for grounding when desired, as during lightning storms, etc. In some cases the station becomes more efficient in transmitting if the tower is grounded. In general, however, the result of grounding can be told only by tests at the receiving station of the loudness of the signals, and not by the readings of the antenna hot-wire ammeter or other means at the transmitting station. The grounding of the tower generally makes it necessary to change the tuning of the transmitter, and there are corresponding changes in the reading of the antenna ammeter, but increases in its reading do not necessarily mean increases in the signals at the receiving station, as part of this increase is due to increased flow of current through the tower to ground. It is for this reason that the results of grounding should always be tested at the receiver.

Ground

An efficient ground for a radio station is very different from that used at an ordinary telegraph station. The latter generally has a metal plate set deep in wet ground, but the former needs a large *spread on the surface* or just under it. Thus, instead of using a large copper plate or rods close together, a far better type of ground would be to use wires radiating out from the station, or to duplicate the umbrella or flat-top antenna system a short distance under the surface of the ground. The advantages of a surface ground may be understood when it is remembered that close to the station the magnetic and static fields are very intense, so that if they had to pass down through the earth to a ground plate instead of being able to travel wholly on the surface, as shown in figure 9, there would be introduced an additional ground resistance and local earth currents would be caused, with corresponding losses. The use of a surface ground serves to reduce these losses to a minimum. It should be noted that the instantaneous values of the transmitting currents are very large and the frequencies are very high, sometimes a million or more per second, so that considerable copper, such as stranded wires or copper strip, should be used both in the ground wires and in the leads connecting the set to them.

Another type of ground connection which has been successfully used at permanent stations, and also in the portable field sets, is known as the *counterpoise*. In the permanent stations this consists of a set of bare horizontal radial or parallel wires, which are supported by insulators on posts 7 feet or more above ground. A counterpoise of a fan type has been installed at Fort Sam Houston, Tex., in which bare wires, No. 10, B. & S. gauge, 190 feet long, extend outward from the station under the antenna, being spaced 6 feet apart at the station and 20 feet at the distant ends. A counterpoise of the radial type has been installed at the Fairbanks (Alaska) station, as shown in figure 43, where the wires are bare, hard-drawn copper No. 12, B. & S., about 210 feet long, and spread out in two arcs, each of 90 degrees. A counterpoise is particularly efficient in case the soil is dry, as at Fort Sam Houston, and also where there is a heavy snowfall, as at Fairbanks. At the latter station both a ground and a counterpoise have been installed. In the case of the Signal Corps wagon sets, radial counterpoise wires mounted on temporary poles, carried as part of the set, were used at first, but now have been replaced by the same type as that of the pack sets, which consist of rubber-covered wires, each 100 feet long, laid out radially on the ground. Although not directly connected with the ground at all, these wires really constitute one plate of a condenser, the ground being the other.

Wave Lengths

Before describing the various receiving circuits and the theory of their operation, some of the terms applied to them and to the transmitting circuits will be defined.

In the mechanical illustrations of damped oscillations and resonance, by means of the steel spring and the tuning forks it was convenient to use both the *frequency* expressed in the number of oscillations per second and the *period* expressed in fractions of a second. The same terms were used in describing the electrical oscillations in the radio circuits, and although this usage is entirely correct, it is somewhat more common to use the term *wave length,* which will be defined in the following paragraphs.

At the end of one second of time after an electromagnetic wave has begun to radiate from an antenna, it will have reached a point 300,000,000 meters distant; that is, it is said that its velocity is 300,000,000 meters per second, or, as it is often abbreviated, V = 300,000,000 meters. During this interval of time the direction of the magnetic and the static lines of the waves has been reversed very many times; in fact, as many times as the oscillations in the antenna have been reversed. Similarly in this interval of space both fields will be in the same direction at very many points, all separated by equal distances, as represented in figure 9. The distance between any two such points is called a *wave length* and is generally given in meters, the symbol for which is λ.

It is evident that the greater the number of times per second that the two fields have been reversed the shorter will be the distance in meters between the points where the fields are in the same direction; that is, the shorter the wave length; and, vice versa, the fewer the number of times per second that the fields have been reversed, the longer will be the distance between the points where the fields are in the same direction;

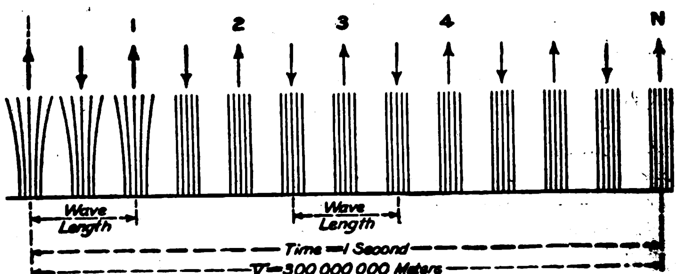


FIG. 46.—WAVE LENGTH GRAPHIC OF STATIC FIELD DIRECTION

that is, the longer will be the wave length. If N is the number of points in the distance 300,000,000 meters that the fields have the same direction, and if λ is the wave length in meters, then we have the relation $N \times \lambda = V$. This is one of the fundamental relations in radiotelegraphy and is shown graphically in figure 46, where to secure simplicity only the static field is indicated, in which it is seen that the direction of the field is repeated N times in the distance $V = 300,000,000$ meters, which is traveled in one second of time.

A short table of wave lengths and frequencies, computed from the equation $N \times \lambda = V$, is given below:

Wave length in meters	Frequency in oscillations per second
100	3,000,000
200	1,500,000
300	1,000,000
400	750,000
500	600,000
600	500,000
1,000	300,000
2,000	150,000
3,000	100,000
4,000	75,000
5,000	60,000
6,000	50,000
10,000	30,000

From this table and from the relation $T = \frac{1}{N}$ it is seen that the shorter the wave length the higher is the frequency in number of oscillations per second and the shorter the period of each oscillation in fractions of a second; and, vice versa, the longer the wave length the lower is the frequency in oscillations per second and the longer the period of each oscillation in fractions of a second.

Although the wave length is rarely, if ever, measured as the distance in space between two points where the electromagnetic fields have the same direction, yet it can be very accurately measured by other means. One of these makes use of the relations $N \times \lambda = V$, and may be briefly described as follows: It consists in photographing the discharges in a wave train at the spark gap at a very rapid but known speed. From the speed of the plate and separation of the successive images it is possible to determine the frequency—that is, N—and hence the wave length λ.

Frequencies in Radio Measurements

It will be noted that it has been necessary to speak of the frequency of circuits from two or three different points of view, which will be summarized as follows: (1) The frequency of the alternator, which depends upon the speed and design of the machine, as from 60 to 500 cycles per second. This frequency is independent of all of the radio circuits. (2) The spark frequency or wave-train frequency, which depends on the alternator frequency, the capacity of the closed-circuit condenser, the voltage at the spark gap, etc., as 120 to 500 or 1,000 sparks or wave trains per second. (3) The frequency of the oscillations in the radio circuits, which depends only on the capacity and inductance in the circuit in question, as 1,000,000 oscillations per second for a wave length of 300 meters, or 100,000 oscilations per second for a wave length of 3,000 meters. Use must be made of all of these frequencies in dealing with the problems of radiotelegraphy.

Wave Meter

The instrument used to measure the wave length of the oscillations, and hence the frequency or period as may be desired, is called a *wave meter*. It consists essentially of a closed circuit of coil and condenser and some means of indicating resonance as a low resistance hot-wire ammeter. From the

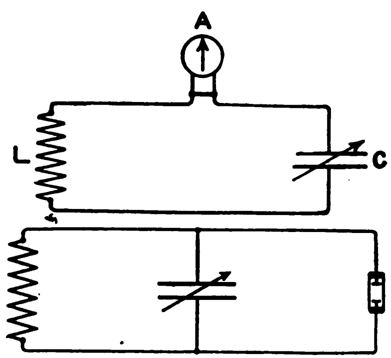


FIG. 47.—AMMETER IN CIRCUIT TO INDICATE RESONANCE

known values of the inductance and capacity the frequency or wave length can be computed by the formulæ

$$N = \frac{1}{2\pi\sqrt{LC}} \quad \text{and} \quad \lambda = 2\pi v \sqrt{LC}$$

where the inductance L and the capacity C must be expressed in the units of the electromagnetic system, and λ will be in meters if v is in meters, or $v = 300{,}000{,}000$. As it may be sometimes more convenient to use the units of the practical system, as microfarads and millihenrys, for example, the formula will also be given for these units as follows:

$$N = \frac{5033}{\sqrt{LC}} = \frac{5000}{\sqrt{LC}} \text{ approximately}$$

$$\lambda = 59600\sqrt{LC} = 60000\sqrt{LC} \text{ approximately.}$$

Thus if L is 0.0352 millihenrys and C is 0.0020 mf., $L \times C$ is 0.0000704, $\sqrt{0.0000704}$ is 0.00839, and λ is 59600×0.00839 meters, or is 500 meters. Similarly N is $\frac{5033}{.00839} = 600{,}000$ oscillations per second, which agrees with the value in the table previously given for a wave length of 500 meters.

In order to include a wide range of wave lengths or frequencies several coils are generally provided, which, in the best meters, are wound with litzendraht, thereby to make the high frequency resistance low, and hence the meter sensitive and the tuning sharp. The variable condenser has either air or oil for the dielectric rather than a solid material, so that there is little or no internal loss. By means of the variable condenser the circuit can be tuned to resonance with any circuit whose wave length is desired. To indicate resonance a hot-wire ammeter or wattmeter may be used, with a suitable shunt to keep the resistance in circuit low, as shown in figure 47, where C is the variable condenser, L the inductance, and A the shunted ammeter or wattmeter. To measure the wave length the wave meter is brought near the circuit in question, but loosely coupled with it, and the capacity of the condenser is varied until a setting is found that gives a maximum reading in the hot-wire meter. From this setting and the calibration of the instrument the wave length can be found. In some cases meters are provided with a partially exhausted tube containing some gas, such as helium or neon, to be connected across the terminals of the condenser to indicate resonance. When the meter is in resonance there is a maximum current flowing in its circuit, and this produces a maximum voltage across the condenser terminals. This potential causes a very small current to flow through the gas, which is lighted up thereby, and thus indicates the setting for resonance from which the wave length can be found as before. In other cases it is convenient to use a detector to indicate resonance, in which case the meter becomes a receiving set with telephones, etc., as shown in figure 48, where, as before, C and L are the capacity and inductance, D the detector, T the telephones, etc. The setting of the condenser where the signals are loudest is the resonance point, from which the wave length can be obtained as before. In a few cases a receiving circuit such as that shown in figure 49 is used, which from the character of the connection to the detector is sometimes called a *unipolar connection.* The explanation of its

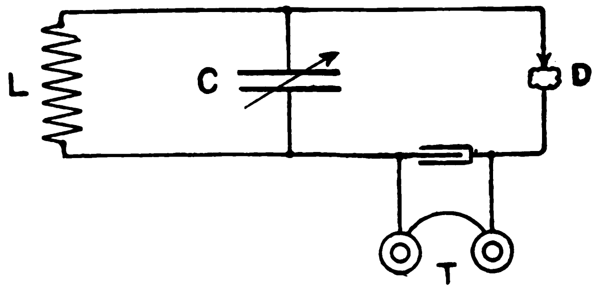


FIG. 48.—DETECTOR USED TO INDICATE RESONANCE

operation is that when the current circulates in the wave meter itself there is current enough sent along the short wire to operate the detector and telephones.

In addition to these uses of the wave meter at a transmitting station there are other equally important ones at a receiving station which will be described under the subject of receivers.

Natural or Fundamental Wave Length, Frequency, and Periods

One of the simplest and at the same time one of the most important uses of a wave meter at a transmitting station is in the measurement of the fundamental wave length of an antenna, which will be described next. It has been stated that a circuit having a capacity C and inductance L has a wave length

$\lambda = 2\pi\ v\ \sqrt{LC}$, a frequency $N = \dfrac{1}{2\pi\sqrt{LC}}$ and a period

$T = \dfrac{1}{N} = 2\pi\sqrt{LC}$. These values are generally called, respectively, the ***natural*** or *fundamental wave length, frequency,* and *period.* These terms apply to an antenna as well as to a closed circuit. Although the antenna has no coil or condenser in its circuit, the inductance is distributed along the length of the wire, as is the capacity. In such a circuit it is said that there

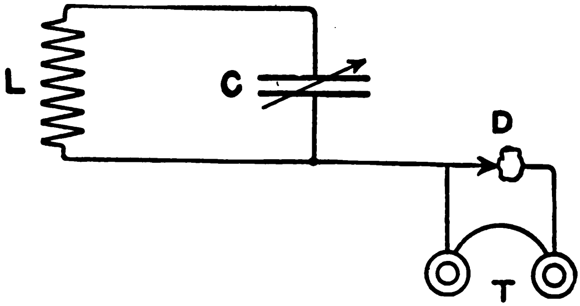


FIG. 49.—CIRCUIT WITH UNIPOLAR CONNECTION TO DETECTOR

is *distributed inductance* and *distributed capacity*, as distinguished from the *concentrated* or *lumped inductance* and *lumped capacity* in a coil and condenser of a local circuit. Theory and experiment have shown that a *single vertical* wire of length L has a natural wave length of about 4 times its length; that is, the fundamental wave length is approximated 4L. Thus, a wire 100 feet long will give a fundamental wave length of 400 feet; that is, about 122 meters, in even numbers.

1 inch = 2.54 centimeters.
1 foot = 30.48 centimeters.
100 feet = 3,048 centimeters = 30.48 meters.
400 feet = 122 meters.

If the single-wire antenna is of the inverted "L" type or is horizontal, the fundamental wave length will be increased to between 4L and 5L. If there are several wires in the antenna these simple relations do *not* apply and the fundamental wave length must be measured by a wave meter.

The plain Marconi antenna, shown in figure 34, is one of the simplest circuits for the measurement of the fundamental wave length of an antenna.

A single turn of wire 4 or 5 inches in diameter is often inserted in the antenna near the ground where the potential is low, which serves as a convenient means of coupling the wave meter to the antenna. The insertion of such a small turn has no appreciable effect on the fundamental wave length, and in many stations it forms a permanent part of the antenna.

The fundamental wave length of an antenna in small-sized sets, as in field sets or on artillery tugs, may be as short as

200 to 250 meters, and in large-sized sets may be as long as 1,500 to 2,000 meters. In general the longer the antenna wires, the higher the masts, and the greater the number of the wires the longer is the fundamental wave length.

In the circuits shown in figure 35-42, illustrating some of the common types of transmitting circuits, it will be noted that a coil has always been inserted in series between the antenna and ground. The insertion of such an inductance always increases the wave length of the circuit. Thus the fundamental wave length of a certain antenna alone may be 300 meters; an antenna coil of inductance of 0.12 millihenry is inserted and the wave length of the circuit, antenna-coil-ground. has now been

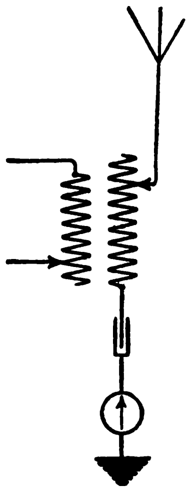


FIG. 50.—SERIES CONDENSER IN CIRCUIT TO SHORTEN WAVE LENGTH

increased to about 600 meters. It is evident then that none of the transmitting sets of figures 35-42 can radiate a wave length shorter than the fundamental wave length of the antenna itself. Inasmuch as both ships and shore stations must be prepared to use a wave length of 300 meters, according to the regulations of the International Radio Telegraph Convention, it is evident that the wave length must be shortened.

The insertion of a *series condenser*, as shown in figure 50, always shortens the wave length of the circuit. Thus, if an antenna installed on a ship was found to have a fundamental wave length of 450 meters and it became necessary to use a wave length of 300 meters, a coil must be inserted in the antenna circuit to permit it to be coupled to the closed circuit, which would lengthen the wave length somewhat, and then a series condenser must be inserted to bring the wave length of the circuit antenna-coil-condenser-ground to 300 meters. Such a condenser should be used only when it is absolutely necessary, as it is generally subjected to high potentials which give brush discharges and consequent losses. In many cases it is better to install a second and smaller antenna having a fundamental wave length sufficiently short for the purpose in question. This has often been done both on ships and at shore stations. When transmitting on the short antenna, the station end of the large antenna should be left insulated, and vice versa, when transmitting on the large antenna, the short antenna should be left insulated or else connected into circuit as part of the large antenna.

Tuning of Transmitting Sets

MECHANICAL ILLUSTRATION OF COUPLING

Before describing the methods of tuning the various types of transmitters and the measurement of the radiated wave

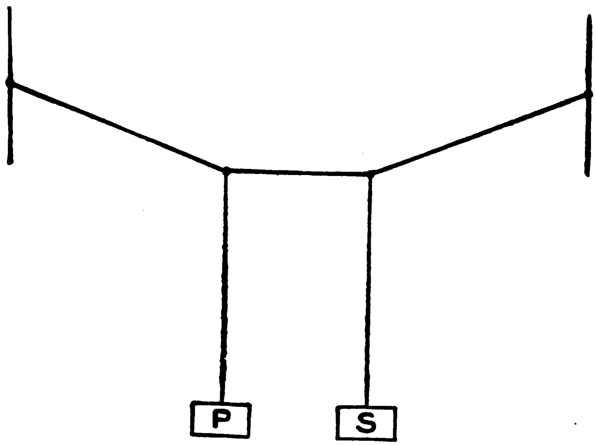


FIG. 51—MECHANICAL ANALOGY OF RADIO OSCILLATIONS

lengths, some mention must be made of coupling and its effects on the tuning of circuits.

The theory of coupled circuits, including that of the quenched-spark transmitter, can be simply illustrated by a mechanical model consisting of two equal weights suspended by two equal lengths of string from points on a slightly stretched string, as shown in figure 51. If the weight P is pulled to one side and released it will execute a series of damped oscillations (corresponding to the charging and the

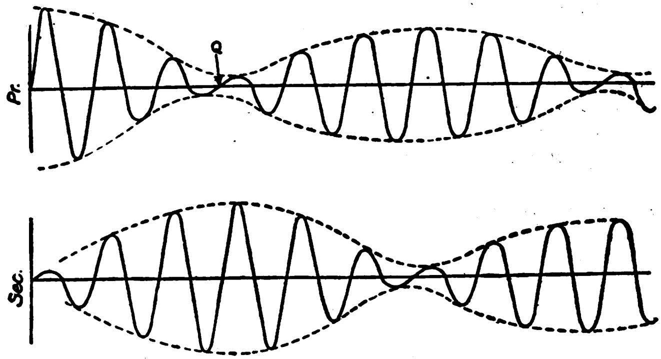


FIG. 52.—GRAPHIC REPRESENTATION OF OSCILLATIONS

oscillatory discharging of the primary or closed-circuit condenser). On account of movements of the stretched string (corresponding to the coupling) this soon causes the weight S to begin oscillating (corresponding to the induced oscillations in the secondary circuit), and in a short time it will be oscillating very nearly as much as P had been doing, but in the meantime P has practically stopped oscillating. In a short time, however, P will be oscillating nearly as much as before, but S will have stopped. Thus it is seen that the energy is first in one oscillating weight and then in the other, or that there is a transfer of energy back and forth from one to the other. This exchange will continue until the energy is all wasted or used up in friction, etc. This can be represented as in figure 52, where the upper and lower curves correspond respectively to the oscillations of the weights P and S. It will be noted that in both curves of figure 52 the amplitudes do not die down steadily toward zero, but rather through a series of values. Whenever such a series of maximum and minimum values occur, sometimes called *beats*, it can be shown by theory that it is due to the fact that each weight is oscillating successively at two slightly different rates or frequencies, one being slightly slower and the other slightly faster than its normal rate; that is, when not coupled with the other weight. In general, it will be found that the less the movement of the horizontal string (corresponding to *loose* coupling) the less frequent will be the transfer of energy from one weight to the other, and, vice versa, the greater the movement of this string (corresponding to *close* coupling) the more frequent will be the transfer.

If two circuits, one of which contains a spark gap, are separately tuned to the same frequency or wave length by means of a wave meter and then are very loosely coupled, it will be found that there can be detected only one wave length in each, which is the same as that to which they were independently adjusted at first, for example, as shown by the curve with the single hump of 300 meters in figure 53. When, however, the coupling has been somewhat increased or made tighter it will

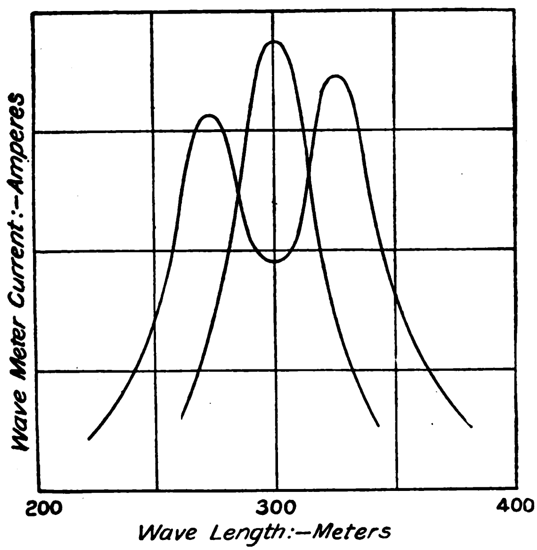


FIG. 53.—WAVE CURVES OF LOOSE AND CLOSE COUPLING

be found that now there are two wave lengths in each circuit, one of which is shorter and the other longer than that to which the circuits were tuned at first. At this coupling no readjustment of the tuning of the circuits can be made which will give a single wave in both of the same length as before. If the coupling is still farther increased, the two wave lengths will be separated still farther from the single value first measured. If the circuit containing the spark gap is the closed oscillatory or primary circuit of a transmitter and the other circuit is the open or radiating circuit, then it is evident that two wave lengths will be radiated as shown in figure 53, one at a wave length of 275 meters and the other at a wave length of 330 meters.

The two very loosely coupled circuits with the same wave length in each correspond to the case of a *very small* motion of the string with a single transfer of energy from one weight to the other. The closely coupled circuits with two wave lengths in each correspond to the case of a large motion of the string with frequent transfers between the two weights. In other words in very loosely coupled circuits the normal frequency or wave length of each is unchanged, and only one wave length can be detected in both. On the other hand, in closely coupled circuits the normal frequency or wave length of each is changed, being made slower (longer wave length) and then faster (shorter wave length), so that oscillations are taking place successively at two lengths as shown by the wave meter in figure 53. The existence of the two frequencies is thus due to the transferring of the energy back and forth between the two circuits, the disadvantages of which will be mentioned in the description of quenched spark sets.

TUNING WITHOUT WAVE METER

The circuits of a directly or inductively coupled set using the ordinary type of open spark gap can be tuned to resonance, either with or without the help of a wave meter, but the meter should be used whenever possible. If no wave meter is available the adjustments can be made as follows: Insert several turns of inductance in the open or antenna circuit, a few in the closed circuit, and note the antenna ammeter reading. Change the number of turns in the closed circuit and also the coupling if necessary until a maximum reading is obtained in the ammeter. Make a record of these best adjustments—the number of turns in each circuit, coupling, and antenna ammeter reading. Next, using a different number of turns in the open circuit, repeat until the best adjustment is obtained under these conditions, and make a record of these readings, etc. Sometimes it may be more convenient to insert several turns of inductance in the closed circuit and then to vary the number in the open circuit and the coupling between the two circuits until a maximum reading is obtained in the ammeter. After making a record of these best adjustments, use a different number of turns in the closed circuit, and adjust the number of secondary turns and coupling, etc., as before. In the first case the closed circuit is tuned to the open circuit, and in the second case the open to the closed. Both methods are correct under circumstances and will give the same adjustments.

transmitter is sending out signals on 275 and 330 meters wave lengths and is preventing another station from working on either wave length, whereas if properly tuned as at 300 meters the interference is reduced to one wave length. It is for this reason that legislation has been enacted prohibiting the operation of a station with two such humps. The law permits the use of the double hump when one is not greater than one-tenth of the other as tested in a wave meter. There are further restrictions about the larger of the two humps, or about a single hump in case only one is found. It must not be broad or flat topped, meaning that the oscillations in the antenna can not be highly damped, as is the case of the plain Marconi antenna of figure 34. A measure of the damping is prescribed which must not be exceeded. This measure is called the logarithmic decrement.

Theory of Operation of Quenched-Gap Transmitter

Most of the sets now supplied by the Signal Corps are of the quenched-gap type, and a brief outline of the theory of its operation will be given.

If in a quenched-spark transmitter, with its circuits correctly adjusted to radiate a single sharply defined wave length, the gap is replaced by an ordinary type of open gap, it will be found by a wave meter test that there are now two wave lengths. This shows that the single wave length was not secured by an adjustment of a very loose coupling between the circuits, but rather by a property of the quenched gap itself. An explanation of the action of the gap can be made by reference to figure 52, where it will be noted that near the point marked "Q" in the upper curve, the amplitude of the primary current has reached its first minimum value in the course of the beats. On account of the strong cooling action of the gap, due to the use of the cooling flanges and the blower, the spark is *quenched* or stopped at this point in the wave train and the primary circuit is thus opened. When proper cooling is provided the spark can not be started again in this wave train and the gap is not broken down until the next alternation. At the same time that the primary current is a minimum it will be noted that the secondary current is a maximum; that is, practically all the energy is located in the secondary circuit. As the primary circuit has now been opened so there can be no transfer of energy back to it, all is retained in the secondary, where it is available for radiation. As a result there are no beats in the secondary, the oscillations in it persist for a longer time, and more energy is radiated. This is shown in figure 55, where the primary current has been stopped at the point corresponding to Q of figure 52 and the secondary continues to oscillate as shown. Whenever there is a transfer of energy back to the primary where it is not available for radiation there are losses due to heating, etc., and so less energy is left for radiation than if there had been no such transfer. The quenched spark transmitter has then two advantages over a transmitter with the ordinary type of open gap—greater efficiency and the radiation of more sharply defined wave lengths.

When the adjustments of a quenched spark transmitter have been correctly made—that is, the circuits are in resonance, the

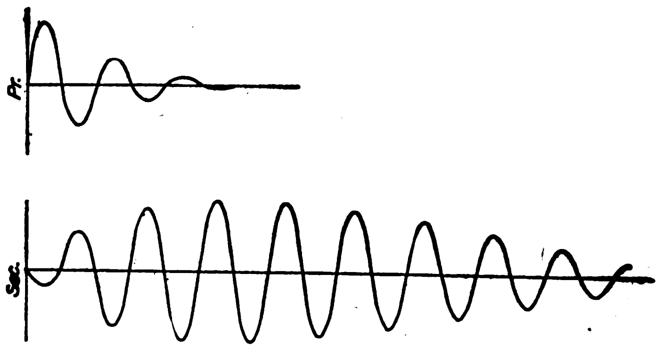


FIG. 55.—OSCILLATIONS OF PRIMARY AND SECONDARY CURRENT WITH QUENCHED SPARK TRANSMITTER

coupling is right, etc.—a simple experiment will show that the primary current is a *minimum*; that is, the spark has been quenched and the primary current has been stopped quickly, as at the point Q of figure 52, and that at the same time the secondary current is a *maximum*; that is, it persists for a long time, as shown in figure 55. The experiment consists in making simultaneous readings of the currents in the primary and secondary oscillating circuits, and plotting the readings for the different couplings of the primary and secondary circuits. This is shown in figure 56, where the scale at left is in amperes and that at the bottom is the coupling of the two circuits, the upper curve being for the primary and the lower for the secondary. At the point of correct coupling the primary current was a minimum and the secondary or antenna current a maximum.

From these curves it will be seen that the coupling of the two circuits of a quenched-spark transmitter is a very important and critical adjustment, upon the correct value of which the efficiency is largely dependent.

Sometimes when the adjustments of a quenched-spark set are not correct it is possible to detect two wave lengths, but of very small amplitude, in addition to the single wave length just mentioned, one of these being of shorter and the other of longer wave length than the normal. The development of these two wave lengths is generally due to excessive coupling so that the spark is not quenched at the proper point but allows one or two transfers of the secondary energy back into the primary during which two wave lengths are produced. After

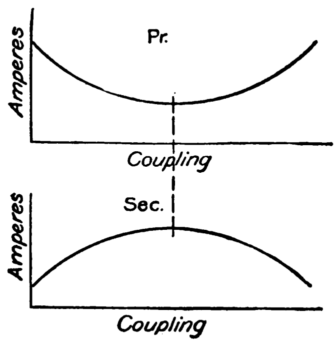


FIG. 56.—CURVES OF PRIMARY AND SECONDARY OSCILLATING CIRCUITS

the spark is properly quenched, the energy is retained in the secondary, and the normal wave length of much greater amplitude is developed.

Arrangements at the Receiving Station

The electromagnetic waves sweeping across the antenna at the receiving station generate damped alternating currents therein of the same frequency as those in the transmitting antenna. At great distances the oscillations or currents are exceedingly feeble, perhaps only a few millionths of an ampere, and it requires correctly adjusted circuits and very sensitive devices to detect them. The various types of receiving circuits will be described next, and the detectors later.

It is evident that the strongest oscillations will be produced in the receiving antenna when it has the same frequency or wave length as the transmitting antenna. In the simplest case an antenna identical in construction with that at the transmitting station can be used, in which the detector is inserted directly by the antenna, as shown in figure 57. This circuit is sometimes known as the *plain Marconi antenna* for receiving and corresponds to the transmitting

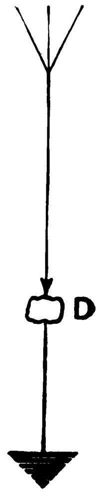


FIG. 57.—PLAIN MARCONI RECEIVING ANTENNA CIRCUIT

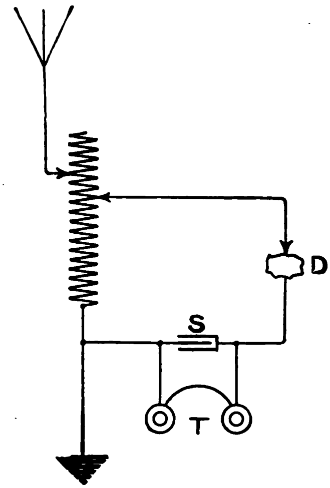


FIG. 58.—TUNED RECEIVING CIRCUIT

circuit of figure 34. Owing to its many disadvantages, such as trouble from static, interference, etc., this circuit, like the plain transmitting circuit, is not now used in practical radiotelegraphy.

DIRECTLY CONNECTED CIRCUITS

A simple circuit for tuning the receiving antenna to the same frequency or wave length as the transmitter is shown in figure 58, where the adjustments are made by using a variable inductance; thus the larger the number of turns in circuit the greater the inductance and the lower the frequency or the longer the wave length of the oscillations to which it is tuned, and, vice versa, the fewer the number of turns the less the inductance and the higher the frequency or the shorter the wave length of the oscillations. In this case the detector D is in a branch circuit with the condenser S and the telephones T, which is connected across a variable number of turns by means of a sliding contact. It is seen that the detector circuit is thus connected directly to the antenna inductance coil and hence is called a *directly connected* or *directly coupled* receiving set, thus corresponding to the directly connected transmitting sets of figures 36, 37 and 38. This circuit is of a type similar to that in the double-slide tuning coil sets formerly used by the Signal

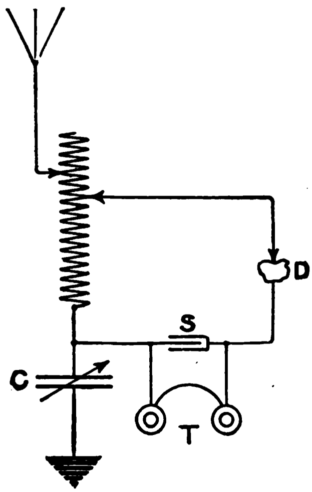


FIG. 59.—RECEIVING CIRCUIT WITH SERIES CONDENSER

Corps. In order to be able to tune the antenna circuit to wave lengths shorter than the fundamental, as is often necessary, a series condenser must be used, as shown in figure 59.

INDUCTIVELY CONNECTED CIRCUITS

Most receiving sets now in use are of the ***inductively connected*** or ***inductively coupled*** type, as shown in figures 60 and 61, in which it is seen that the oscillations in the tuned antenna circuit induce oscillations in a circuit coupled with it, thus corresponding to the inductively coupled transmitting sets of figures 35 and 39. In this case the antenna circuit is the primary and its coil L_1 is generally called the primary coil of the receiving transformer. The closed circuit is the secondary circuit and its coil L_2 is the secondary of the receiving transformer. It is to be noted that these terms are the reverse of those used in the transmitting circuit. Circuits of the inductively connected type have advantages over those of the directly connected type, in that they can generally be rendered less liable to static disturbances and will have sharper tuning, so that it is more nearly possible to cut out undesired stations, etc.

The closed or secondary circuits are of two general types called *untuned* and *tuned,* as shown respectively in figures 60 and 61.

In the untuned circuit there is no secondary tuning condenser, the only adjustment being in the number of turns in L_2, which is generally in steps of many turns. In the adjustment of such a set to get signals of maximum loudness, the circuits must be adjusted to resonance, and the proper coupling between them be used. The primary circuit will be sharply tuned, but the secondary only very broadly if tuned at all. If a close coupling is used between the circuits the tuning of both will be broad, and hence the set will have the disadvantage of being liable to severe interference. Under certain conditions, however, as in searching for an unknown station, it may be of advantage to use this coupling at first, and then when the station has been picked up,

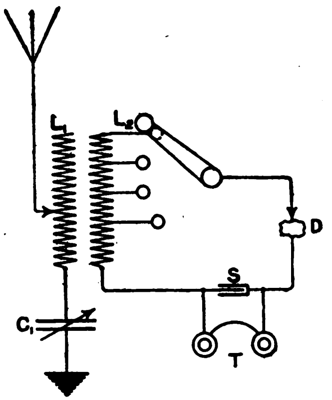


FIG. 60.—UNTUNED INDUCTIVELY COUPLED RECEIVING CIRCUIT

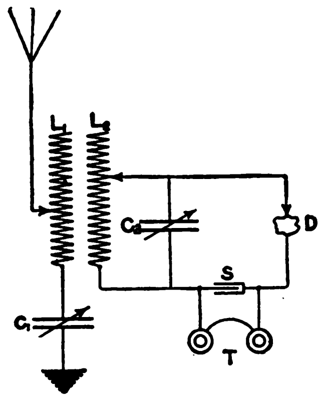


FIG. 61.—TUNED INDUCTIVELY COUPLED RECEIVING CIRCUIT

to loosen the coupling and to make such changes in both circuits as will give the sharpest tuning and the loudest signals. In many receiver sets of this type the so-called untuned secondary circuit is really a broadly tuned one in which the inductance of the coil and its distributed capacity form the tuning elements. The range of wave lengths to which each step is thus broadly tuned is generally marked for each contact, thus 400 to 600 meters, 600 to 1,000 meters, etc.

In the tuned circuit there is a variable tuning condenser, as C_2 in figure 61, the adjustment of which is necessary to secure the maximum loudness of signals. The secondary inductance is sometimes variable by steps and in a few cases by single turns. It must be noted that adjustments for any wave lengths can be made with different combinations of inductance and capacity. In general it will be found that in both the primary and secondary circuits there is a best value of these combinations of inductance and capacity for any given transmitting station, and that these combinations may be different for each different station, and hence must be found by trial. The tuning of the inductively coupled receiving set requires a careful adjustment of both circuits and of the coupling between them. The three adjustments are all dependent one on the other, so that if the circuits are adjusted to resonance with loose coupling and the coupling is then increased and made close, the circuits will be put out of resonance and retuning of both is necessary. Similarly, if the circuits are closely coupled and then each is tuned, it may be found that there are two points of resonance or two wave lengths in each circuit, although only a single wave length is being radiated by the transmitting station. On account of these changes in wave length with changes in coupling, it is best to work with as loose a coupling as possible in this type of receiver, also the tuning will be sharper and the interference will be less under these conditions. There is an additional advantage in some cases, as the secondary circuit can be calibrated in wave lengths for different settings of the condenser, and hence the wave lengths of the received signals measured at the time of reception. The best value of the coupling will depend not only on the constants of the circuits, but also upon the character of the waves radiated by the transmitter. The broader the tuning in the transmitting station or the larger the damping of the waves radiated by it, the closer may be the coupling between the circuits and vice versa: the sharper the tuning in the transmitting station, or the smaller the damping of the radiated waves, the looser must be the coupling between the circuits. In some cases in actual practice it is found that when *sustained* or *undamped waves* are used, the damping of which is zero, the coupling between the circuits must be made so loose that signals of the *same wave length* from a station using *highly damped waves* may not be heard at all.

STATIC AND INTERFERENCE

The elimination of static disturbances and interference from other stations is one of the most difficult problems in radiotelegraphy. At the present time it is doubtful if there is a complete solution of both troubles. The elimination of static is dependent largely on the design of the apparatus at the receiving station, whereas that of interference is dependent on both the transmitting and the receiving apparatus. In some cases static can be cut down by connecting a very high resistance, as 10,000 ohms or more, between the antenna and ground, thus giving a shunt path to earth for the static. In many cases a very loose coupling between the receiver circuits may reduce the static more than the desired signals, which although much weakened can still be read. When the transmitted signals are of high pitch they can be read through moderate static much easier than those of low pitch. If the diaphragms of the receiving telephones are tuned to the pitch of the transmitted signals the static can be still further eliminated. There are many types of circuits which have been suggested as useful in reducing static, which although effective in stations with *small antennae* are often of little use with the *large antennae* which must be used in powerful transmitting stations. This fact has sometimes led to the installation of two antennæ at a station, a large one only for transmitting and a small one of two or three wires for receiving. It is often possible then to get messages on the small antenna that can not be copied on the large one.

The elimination of interference is dependent on both the transmitter and receiver design. The more nearly that the transmitting

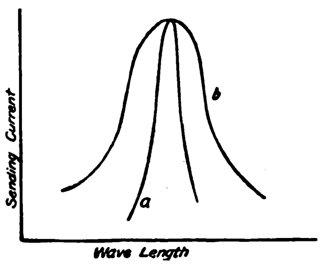


FIG. 62.—TRANSMITTER CURVES FOR RESONANCE TUNING

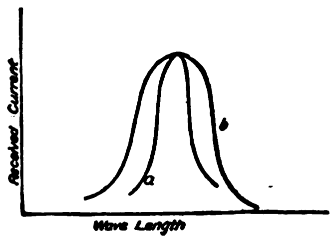


FIG. 63.—RECEIVER CURVES FOR RESONANCE TUNING

oscillations are undamped; that is, the more sharply that the radiated energy is confined to single wave lengths; and at the same time the lower the resistance of the receiver circuits and the more sensitive the detector, the more certainly is it possible to prevent interference. Thus if two stations have transmitters whose radiated wave lengths, as tested by a wave meter, are as shown by *a* in figure 62, and have receivers whose circuits permit of reception of wave lengths as shown by *a* in figure 63, it is evident that they can work together without causing interference at other stations and without being subject to interference except at lengths very near their own. On the other hand, if two stations radiate waves as shown by *b* in figure 62, and receive wave lengths as shown by *b* in figure 63, it is evident that they will cause interference at other stations on account of the broad tuning of the transmitters and will be subject to interference on account of the broad tuning of the receiving circuits.

There are many types of circuits which have been found useful in helping to prevent interference, one of the simplest of which is the loosely coupled inductive receiving set as shown in figure 61. When these circuits are of low resistance, the inductance and capacity of each circuit variable so as to secure the best combination of the two, and the coupling as loose as the signals permit, such a set can be used to receive signals at any one wave length from one station and to exclude signals of slightly different wave lengths from other stations. This property of the reception of signals of one wave length and the exclusion of those of other wave lengths is called *selectivity* and such a receiver is said to be *selective.* In figure

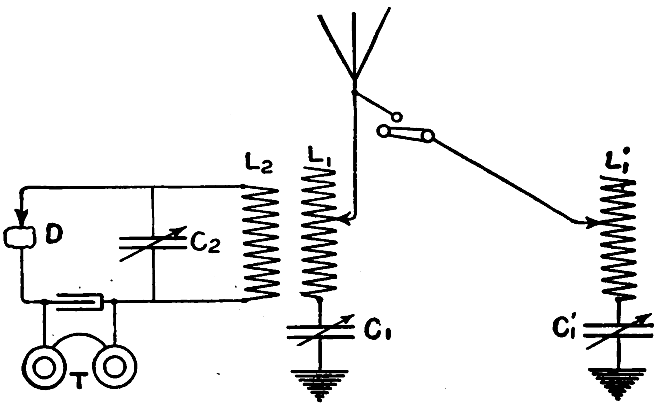


FIG. 64.—AN INTERFERENCE MINIMIZER CIRCUIT

64 is shown a receiving set which is provided with an additional circuit of coil L'_1 and Condenser C'_1 connected between the antenna and the ground, which with the antenna is tuned to the wave length of the interfering station and thus furnishes a tuned shunt path to ground for the undesired signals. This is sometimes called an *interference minimizer* circuit. The connection of this circuit to the antenna will slightly change the tuning of the primary circuit, so that both have to be adjusted together, one to decrease the undesired signals to a minimum and the other to increase the desired signals to a maximum. In order to prevent the grounding of the desired wave lengths by the shunt circuit at times when it is not needed, the circuit should be opened by the switch. Figure 65 is a similar type of circuit for absorption of undesired wave lengths, the circuit being coupled to the antenna circuit as needed and tuned to the interference.

Detectors

The form of detector first used in radiotelegraphy was the *coherer,* which permitted the signals to be received on a relay and sounder. The coherer is not now used in practical work, having been replaced by other more sensitive and satisfactory types of detectors.

An important improvement in sensibility and certainty of operation was made by the introduction of the telephone receiver as the receiving instrument instead of the sounder, the dots and dashes being received as short and long buzzing sounds of the same audible frequency or note as that at the transmitting station. Experiments have shown that the ear is more sensitive to notes of a *high pitch,* as several hundred or a thousand vibrations per second, the latter being given by a 500-cycle alternator, than to notes of a *low pitch,* as 120 vibrations per second, as given by a 60-cycle alternator. It has also been found easier to read a note of high pitch than one

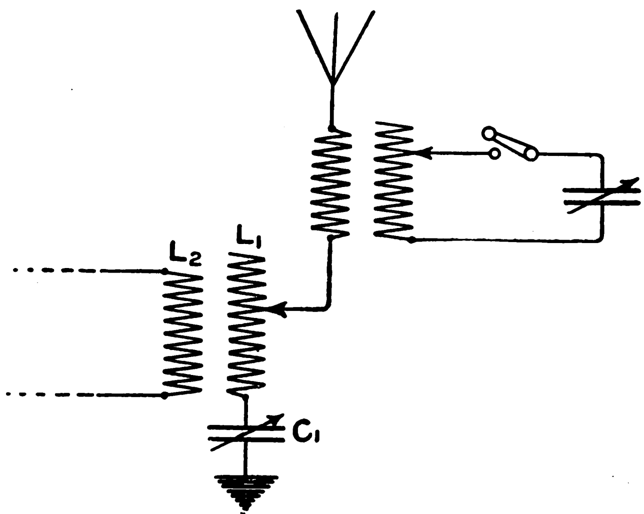


FIG. 65.—A CIRCUIT FOR ABSORBING UNDESIRED WAVE LENGTHS

of low pitch in static or other irregular disturbances. These are two advantages of the high-spark frequency or high-wave train frequency at the receiving station, the corresponding advantages at the transmitting station having already been mentioned.

The high-frequency currents in the receiving antenna have a frequency of from, say, 50,000 to over 1,000,000 per second, but as the telephone diaphragm can not vibrate at this great frequency, the telephone receiver can not be used directly as a radio receiver. Even if the diaphragm could vibrate at this frequency, we would be unable to detect any sounds, as the human ear does not respond to more than about 20,000 vibrations per second. It is evident, then, that the telephone receiver itself can not make the signals audible, but that it must be used in connection with some of the detectors described below.

A number of forms of detectors have been invented, most of which *rectify* the high-frequency currents—that is, change them from alternating to direct currents by some kind of valve action—and thus render them capable of operating the telephone at an audible frequency. In figure 66 the upper curve shows several damped wave trains as in the receiving circuits, the middle curve shows them as theoretically rectified by the detector so that the current is allowed to pass in one direction, and the lower curve the actual current through the telephone, where the rectified current is smoothed out by the inductance of the telephone. Each wave train is practically the equivalent of a direct current lasting a small fraction of a second, or a *pulsating current,* as it is often called. Thus,

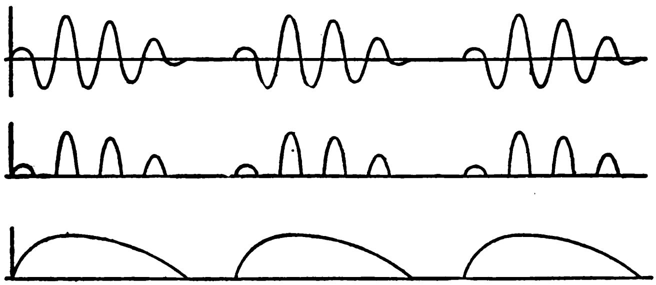


FIG. 66.—DAMPED WAVE TRAINS RECTIFIED BY DETECTOR AND TELEPHONE

in the case of a spark frequency of 1,000 per second there will be 1,000 pulsations of current as in the lower curve of figure 66, and the telephone will be operated as though by a direct current interrupted 1,000 times per second.

One of the earliest of the rectifying detectors that was used with a telephone was the *electrolytic,* but like the coherer it is not now used in practical work.

Other kinds of detectors, sometimes called *crystal* or *contact* detectors, consist of various substances in light contact, such as steel-carborundum, steel-silicon, etc.; metallic contact on pyrite, galena, etc.; zincite-chalcopyrite, silicon-arsenic, silicon-antimony, etc. These have all been patented, and some of them have received trade names, such as "perikon" for zincite-chalcopyrite, "pyron" for metallic contact on pyrite, etc. In the case of the perikon, silicon-arsenic, silicon-antimony, etc., the materials are embedded in flat buttons of fusible alloy or solder on an adjustable holder and held in light contact by a spring; in the steel-silicon, pyrite, galena, etc., contact is made by a light spring on a universal jointed holder.

Most of these detectors are sensitive to the high-frequency oscillations without the application of an external electromotive force, as the steel-silicon, galena, etc., and the simplest circuit in this case is shown in figure 67, where D is the detector, T the telephones, and S a fixed condenser of about 0.003-microfarad capacity. Other detectors are more sensitive when a small electromotive force, as from a potentiometer, is applied to them as the perikon, pyron, etc., and in this case the circuit is shown in figure 68, where D is the detector, T the telephones, S the condenser, generally fixed, but sometimes variable by steps.

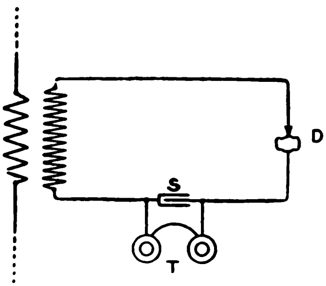


FIG. 67.—SIMPLE DETECTOR CIRCUIT

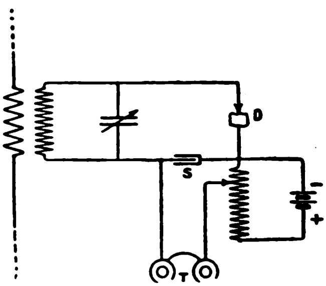


FIG. 68.—DETECTOR CIRCUIT WITH POTENTIOMETER

Another type of detector is the vacuum valve, or tube, of two or three elements; the latter called the "audion" and shown in figure 69, consists essentially of a partially exhausted bulb in which have been sealed a metallic filament, F, two small grids, G, one on each side of the filament, and two small plates P, outside of each grid, the plates and grids being insulated from each other and the filament. The filament is heated to incandescence by a storage battery, A, often called the "A battery," of about 6 volts, the current from which is regulated by means of a small rheostat, R. The plates, P, entirely insulated within the bulb, are connected to one terminal of the telephones, T, the other one of which is connected to a battery of small dry cells, B, often called the "B battery," of 30 to 50 volts, the number of which in circuit, and hence the voltage, is controlled by a switch. The *positive* terminal of the B battery should always be connected to the plates, P, through the telephones. The terminals of the detector circuit are connected, one to the base of the filament and the other to the insulated wire grids, G, through a small stopping condenser, S. The action of the vacuum valve seems to be that of a relay, and its operation is as follows: Under the influence of the hot filament the molecules of gas remaining in the bulb acquire the property of conducting a small current on the application of 30 to 50 volts in the direction of filament to plates, but not in the reverse direction, and if the telephone is connected in this circuit as shown, a small steady current will flow through it. On the arrival of the high-frequency oscillations at the grids and the filament it is probable that they can flow only in one direction, and during their passage over part

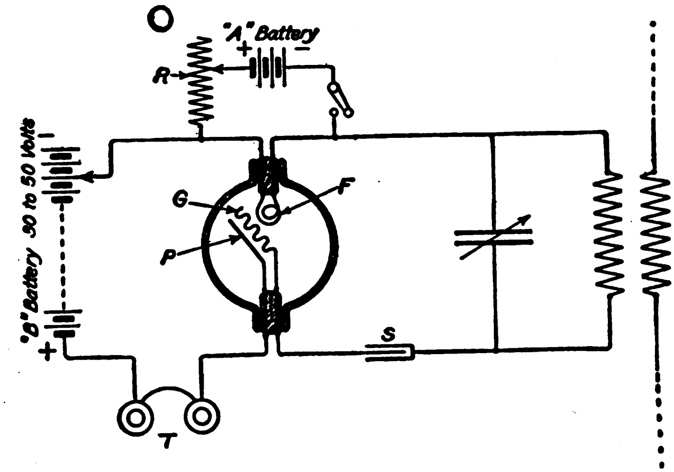


FIG. 69.—CONNECTIONS TO VACUUM VALVE DETECTOR

of the path of the telephone current they change its resistance, and hence the current in the telephones, and thus make audible signals. For reasons previously given, the pitch of the note in the telephones is the same as that of the spark frequency at the transmitting station.

A sensitive detector of a somewhat novel type is now coming into use, called the ticker, consisting essentially of fine steel or other wire resting with light contact in a groove on a rotating disk of brass or other suitable material. This detector can be used instead of D in the circuit shown in figure 67 in which the condenser S should now be about 0.01 mf. and the telephones of low resistance.

Telephones

The telephone receivers used in detector circuits are wound to a *high resistance*, as 1.000 ohms or more for each one of a pair. The reason for this is as follows: The movements of the telephone diaphragm are caused by the attraction of the telephone magnet, which increases as the product of the current in the telephone and the number of turns in the windings. As the current from the detector is very small, it is evident that a large number of turns must be used to secure the necessary attraction, and hence the telephone becomes one of high resistance.

Every telephone diaphragm has a certain natural period of mechanical vibration or pitch. When the incoming signals are of the same pitch—that is, they are in resonance with the period of the diaphragm—these signals will be heard louder than others from transmitters of the same power but of different pitch. In some cases the natural pitch of a diaphragm may coincide with that of the signals, and thus the telephone will be found to be very sensitive. The pitch of the diaphragm can, however, be changed by changing the distance between it and the magnet, and some types of telephones are supplied with *adjustable pole pieces*. By this means it is possible to tune the telephone to mechanical resonance with the spark frequency of the transmitter and often increase the loudness of the signals.

The fixed condenser is shunted across the telephone terminals in order to provide a complete circuit for the oscillations between the secondary condenser terminals without having to flow through the telephones, the high inductance of which in circuit would tend to choke back the oscillations and so possibly prevent their detection. It is evident that a very large condenser can not be used, as it would serve as such a low-impedance shunt for the pulsating currents from the detector that no current would flow through the telephone, and on the other hand a very small condenser can not be used, as it would not allow the oscillations to flow through it. The best value must then be determined by trial and it is found in practice to vary slightly with the spark or wave train frequency. With the high-resistance telephones in general use the capacity of the condenser is about 0.003 to 0.0035 mf. for low-frequency transmitters, as 60 cycles, and about 0.002 to 0.003 mf. for high frequencies, as 500 cycles. In some cases this condenser is variable by steps so as to be able to adjust to different spark frequencies or to *group tuning*, as it is sometimes called. By the use of such a variable condenser and of a telephone with adjustable pole pieces it is often possible to increase the loudness of signals and the selectivity of the circuits without making changes in the tuning.

Calibrating Wave Lengths of Receiving Circuits by Means of the Wave Meter

In the previous illustrations of the wave meter it was used to *receive* oscillations from a transmitter and to measure its wave lengths. It may, however, be used to *send out* oscillations of known wave lengths of comparatively feeble intensity like a miniature transmitter. Several types of circuits may be used to excite the meter, as a buzzer shown in figure 70, where A is a battery of not more than two dry cells, B is the buzzer, and L C is the meter. This circuit is sometimes known as the *buzzer method of excitation* of the wave meter, which thereby becomes a source of slightly damped oscillations. The action of the buzzer circuit seems to be that at each spark at the buzzer contacts, the meter condenser is

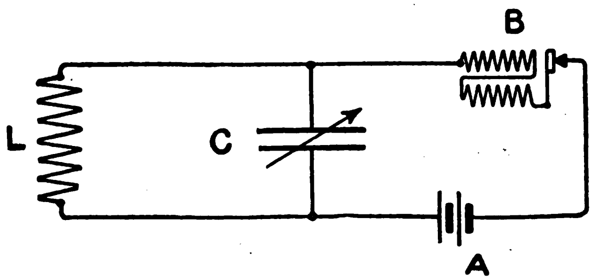
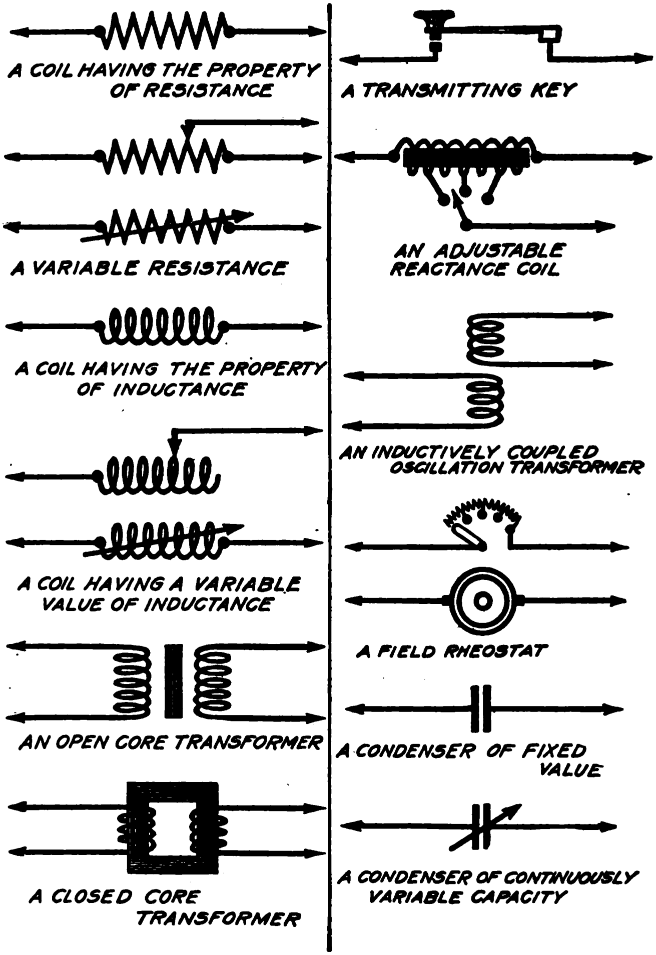


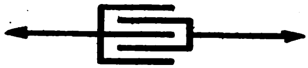
FIG. 70.—BUZZER EXCITATION CIRCUIT FOR WAVE METER EMPLOYED AS A TRANSMITTER

charged and then discharged through the inductance and thus sets up oscillations, independently of the charging circuit in a manner similar to that of a closed circuit as charged by the secondary of the A. C. transformer. If a circuit is brought near the coil L and loosely coupled with it the meter will induce in the circuit oscillations of the wave length or frequency corresponding to the setting of the wave meter condenser. The circuits of a station receiver connected to the station antenna may be calibrated by this method.

This circuit may be used in making many measurements and tests in radio work, such as inductance, capacity, sensitiveness of telephones, detector, etc.

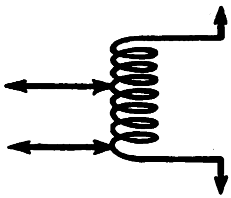
EXPLANATION OF SYMBOLS
USED IN CIRCUIT DIAGRAMS



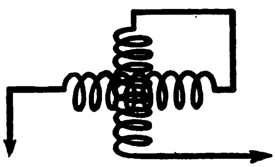


A CONDENSER, THE CAPACITY OF WHICH IS ADJUSTABLE BY STEPS.

CELLS OF BATTERY CONNECTED IN SERIES

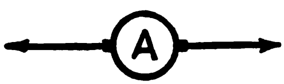


A CONDUCTIVELY COUPLED OSCILLATION TRANSFORMER

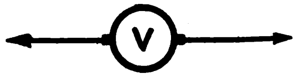


A VARIOMETER INDUCTANCE

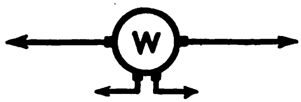
PROTECTIVE RESISTANCE ROD



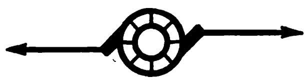
AMMETER



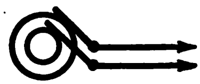
VOLTMETER



WATTMETER



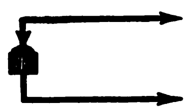
D.C. ARMATURE



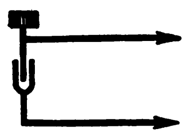
A.C. ARMATURE

INCANDESCENT LAMP

RECEIVING HEAD TELEPHONE



CRYSTALLINE DETECTOR



ELECTROLYTIC DETECTOR.

RADIO APPARATUS OF THE SIGNAL CORPS

Two types of portable field sets have been issued by the Signal Corps. The smaller size, known as a field radio pack set, is furnished to the Organized Militia as well as to the field companies. The range of these sets under normal conditions is about 25 miles over land, but much greater over water. Thus one of the one-eighth kilowatt sets, with a 100-foot mast, at Habana has worked with the naval station at Key West, a distance of about 110 miles.

The larger size of field sets, known as a wagon set, is of 2-kilowatts output and is carried on a two-chest pintle wagon, one chest with the engine and generator and the other with the transmitting and the receiving apparatus. The range of these sets varies from 75 to 800 miles, depending on favorable weather conditions, time of day or night, character of the land between the sets, and similar considerations.

FIELD WAGON SETS

The following are the general instructions for the operation and care of the two-wagon 2-kilowatt set:

Engine.—The engine supplied with this set is a water-cooled, single-cylinder gasoline engine with a normal speed of 1,500 R. P. M., and the same general directions as to care and operation which apply to water-cooled gasoline engines in general apply in this case, and the principal points are briefly as follows:

Before starting make sure—

1. That the water tank is full.
2. That all bearings have been oiled.
3. That the engine has sufficient lubricating oil by means of the stopcock on under part of crank case. If it drips when opened, there is sufficient oil.
4. That there is sufficient gasoline in the tank as indicated by the gauge on the front of the tank.
5. That the main switch of the generator is open.

To start—

1. Open gasoline feed cock.
2. Prime carburetor by plunger on top.
3. Set the governor control handle (just above the crank) vertically, i. e., halfway across the scale.
4. Set the spark-control lever on the magneto on bottom notch.
5. Crank.

After starting—

1. Make sure that the fan is running.
2. Close main switch.

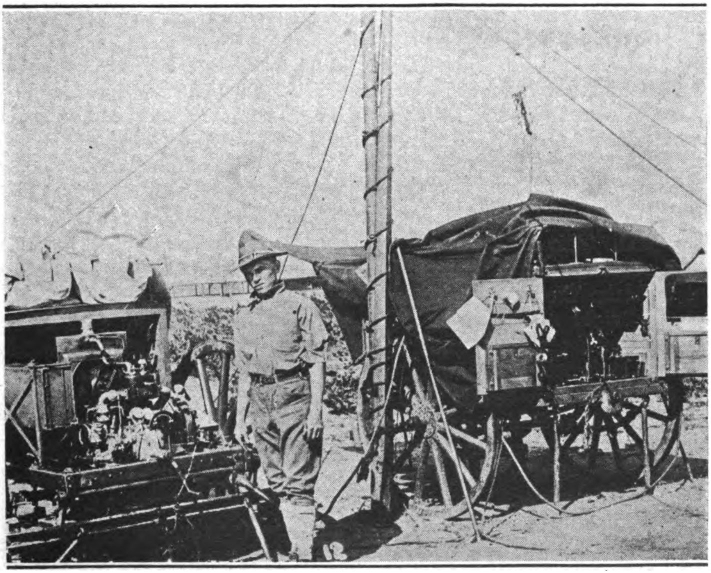
Speed: The speed, as indicated by the tachometer on the engine, is controlled by the position of the governor control handle (directly over the crank) and by the position of the spark control lever on the magneto (at the right), and the best position of each for any particular speed is best and easily determined by experiment.

To shut down temporarily—

1. Open main switch of generator.
2. Press button on front of magneto until engine stops.

To shut down permanently—

1. Same as above.
2. Ditto.



THE FIELD WAGON SET OPEN AND READY FOR OPERATION

3. Turn off gasoline.

4. In cold weather empty all water out of every part of cooling system by means of the cocks provided for that purpose.

Generator.—The alternating current generator supplied with this set is of the inductor type with the field and armature winding stationary, and has therefore no brushes or sliding contacts of any kind. Its normal voltage is 85. The exciter is an ordinary low. voltage direct current machine. The voltage of the alternating-current generator is varied by means of the rheostat in series with its field. The rheostat is located in the lower left-hand corner of the front part of the instrument wagon. The connections between the power wagon and the instrument wagon are made by means of a flexible armored four-conductor cable having the sockets so arranged that the terminals can be inserted only in the proper manner, the circuits of the alternator, exciter, etc., being shown in figure 3.

Transmitter and receiver.—The connections of both are clearly shown in the drawing and require no further description.

To adjust the transmitter for any wave length within the range of the set proceed as follows, assuming that the desired wave length is 1,000 meters:

1. If it is intended to send at full power, adjust the voltage of the generator by means of the slide rheostat (at the left) to about 85 volts.

2. If it is intended to send at less than full power, short-circuit one or more of the gaps by means of the clips provided and at the same time reduce the generator voltage about 10 per cent per gap short-circuited.

3. Set the primary variometer (at the left) at the wave length desired, viz, 1,000.

4. Put the aerial-coil plug (at the right) in hole No. 1, marked 680/1050. This adds sufficient inductance to the aerial to bring the final adjustment within range of the aerial variometer.

5. Make the final adjustment with the aerial variometer (also on the right and on one side of the aerial coils) by turning it slowly up from zero until the ammeter in the aerial or ground circuit indicates a maximum.

6. The transmitter is now adjusted for the most efficient production and radiation of the wave length selected when used with the aerial and counterpoise supplied with the set.

Receiver—To receive, close the large double-pole switch at the top of the receiver.

The plug holes marked Roman numbers (at the right on the receiver) are connected to taps on the aerial or primary coil. The wave range of this coil is approximately as follows, with a proper aerial:

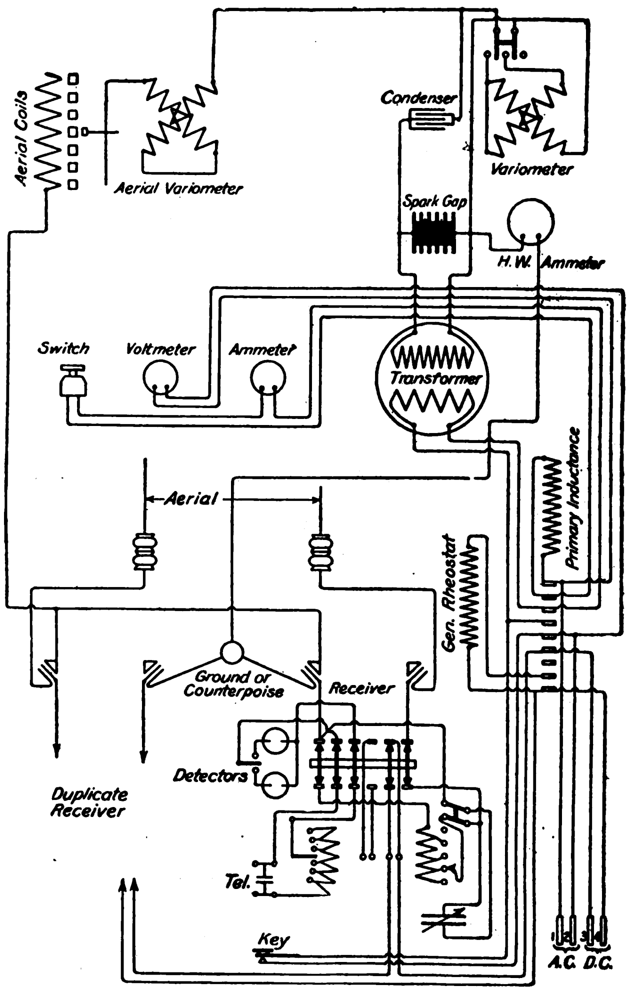


FIG. 1.—CONNECTIONS OF WAGON SET

Plug	Condenser switch at—	
	Short waves	Long waves
	Meters	Meters
I	260-400	500-600
II	310-510	640-910
III	370-730	900-1,410
IV	540-1,060	1,270-2,150
V	....	1,860-3,080
VI	....	2,700-4,000

The turns on the detector or loose coupling coil are variable by means of the switch located on its top, the wave range for each tap being marked.

Either of the two detectors can be used by means of the switch located between them.

For receiving a signal of a known wave length the following procedure can be recommended:

1. Use tight coupling.
2. Plug in on the aerial coil.
3. Set the switch on the detector coil at about "λ=500/1000."
4. Turn the condenser very slowly over the entire scale.
5. Change the plug on aerial coil and repeat No. 4. When signals are finally heard, the coupling and the position of the switch on the detector coil are varied until the best results are obtained.

NOTE.—In some cases two combinations of the aerial plug and condenser give almost equally good results. The best one is that in which the larger part of the condenser is used with condenser switch at "short waves" and vice versa, with the condenser switch at "long waves." The aerial used with this set should have a capacity of 0.0011 mf and a natural period of 450 meters.

The following detailed notes on the circuits and operation of the set have been found useful as a result of actual work in the field:

POWER CIRCUITS

Referring to connection diagram Fig. 1, it is seen that D. C. leads marked 3 and 4 go to both receiving switches in series. It is therefore necessary to have the main switches of both receiving sets in the same position—that is, cut off—when sending, even though one receiving set may have no aerial wire connected to it. A flash due to the breaking of this D. C. circuit will be seen at the rotary switch if the receiving set is cut in before the engine is stopped. The large double-pole switch at the top of the receiver when closed so as to connect the receiver to the aerial and counterpoise automatically disconnects the sending side from the aerial and counterpoise. This feature is not indicated in the diagram of connections where the receiving set when cut in is apparently shunted by the sending set.

TRANSFORMER PRIMARY CIRCUIT

From A. C. lead No. 1 to the primary inductance, to the snap switch, to the ammeter, to the primary of the transformer, to the key, and via A. C. lead No. 2 back to the generator. The voltmeter is across the A. C. leads as shown. If the voltmeter shows volt-

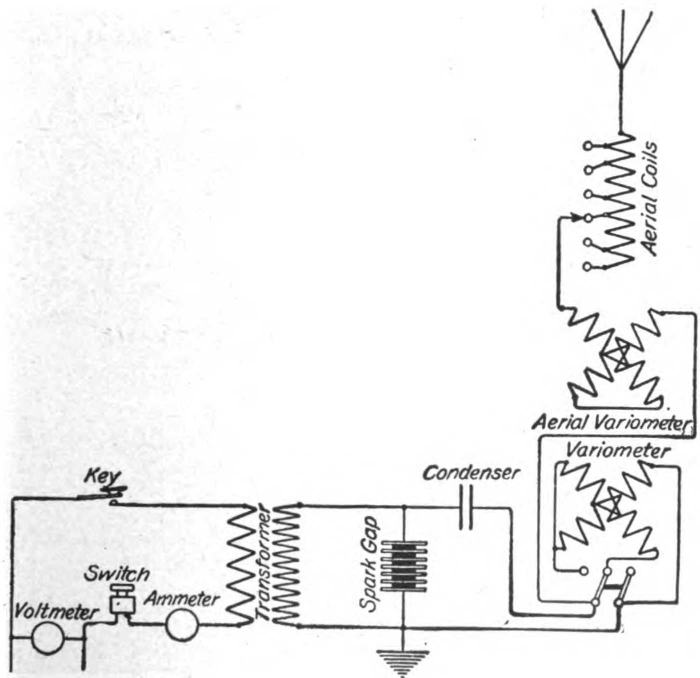


FIG. 2.—CONNECTIONS FOR SENDING

age, but upon closing the key no spark takes place at the spark gap, the snap switch in the primary circuit is probably open.

The voltage, as indicated by the voltmeter, must never be more than 85. If it is desired to change the generator frequency (and the pitch of the note emitted), in order to secure greater selectivity for the set when working in the presence of other sets having about the same generator frequency, the engine may be slowed down or speeded up, but the drop or rise in voltage incident thereto must be compensated for by a change in the generator rheostat, so that the voltage will be kept constant at 85 when using all the gaps of the spark gap. ***Any violation of this rule will cause a breakdown in the transformer.***

HIGH-FREQUENCY CIRCUITS—TRANSMITTER

Closed oscillating circuit.—This consists of the condenser, variometer, and spark gap. It is to be noted that the variometer is common to both closed and open oscillatory circuits, and, therefore,

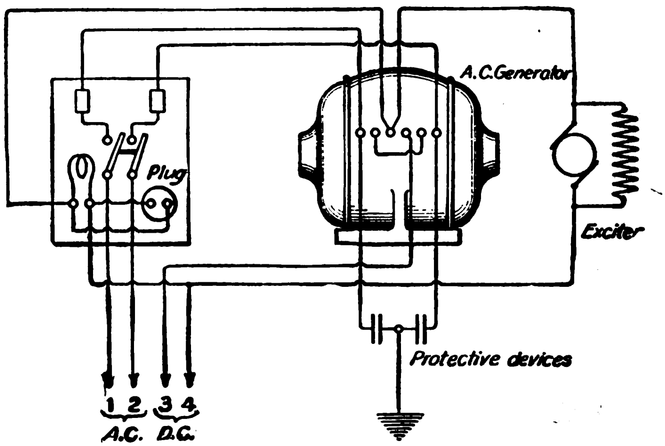


FIG. 3.—THE GENERATOR CIRCUITS

that changing the variometer (which is the one at the left-hand side of the chest with scale divisions in wave lengths marked upon it) not only changes the period to which the closed oscillatory circuit is tuned, but also slightly changes the tuning of the open oscillatory circuit. A word of caution should be given concerning the switch marked "Little" and "Great" which throws the coils of this variometer from a parallel to a series connection or vice versa. This switch can only be moved to the right or left—to "Little" or to "Great"—when the index is directly opposite the dividing line between the red and the white divisions. ***Any attempt to throw this switch when the variometer coils are in any other position will only result in damage to the switch.***

OPEN OSCILLATORY CIRCUIT

This consists of the aerial, aerial or loading coils, plug for cutting in proper coil, the aerial variometer (marked from zero to 1800), the variometer common to both closed and open oscillatory circuits, the hot-wire ammeter, and the counterpoise or ground.

The antenna supplied by the Signal Corps for this set has a natural wave length of 450 meters and a capacity of about 0.0011 mf.

It is found by experiment that the set using the Signal Corps 80-foot mast and rubber-covered counterpoise works best at about 1,000 meters, where the antenna hot-wire ammeter reads about 7¼ amperes.

CODING OF WAVE LENGTHS

The great advantage of this set lies in the fact that any desired wave length from 675 to 2,220 meters can be sent out at will and if the wave length is changed after every word of a message, according to a pre-arranged code of wave lengths—for example, the first word sent with 700 meters, the next with 2,100, the next with 1,400, etc.—it will be difficult for any eavesdropping operator who has not the wave-length code to follow the changes of wave length with any success. Hence, messages may sometimes be kept confidential even when sent in plain English. This will take considerable drill on the part of two men, the operator and an assistant, who will rapidly make the necessary changes in the loading coils and variometers at a signal from the operator.

The first step will be to make experimental determination of the combinations of loading coils and variometers necessary to produce the best radiation for every wave length within the range of the set and to set them down in the form of a table. Thus, **starting** with 700 meters, put the left-hand variometer at 700, put

TABLE 1

Wave length	Variometer	Loading coil	Aerial variometer	Amperes on hot wire
700	700	675-1,080	12	6.9
750	750	675-1,080	20	6.95
800	800	675-1,080	50	7
850	850	675-1,080	80	7.05
900	950	675-1,080	120	7.1
950	900	920-1,310	4	7.15
1,000	1,000	920-1,310	10	7.25
1,050	1,050	920-1,310	60	7
1,100	1,100	920-1,310	90	6.8
1,150	1,150	920-1,310	105	6.6
1,200	1,200	920-1,310	130	6.4
1,250	1,250	1,240-1,510	5	6.2

the plug in the hole marked 675-1,080, and then slowly move the aerial variometer from 0° toward 180° until the hot-wire ammeter shows the best reading. The various adjustments can then be noted in a table for future reference, thus: (The figures given are not the actual figures. These must be determined for each set separately.) Find the best combination for every 50 meters increase in wave length up to the limit of the set.

LIMITATIONS OF SYSTEM OF CODING WAVE LENGTHS

It will be noted that there is one best wave for the set, namely, about 1,000 meters. From some experiments made recently at Fort Leavenworth it is concluded that it is safe to state that, up to about 75 miles over average land, the falling off of energy due to the use of the longest wave lengths will not be so great as to prevent the use of any wave length within the limits of the set (675-2,220 meters), but that beyond that distance, up to the extreme daylight distance of the set (about 185 miles), it would be safer not to work with any wave length greater than 1,800 meters.

Only further experiments in the field between two similar sets working at gradually increasing long ranges, will determine the greatest distance at which the whole scale of sending wave lengths may be used.

From the table plotted, different codes of wave lengths, differing by many meters from each other, may be agreed upon, to be changed daily in actual work, and confided to all operators concerned.

RECEIVING CIRCUITS

Primary or aerial circuit.—One lead from aerial comes through combination switch to the primary of the transformer (shown on the left of Fig. 4), from there through plug contact to a point on the little switch marked "Long waves"—"Short waves"; and, if the switch is thrown to the long-wave side, the circuit goes direct to the ground; the variable condenser being then in parallel with the primary of the transformer. If the switch is thrown to the short-wave side, the variable condenser is in series with the aerial, the primary of the receiving transformer, and the counterpoise or ground.

The secondary or detector circuit consists of the secondary of the transformer in series with the usual stopping condenser, connected through the main switch to the detectors. The telephones are in shunt to the stopping condenser.

The detector supplied is of the iron pyrites variety, which lacks the sensitiveness of the Perikon. Any other detector may easily be substituted for the detectors supplied with the set, the range of which may be thereby easily increased.

With the switch thrown to "Long waves" the operator will get the best results when using a small number of degrees of the variable condenser and as large primary as possible, and, vice versa, with the switch "Short waves," which places the variable condenser in series with the primary coils. The largest possible amount of capacity of the variable condenser and the smallest amount of primary inductance should be used for maximum strength of signals.

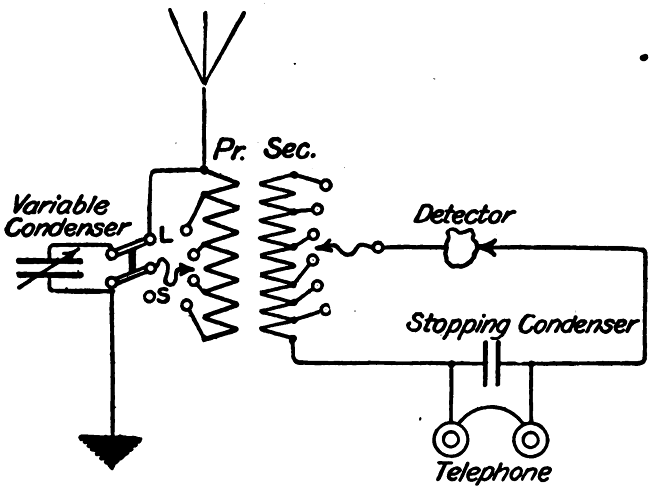


FIG. 4.—CONNECTIONS FOR RECEIVING

The combination switch which is used primarily to cut the receiving set on to the antenna and counterpoise simultaneously performs several operations. Opening this switch disconnects the receiving set from the antenna and counterpoise; automatically connects sending set to the aerial and counterpoise; closes D. C. circuit of generator; disconnects detectors from secondary of receiving transformer, thus opening that circuit and preventing detectors from being affected by the spark when sending, and also opens the primary circuit of the receiving transformer. As the limits of the various coils of the primary and secondary are marked, there should be no difficulty about setting the receiving apparatus approximately for the wave length of a station whose wave length is known. The operator then varies his condenser, and also the coupling between the primary and secondary of the receiving transformer, until he gets the best adjustment. Changing the coupling (that is, pulling the secondary away from or pushing it closer to the primary) *changes the wave length,* though to not as great an extent as does varying the condenser. Some stations can not be heard at all well unless the secondary coil is pulled some distance away from the primary. Practice is the best guide to a working knowledge of the tuning of the receiving set.

Figure 2 shows simplified schematic diagram of the transmitting circuits. Figure 3 shows the generator circuits.

CALIBRATION IN WAVE LENGTHS

The receiving set should be calibrated so as to locate the actual combinations necessary for receiving the wave lengths sent out by a similar sending set, either by actual tuning to another set sending out successive wave lengths differing from each other by 50 meters, as outlined, or by using the wave meter provided with each wagon set as a sending device, and with its coupling coil held near the antenna lead, set up, consecutively, different wave lengths in the antenna and make adjustments of receiving set necessary to tune to the particular wave lengths sent out; then compile a table showing adjustments of condenser switch, primary, secondary, and variable condenser necessary for each wave length in turn, so that the receiving operator can at once adjust his receiving apparatus to any desired wave length, and, by quick changes, constantly follow, according to prearranged code, the message sent out by the other station.

It is recommended that, in order to eliminate one adjustment of the receiving set, the primary and secondary of the receiving transformer be kept in the same relative positions throughout; that is, as close to each other as possible. This, while possibly sacrificing efficiency, secures simplicity. The receiving operator's chart may be arranged as follows:

Best receiving adjustments necessary to tune to wave lengths used by similar wagon-set sending wave lengths shown in Table I.

TABLE II.

Wave length	Switch	Primary	Secondary	Condenser
700	Short waves...	370-730	500-1,000	80°
750	Long waves....	640-910	500-1,000	40°

And so forth for every 50 meters.

Note.—The condenser adjustments given above are not the actual ones necessary for wave lengths given.

Constant drill in changing, sending and receiving adjustments, carried on between two or more similar sets, will result in remarkable efficiency and rapidity, and the time necessary for transmission of messages will be found to be but little increased over that required when sending on a single wave length.

RECEIVING BY CODING OF WAVE LENGTHS

Two complete receiving sets are provided with each wagon set, though ordinarily only one is used. Two messages from different stations may be copied from the same antenna without either operator hearing the message copied by the other. To do this it is, of course, necessary to have a lead from the aerial running to each of the receiving sets. A change in the tuning of one receiving set will call for a slight readjustment of the other receiving set, however, in order that the latter set may stay in tune with the given wave length.

The use of two receiving sets in parallel makes it comparatively simple to follow a message sent according to a pre-arranged code of wave lengths, for it is perfectly practicable to so arrange the wave-length code that the waves of any length within certain limits will fall within the limits of the condenser of either one set or the other, and either one operator or the other, without making any change of adjustment other than a mere movement of the condenser handle, will have his apparatus constantly in resonance with the incoming waves.

Thus, let us say that in the code agreed upon, which includes all wave lengths between 900 and 2,150 meters, the first word will be sent with a 900-meter wave, the next with 2,100, followed by 1,500, 1,850, 1,050, 2,000, etc.

The two sets are cut in at the receiving station and are each manned by an operator. Operator No. 1, at the left, puts the plug in the hole of the primary of his receiving set marked "900-1410," couples his primary and secondary as closely as possible, throws his receiving switch to "Long waves," and puts the switch of the detector coil on whatever coil will give him the strongest signals. He can then, by merely moving his condenser from 0° toward 180°, tune his set to any desired wave between 900 and 1,410 meters, and it will be his duty to copy all words of the message which may fall within those limits.

Operator No. 2, on the right, similarly throws his switch to "Long waves" and plugs in primary coil marked "1270-2150," and makes the other adjustments as given for No. 1. He is then ready to receive any wave between 1,270 and 2,150 meters by merely setting the pointer of his condenser at the proper number of degrees on the condenser.

From Table II, prepared as before described, either operator can set his condenser accurately and instantly to the proper reading for any desired wave length within limits; hence when the message is to be received the first word sent as per schedule at 900 meters is copied by No. 1 operator, who has his pointer at the proper place on the condenser scale; the second word at 2,100 meters by No. 2, who has already set his pointer at the proper place. As the third word is sent at 1,500 meters, No. 2 readjusts his condenser for the next word, and later turns the pointer to the proper place for the next word at 1,850; then No. 1 comes in on his set and copies the next word at 1,050 meters, No. 2 the next at 2,000, and so forth, the words being placed together in accordance with the order of their receipt so as to make a complete message.

This method of using two operators saves time by dispensing with a number of switch and plug changes, which a single operator would have to make in using only one receiving set.

The method of using two receiving sets tuned as described could easily be worked by one operator who could wear the single head receiver of one set on one ear and that of the other on his other ear.

All these methods should be practised continually to improve the skill of the operators.

Care must be taken to close or open both main switches of the receiving set at the same time when working both receiving sets in order to prevent sending into one of the receiving sets and burning it out.

Field Radio Pack Sets

The smaller size of portable sets, known as a field radio pack set, has been made in several models designated by the number of the year in which they were made. Owing to the rapid improvement in design and construction, the 1912 model has become practically obsolete.

1913 model

Radio pack set, model 1913, consists of the following *units*:

1 operating chest.
1 hand generator.
1 mast.
1 pack frames, set (3 frames).
1 tent.

Each *unit* contains *component parts* as follows:

Operating chest:

1 chest.
1 resonance transformer.

1 condenser.
1 oscillation transformer.
1 sending key.
1 spark gap.
1 hot-wire ammeter.
1 switch.
1 receiving set.
1 connecting cord for generator (4-conductor, with plugs).
1 connecting cord, with plug, for antenna.
1 double-head receiver.
1 test buzzer.
1 tool kit.
1 extra section for transformer secondary.
1 extra set crystals.
1 canvas case for receiver.
1 connector, 4-wire (lower half), generator.
2 connectors, 2-wire (lower half), antenna and counterpoise.
1 copy "Radiotelegraphy."

Hand generator:
1 generator.
2 cranks.
1 stand.
1 speedometer (carried in operating chest).
1 cap for speedometer opening.
1 canvas hood.

Mast, type F. (Type D mast has 1 top, 1 bottom, 5 intermediate, and 3 extra sections):
1 top section.
1 bottom section.
8 intermediate sections.
4 intermediate sections, extra (3 for tent).
1 antenna.
1 counterpoise.
9 carriers, wire.
4 pins, antenna.
2 hammers.
1 set adapters for tent (4 pieces).
1 bag, antenna and counterpoise.
1 bag, accessories.

Pack frames, set:
3 frames (1 set). Each frame is complete with cincha, 3 cincha straps with rings and snap hooks, and 2 straps with snap hooks at each end.

Tent:
1 tent.
14 pins.
2 guy ropes.
1 insulating device.

Complete sets should be designated as *"radio pack sets, complete,"* giving *year* and *serial number,* and should be so carried on property returns, invoices, and shipping manifests.

Incomplete sets should not be so designated, but *units* in them which are complete should be designated as under the *unit* heading above and *units* that are not complete should be designated as under the *component part* heading. When *units* or *component parts* are used to complete sets they should be extended.

Operating chests and hand generators should always be designated by the *year* and *serial number,* and masts by the *type letters.*

SECTIONAL MAST

The new type F sectional mast with short sections is superseding the type D with long sections as the stock of the latter becomes exhausted, as it has been found by experience that a mast with short sections can be raised more easily from the ground than one with long sections. The type F mast equipment consists of 14 sections, each 4 feet 2 inches long or 5 feet 2 inches over all, including the coupling tube. The 10 sections are used for the mast itself, 3 sections for the shelter tent when erected, and 1 extra section for use in case one of the others becomes unserviceable.

When starting to erect the mast, the four antenna wires and guys should be laid out on the ground at right angles to each other and the umbrella insulator put on the upper end of the section that is not provided with a coupling tube. This section should then be raised and eight more sections with coupling tubes added, section by section, the tenth and last section being the one provided with the insulator fixed at the bottom end. During the erection the mast should be kept as nearly vertical as possible by the men holding the distant ends of the antenna guy ropes. Owing to the liability of the mast to buckle, no attempt should be made to erect the entire mast at one time; that is, by coupling all sections together and raising by means of the guys.

ANTENNA AND COUNTERPOISE

The standard antenna is of the umbrella type with four radiating wire, each 85 feet long, suitably insulated at the open ends and held as nearly horizontal as possible by guy rope extensions, each 85 feet long, the outer ends of which are made fast to ground pins.

The standard counterpoise has four radiating insulated wires, each 100 feet long, laid out on the ground under the antenna wires. Both antenna and counterpoise wires are carried on hand reels for convenience in packing and quick reeling and unreeling in setting up and taking down the mast.

GENERATOR

The generator is a hand-driven, 18-pole, alternating-current machine having an intermittent output of 250 watts at 110 volts and 500 cycles at a speed of 3333 R. P. M. It is self-excited, the exciting current for the fields being generated by a small shunt-wound direct-current machine, the armature of which is mounted on the same shaft as the alternator armature. The exciter has two poles and delivers the direct current at about 110 to 150 volts. The whole machine is driven by two handles, which should be turned at the rate of 33 R. P. M. to give the necessary armature speed of 3333 R. P. M., the combination gear having a ratio of about 100 to 1. The direction of rotation of the handles must be as shown by the arrow on the top of the gear case, as otherwise the machine will not deliver any current. The whole is inclosed in a dust-proof aluminum case. To obtain access to the commutator, remove the flywheel, taking care not to lose the key on the flywheel shaft; then remove the large brass nut and the aluminum disk held in place by the latter, after which it will be found that the commutator is readily accessible. To remove the armature from the machine, proceed as above; then take off the casing covering the spur gears at the opposite end of the shaft, and the gears themselves; before removing the armature take the brushes out of the holders to avoid injuring or breaking them.

The tension on both sets of the generator brushes should be kept as light as possible consistent with good commutation. A small increase in the friction of these brushes will require considerable additional power to drive the machine. Both sets of brushes can be removed when necessary through openings in the lower part of the case, the D. C. exciter brushes being at the flywheel end and the A. C. brushes at the opposite end.

A canvas cover is provided for the generator, which should be kept on at all times when the generator is not in use.

SPEED INDICATOR

A speed indicator is mounted on the upper part of the gear case in sight of the men driving the machine so as to show if it is being driven at the proper speed, at which time the red line on the moving vane coincides, with the black index or arrow at the window.

The vane is divided diagonally into black and white parts, the white showing if the speed is too low and the black if too high.

In putting the speed indicator in place it may be necessary to turn handles slightly so as to permit the gears to engage.

In case the vane of the speed indicator comes on the underside when the indicator is screwed into place, it can be turned into proper position after loosening the depressed set screw on the threaded part fitting into the case and then tightening the set screw again.

In making the set ready for transportation, the speed indicator should be removed and packed in its proper place in the operating chest and the opening closed with the brass plug provided.

GEARING

The gearing is a combination planetary worm-and-spur type of high efficiency when in proper alignment. The high-speed shafts have ball bearings and the gears run in grease or oil so as to reduce the friction as much as possible. The gears should never be taken apart unless absolutely necessary to replace worn or broken parts, and then only by an experienced person. If not properly reassembled, or if the driving gear does not run perfectly true with the worm, undue friction and wear will result, the machine will be harder to turn than before, and the gears will be speedily destroyed.

The gears and ball-bearings can be lubricated by either a nonfluid oil or a light, thin oil, such as Medium Monogram, but both must be free from acid and water to prevent rusting. If oil is used it should be supplied through a small cap on the opposite side of the case from the speed indicator. The level should be kept not more than one-eighth inch above the *lower edge* of the glass window at the flywheel end of the gear case; if kept above this, the oil will overflow to the lower part of the case and cause trouble and sparking at the commutator and collector rings. The same kind of oil should be used on the flywheel shaft through the small hole on the upper side of the bearing.

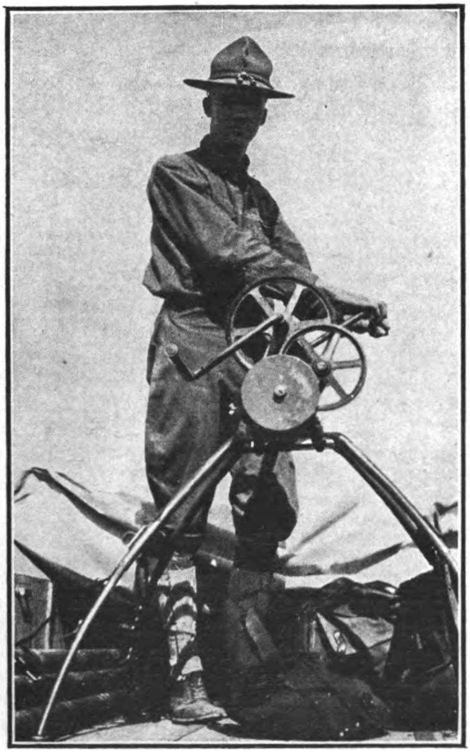
If nonfluid oil is used it should be supplied through the opening where the speedometer is screwed into place. Not less than a pint nor more than a quart should be used in the main gear case, but only a small amount in the spur gear case at the end opposite the flywheel, as otherwise the machine will turn hard on account of choking the gears with too much nonfluid oil in the narow gear case.

With the exception of an occasional addition of oil, the machine should run for months without attention. If the oil becomes thick or dirty, the gearing should be washed out with gasoline and refilled with clean oil *without dismantling.*

Care must be taken *not* to *start* or *stop* the *machine suddenly,* as this may strain or break the gears. The machine must *not* be stopped by means of the handles, but *only* by *friction on the fly-wheel.*

CONNECTIONS

The leads from the armature of the A. C. generator are directly connected to the transformer primary by means of the heavy pair



THE HAND GENERATOR WHICH SUPPLIES CURRENT TO THE PACK WIRELESS SET OF THE SIGNAL CORPS

of leads, the larger plug of which being put into the socket at the left-hand end of the operating chest marked "Gen." and the smaller plug into the socket on the underside of the gear case, also marked

"Gen." The sending key is in the circuit of the alternator fields and the exciter armature, and is so connected by means of the light pair of leads, the larger plug of which being put into the socket at the left end of the chest marked "Fld." and the smaller plug into the socket on the underside of the case, also marked "Fld." By the use of these circuits, the electrical load on the machine is limited to the small one of the exciter field, except when the key is closed in sending. Experiments have shown that twice the output of the former machines can thus be obtained with practically no more tiring effects on the men than before.

Operating Chest

In this chest is mounted the transmitting and receiving apparatus, the diagram of which is shown in Figure 5. To put the chest in condition for sending, connect the double contact plugs of the leads from the hand generator, field, antenna, and counterpoise to the receptacles marked "Gen.," "Fld.," "A," and "C," respectively, and the four variable contact clips on the leads from the condenser, spark gap, antenna, and hot-wire ammeter, to the four points on the flat spiral, as indicated on the diagram, making sure that the counterpoise clip is at the end of the outside turn. Set the control switch at the "sending" or lower position. Release the indicating needle of the ammeter by turning the small knurled screw at the left-hand side of the upper binding post. When the needle is free, adjust to zero position on the scale by means of the small knurled screw at the right side of the upper binding post. Set the variable spark-gap contact on the fifth plate, counted from the left end, so as to put four gaps in circuit. Start the generator, and when the proper speed is obtained the set is ready for sending.

Quenched-Spark Gap

The spark gap used in this set is made up of several copper disks separated by mica washers about 0.01 inch thick. Its action is to allow all of the energy of the closed oscillating circuit to be transferred to the open or radiating circuit in a few oscillations, after which the spark is quenched and the circuit is, in effect, open. The activity in the closed circuit having ceased, the open or radiating circuit continues to oscillate at its own period, radiating waves of its own wave length without any retransfer of energy to the closed oscillating circuit, which continues to remain open until a spark breaks down the gap again at the peak of the next alternation.

In order to work at maximum efficiency, the quenched-spark gap should be kept cool. It is for this reason that the plates are provided with thin cooling flanges having a large surface exposed to the air, and are blackened, a black body cooling more rapidly than

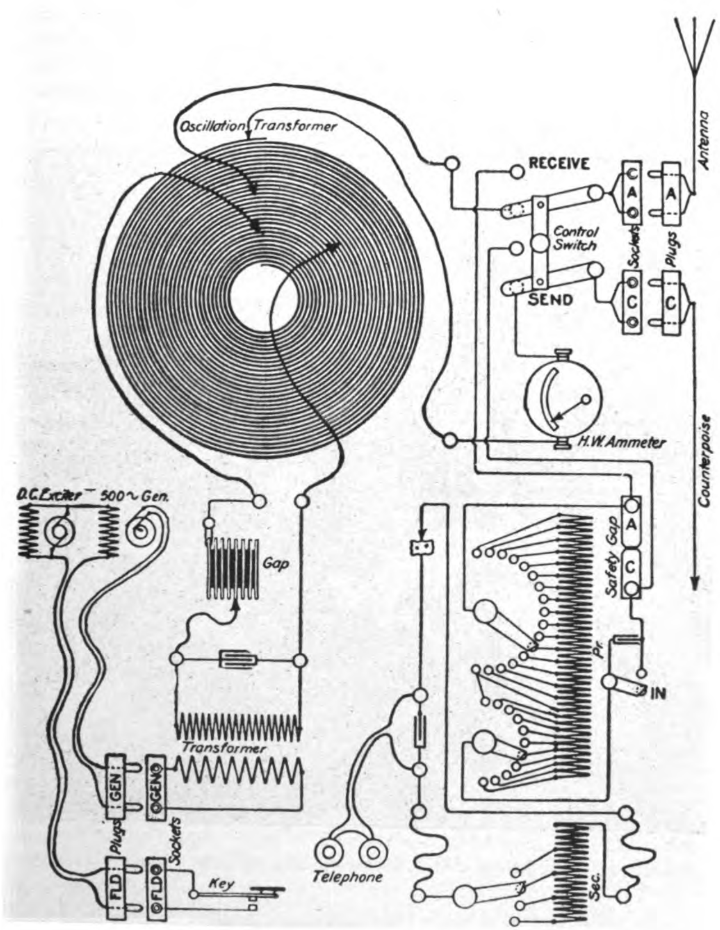
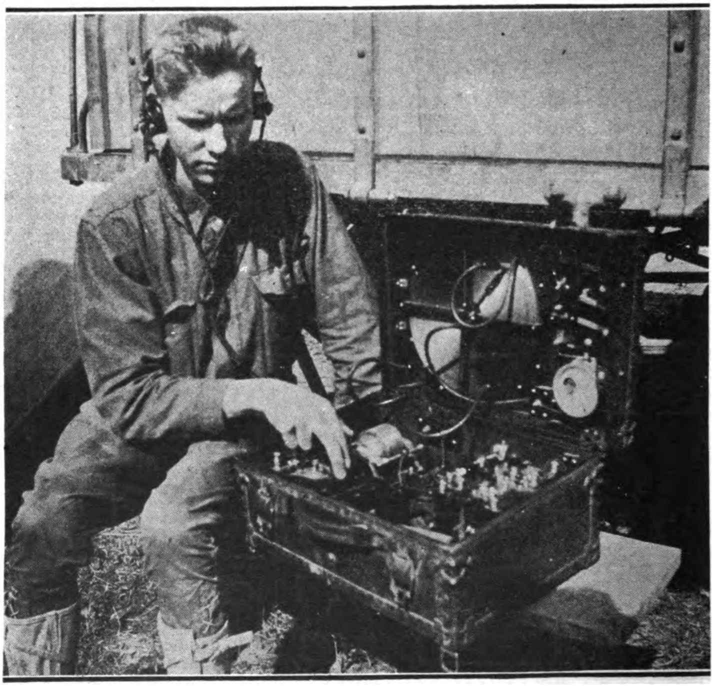


FIG. 5.—WIRING DIAGRAM, FIELD RADIO PACK SET, MODEL 1913

one highly polished. If the gaps have become too hot, as by keeping the key closed for a long time, the antenna current will gradually decrease, the loss at times being as much as 40 per cent, so that it is always best to allow the gap to cool before using again.

The gap should not be taken apart to clean its sparking surfaces like an ordinary type of open gap. In general the more frequently such a gap is opened the more unsatisfactory may be its operation. The explanation is that the repeated opening of the gaps introduces



OHIO SIGNAL CORPS' PACK SET

air each time, and that with free exposure to air the sparking surfaces are orroded or pitted, but that when kept air-tight they are worn smooth and clean by the sparking action. Sometimes, if there is a flaw in one of the plates or if air leaks into the gap, there will be a noticeable drop in the antenna current, and the note will become poor. When it is believed that the trouble is confined to one or two gaps it is possible to continue sending without dismounting the whole gap by short-circuiting the bad gaps by means of clips provided for the purpose, in which case as many new gaps must be put into circuit by adjusting the movable clip to the right as were cut out by the short-circuiting clips.

The gap should be dismounted *only* when the trouble has been located in the gap and it has been found impossible to remedy it by short-circuiting the different gaps in use. The gap should be dismounted only by an experienced man, who should clean the surfaces by rubbing them face down on fine emery cloth or paper on a *flat surface.* It is absolutely necessary that both the bearing surface and the sparking surface be kept true and plane, as shown by a straightedge.

Great care should be exercised in reassembling the gap to set the mica washers accurately on the annular surfaces of the disk and to put on enough tension with the clamping screws to render all of the gap spaces air-tight.

Tuning of Sending Set

The tuning of the closed and open circuits to resonance, and the determination of the correct coupling between them are the two most important adjustments in a quenched spark transmitter. In the present type of directly coupled set with a flat spiral as the oscillation transformer, these adjustments can be made either with or without the help of a wave meter. If made without the meter the adjustments are more difficult and must be found by trial, but they should satisfy the following tests: (1) The number of turns in the closed circuit should be chosen so as to give the desired wave length; (2) the antenna hot-wire ammeter should show the maximum reading that can be obtained by adjusting the number of turns in the open circuit according to the table given later; and (3) the note as heard in the telephones of the receiving set should be clear and characteristic of 500 cycles. These adjustments are, in general, dependent on each other, an incorrect change in one seriously affecting all the others; but when obtained the circuits will be in resonance at the desired wave length, they will be correctly coupled, and the closed-circuit condenser will be charged and discharged regularly once per alternation.

The adjustments should be made as follows: Set the closed and open circuit clips on the turns corresponding to the desired wave length. These turns are approximately correct with the standard antenna and should be used in beginning to make the adjustments. If the antenna ammeter reads between 2.2 and 3.0 amperes and the note is clear and of 500 cycles, then the adjustments are correct and the circuits properly tuned. If the ammeter reading is low and the note low and clear or low and ragged, possibly the circuits are correctly tuned, but there are too many gaps in circuit, and the condenser is being charged and discharged either regularly or irregularly only every second or third alternation. Reduce the number and see if this change gives a clear 500-cycle note, etc. Similarly if the note is high and hissing, the condenser is being charged and discharged more than once per alternation. Increase the number of gaps and see if this change gives a clear 500-cycle note, etc. If none of these changes give the correct adjustment, then the circuits are not in resonance, or the coupling is wrong. Move one of the *open-circuit* clips to see if the correct adjustments can be obtained; it is impossible to state which clip should be moved or in which direction. If the change of one clip is not sufficient, move both *open-circuit* clips until, by repeated trials, the correct adjustments have been found. If possible, leave the counterpoise clip on or near the outside turn, so that it will be at ground potential. It will be found that the character of the note will be changed as these various changes in coupling and tuning are made, but the clearest 500-cycle note will be obtained when all adjustments are correct and the circuits properly tuned. After the adjustments have been completed at this wave length, tabulate the results as shown and repeat at other wave lengths within the range of the spiral.

Although there is no direct test that can be applied, except with a wave meter, to determine if a single wave length is being radiated, yet in general this will be the case if the adjustments satisfy the tests.

If a wave meter is available the adjustments are much easier to make, and they should satisfy the following tests: (1) A single sharply defined wave should be radiated of the desired wave length, (2) the antenna ammeter and the signals in the telephones of the meter should show the maximum reading and signals obtainable under the first condition, and (3) the note should be clear and of 500 cycles.

It will probbaly be best to use the wave meter with a detector or helium tube, because it will be impossible to turn the hand generator at a sufficiently constant speed to obtain steady readings on the wattmeter and hence difficult to determine the resonance point and wave length.

The adjustments for tuning should be made as follows: Disconnect the open-circuit clips and set the closed-circuit clips on the turns corresponding to the desired wave length. Measure the wave length according to the instructions just given to make certain that it is correct. Set the open-circuit clips on the turns given in the table, and, with the wave meter near the antenna or counterpoise wires, but not near the spiral, see whether there is one wave length or two in the meter. If there is a single sharply defined wave length, and the antenna ammeter reading can not be increased by slight changes of either or both of the *open-circuit* clips and the note is clear and of 500 cycles, then the adjustments are correct and the circuits properly tuned. If there is only one wave length, but the antenna ammeter reading is low and can not be increased by slight changes in the open-circuit clips, then the coupling is too loose and must be tightened. Move the *open-circuit* turns in use inward as a whole, by moving both clips inward and slightly increasing the number of turns in circuit to allow for the decrease in their diameter, until with a single sharply defined wave length the antenna ammeter reading is a maximum, etc., as before, in which case the circuits are properly tuned. If the note is low, decrease the number of gaps; if high and hissing, increase the number as previously described. If, however, there are two wave lengths, move one or both of the *open-circuit* clips, but it is impossible as in the previous case to state which clip or in which direction, until by repeated trials it has been found that there is a single sharply defined wave length, a maximum antenna ammeter reading, etc., as before, in which case the circuits are properly tuned.

After the adjustments have been completed at this wave length repeat at other wave lengths as before and tabulate the results.

If the one-eighth or one-fourth kilowatt motor-generator or the engine-driven one-fourth kilowatt generator supplied by the Signal Corps, is available, it should be used as the source of the 500-cycle current because its voltage will be much steadier than that of the hand generator. When the motor-generator set is used, the A. C. armature and the D. C. motor should be protected from "kickbacks" due to the use of the sending key in the alternator fields, by two high-resistance carbon rods mounted on suitable bases to be connected as follows: The end terminals of one rod to the two A. C. leads close to the machine; the end terminals of the other rod to the two main line D. C. leads close to the machine, and the middle points of both rods to be connected together and this common point grounded on the frame of the machine.

The constant speed of the motor generator makes it possible to get steady readings on the wattmeter of the wavemeter, and hence easy to find the resonance point and wave length. It may also be more convenient than a detector because it is often difficult to keep a detector point in sensitive adjustment on account of the nearness of the spark gap and to determine the resonance point on account of the continuous note in the telephone. However, the detector and helium tube can be used if desired; the circuits will be correctly tuned no matter what means are used for determining resonance. The circuits should be adjusted to resonance, etc., as described in previous paragraphs.

In some cases it may be convenient to use the following slight modification of the method described. Disconnect the transformer secondary from the closed circuit and connect it to the two terminals of a small zinc or brass spark gap, one of which is connected to the counterpoise and the other to the standard antenna. Measure this wave length, which will be the fundamental wave length. Next insert, say, two turns of the spiral, Nos. 28 to 30, counting the turns from the inside turn outward, in series with the antenna, and measure this wave length. Continue in this manner until all wave lengths are measured within the range of the spiral and tabulate. Next make the standard connections, setting the open-circuit clips on the turns corresponding to the desired wave length, as just obtained. Set the closed-circuit clips on the turns given in the table, which follows—"Short Waves," "Long Waves"—and make the necessary adjustments by moving these clips until it has been found by trial with the wavemeter that there is a single sharply defined wave length, maximum current in the antenna, etc., as before. Tabulate these results and repeat for wave lengths within the range of spiral. In this case the *closed circuit* is tuned to the open circuit, whereas in the previous case the open circuit was tuned to the closed circuit, but the same tuning points will be found for the same wave length, whichever method of tuning is used.

It is impossible to use exactly the same method as in this table, in which the number of turns for a given wave length is determined for both the primary and secondary circuits, after which the principal adjustment is one of coupling, because the number of turns in the primary circuit of the spiral at any wave length will depend on the part of the spiral which is included in the circuit, and hence it will vary with every combination of turns. It is for this reason that the primary tuning and coupling must both be found by trial.

OPEN-CIRCUIT AND CLOSED-CIRCUIT TUNING

Wave length	Antenna	Counterpoise
Meters	Turn No.	Turn No.
300	26⅞	30
325	24⅞	30
350	22¾	30
375	20¾	30
400	18⅝	30
425	16⅝	30

Turns to be counted from the inside turn outward.

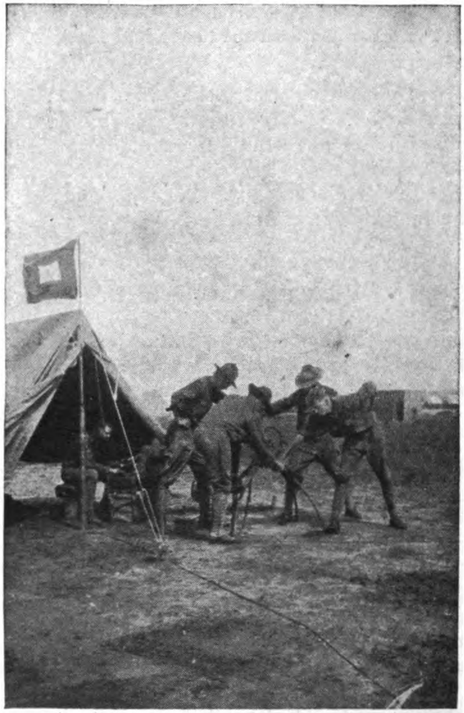
Wave length	Closed-circuit clips	Open-circuit clips
Meters	Turns	Turns
300	8 and 12½	26⅞ and 30
325	8 and 13⅛	24⅞ and 30
350	8 and 13⅝	22¾ and 30
375	8 and 14⅛	20¾ and 30
400	8 and 14⅝	18⅝ and 30
425	8 and 15⅛	16⅝ and 30

Turns counted from the inside turn outward.

Although a transmitting set using the flat spiral oscillation transformer is not as easily tuned as some other types, yet when the adjustments have once been made and tabulated it is practically as efficient as other types. It has the advantage of being one of the simplest, most rugged, and compact forms which can be installed in a field set.

Receiving Set, Type B

The receiving set consists of an inductively connected transformer with broadly tuned secondary circuits, galena, or other similar detector, high-resistance telephones, etc., provided with the necessary switches for tuning to different wave lengths. The primary circuit includes the antenna, primary coil, series condenser or not as may be needed, and counterpoise. The antenna is connected to the primary coil through switches which put into circuit a variable number of turns, steps of 10 turns being inserted by one dial switch and single turns by the other. The total number of primary turns is thus the sum of the numbers on the two dials indicated by the two switch arms, which can be varied by single turns from one to the whole number in the coil. For wave lengths shorter than the fundamental wave length of the antenna, a fixed condenser is inserted in series with the primary coil by throwing the switch near the binding post marked "G" to the position "In," as shown in Figure 5. For the longer wave lengths the switch is thrown to the other position, short-circuiting the condenser, and thus leaving only the coil in circuit. The secondary circuit includes the secondary coil, detector, and the stopping condenser shunting the telephones. The coil is variable only by sections, marked "100," "200," etc., the smaller numbers to be used as the shorter wave lengths and the larger ones as the longer wave lengths. The position of the secondary coil within the primary—that is, the coupling—is variable, and for the sake of convenience a scale is provided so as to be able to note the different adjustments. The coupling is closest when the secondary is inside the primary, in which case the scale reading is 0, and vice versa, the coupling is loosest when the secondary is drawn outside the primary and the scale reading is 40.



FIELD WIRELESS STATION IN OPERATION, WITH POWER FOR TRANSMISSION OF MESSAGES BEING SUPPLIED BY HAND GENERATOR

Short Waves

Primary condenser in series

(Switch on "In" contact.)

Wave length (in meters)	Primary turns	Secondary turns	Coupling scale
200	18	100	20
300	26	200	20
400	36	200	20
500	47	300	20
600	60	300	20
700	74	400	25
800	88	400	30
Etc.	Etc.	Etc.	Etc.

Long Waves

Primary condenser short-circuited

(Switch not on "In" contact.)

Wave length (in meters)	Primary turns	Secondary turns	Coupling scale
300	24	200	20
400	30	200	20
500	38	300	20
600	46	300	20
700	56	400	25
800	65	400	30
900	76	400	30
1,000	91	400	25
1,100	107	400	25
1,200	125	400	30
1,300	144	400	25
1,400	162	400	25
Etc.	Etc.	Etc.	Etc.

TUNING OF THE RECEIVING SET

First, the detector must be adjusted to a sensitive point by means of the test buzzer, the note of which should be clearly heard in the receiving telephones when it is held near the antenna or counterpoise wires or the coil windings. When the wave length of the sending station is known, the number of turns in the primary and secondary coils and the coupling should be set according to the values in the above table, which will be approximately correct for all sets using the standard antenna. When the wave length is unknown, then signals can be found only by repeated trials of different combinations of turns and couplings, in which, however, *consistent* sets of values may be taken from the table. When once the signals have been heard such further adjustments of primary and secondary turns and coupling should be made as will give the maximum sound in the telephones. In general it will be found that when there is interference or static troubles the sharpest tuning and the best protection from interference will be obtained when the loosest coupling is used; that is, when the secondary is pulled out as far as possible and the desired station is still heard. It will be noticed that for some wave lengths there are two different possible combinations in the primary circuit, either without a condenser and a few primary turns or with a condenser and more primary turns. It is impossible to tell which combination is the better without actual trial. In general the best coupling between the circuits will vary with the damping of the transmitting station, close coupling being possible with highly damped transmitters, and loose coupling necessary with feebly damped transmitters.

In changing the coupling between the two circuits by means of the handle on the secondary coil care must be taken to see that the contacts on the various studs are not loosened, as otherwise the signals may be lost entirely or the tuning made much broader on account of high resistance that may be introduced at these contacts.

If the receiver is used with the standard antenna and signals are being received from an unknown station, the table of wave length can be used to determine approximately the wave length of the unknown station.

SHELTER TENT

This tent is similar in dimensions and construction to the standard "common" wall tent issued by the Quartermaster's Department, but is made of lighter material and is not provided with ridge pole or uprights. In erecting the tent the extra sections furnished with the mast should be used as the ridge pole and uprights as follows: One hollow section, one plug, and one extension piece for the ridge, and one section, one extension piece with spike for each upright. The method of erection is illustrated in Figure 6.

INSULATING DEVICE

A device is provided for use in insulating the antenna when the shelter tent is used in damp weather, consisting of a square piece of sheet rubber with small marginal holes for lacing into the ventilator at either end of the tent, and a tube attached to the center for admitting the antenna lead. When in use, sufficient slack should be left in the antenna lead to form a drip loop outside of the tent, and if found necessary a piece of heavy insulated wire can be used as a leading-in wire.

PACKING

The set is normally packed on three mules, but in emergency may be packed on two. In normal packing the first mule carries the generator and six sections of the mast. The second mule carries the operating chest, four sections of the mast, antenna, counterpoise, accessories, bag, etc. The third mule carries the tent, with tent pins and extension pieces folded inside, four sections of the mast, flag kit, lanterns, etc. In emergency packing with two mules, the first mule carries the generator and 10 sections of the mast, and the second the operating chest, four sections of the mast, antenna, counterpoise and tent.

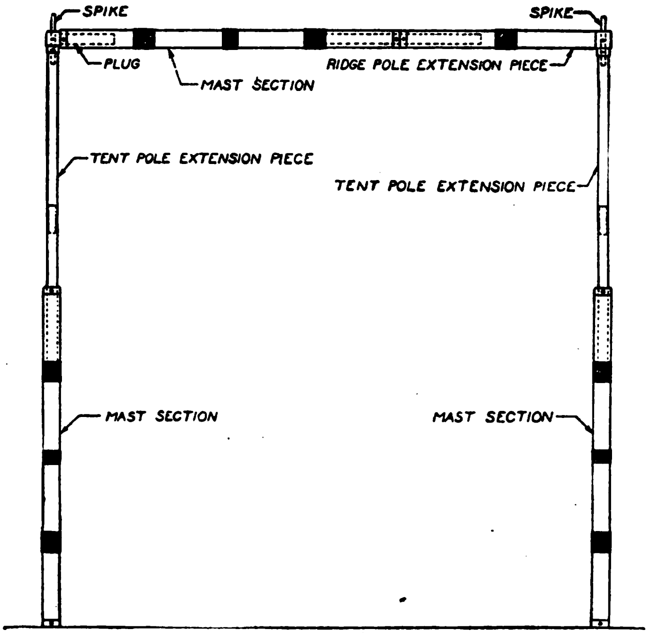


FIG. 6.—METHOD OF ERECTING SHELTER TENT

1915 Radio Pack Set

The 1915 set is similar to the 1913 type and in general the same instructions, etc., apply to it. It consists of the following *units*:

1 operating chest.
1 hand generator.
1 mast.
1 pack frames, set (3 frames).
1 tent.

Each unit contains *component parts* as follows:

Operating chest:
- 1 chest.
- 1 resonance transformer.
- 1 condenser.
- 1 oscillation transformer.
- 1 sending key.
- 1 spark gap.
- 1 hot-wire ammeter.
- 1 switch
- 1 receiving set.
- 1 connecting cord for generator (4-conductor, with plugs).
- 1 connecting cord with plug, for antenna.
- 1 double-head receiver.
- 1 test buzzer.
- 1 tool kit.
- 1 extra section for transformer secondary.
- 1 extra set crystals.
- 1 canvas case for receiver.
- 1 connector, 4-wire (lower half), generator.
- 2 connectors, 2-wire (lower half), antenna and counterpoise.
- 1 flexible connector for antenna inductance.
- 1 connector, 2-wire, small, for receiving set.
- 2 spring hooks.
- 4 legs for chest.
- 1 copy "Radiotelegraphy."

Hand generator:
- 1 generator.
- 2 cranks.
- 1 stand.
- 1 speedometer (carried in operating chest).
- 1 cap for speedometer opening.
- 1 canvas hood.

Mast, type F. (Type D mast has 1 top, 1 bottom, 5 intermediate and 3 extra sections):

1 top section.
1 bottom section.
8 intermediate sections.
4 intermediate sections, extra (3 for tent).
1 antenna.
1 counterpoise.
9 carriers, wire
4 pins, antenna.
2 hammers.
1 set adapters for tent (4 pieces).
1 bag, antenna and counterpoise.
1 bag accessories.

Pack frames, set:

3 frames (1 set). Each frame is complete with cincha, 2 cincha straps with rings and snap hooks, and 2 straps with snap hooks at each end.

Tent.

1 tent.
14 pins.
2 guy ropes.
1 insulating device.

Complete sets should be designated as *"radio pack sets, complete,"* giving *year* and *serial number,* and should be so carried on property returns, invoices, and shipping manifests.

Incomplete sets should not be so designated, but *units* in them which are complete should be designated as under the *unit* heading above and *units* that are not complete should be designated as under the *component part* heading. When *units* or *component parts* are used to complete sets they should be extended.

Operating chests and hand generators should always be designated by the *year* and *serial number,* and masts by the *type letters.*

The essential differences in the two models are in the hand generator, the transmitting oscillation transformer and the receiving set, a brief description of which will be given.

HAND GENERATOR

The 1915 generator is a 24-pole machine, with a speed of 5,000 R. P. M. The ratio of the gearing is 100 to 1, as in the 1913 machine, so that the speed of the handles must be 50 R. P. M. At this higher speed less pull is required on the handles and the tiring effect of the men is less than 33 R. P. M. of the other machine.

On account of the higher speed great care must be taken to keep the D. C. commutator clean and the brushes properly fitted to it. Failure of a machine to generate current is almost always due to a dirty commutator.

Only a non-fluid oil should be used for lubrication of the gears and ball bearings, and in the same quantity as in the 1913 machine.

OSCILLATION TRANSFORMER

The oscillation transformer consists of two open spirals inductively coupled and a third spiral which is to be used as an antenna inductance for obtaining longer wave lengths. This inductance is inserted between the oscillation transformer and the antenna by transferring the long flexible lead from the open circuit spiral to the inductance which is in turn connected to the oscillation transformer by a short flexible connection. Care must be taken to see that these added turns do not oppose the turns of the oscillation transformer; that is, the inside turns of one should be connected to the inside turns of the other.

Ordinarily the antenna inductance will not be in the circuit except a few inches from the lid of the chest.

The wiring diagram is shown in Figure 7, in which the heavy wave lengths, and the dotted lines from it to the antenna inductance and antenna are for the longer waves.

The open and closed circuits of the oscillation transformer are electrically joined together at their base, to which the counterpoise is connected through the control switch and ammeter. This method of construction reduces the number of movable contacts from four to two and also has the advantage that the outside metal rings may be handled without danger of shock.

To put the set into operation: Connect the "Gen," "Fld," etc., plugs into the corresponding sockets; connect the short flexible wire from the rear binding post of the closed circuit condenser to the small angle piece extending out at right angles from the base of the oscillation transformer; connect the long wire at the opposite end of the condenser to the primary or closed circuit spiral, inserting the number of turns corresponding to the desired wave length, counting the turns from the outside turn inward; connect the wire from the control switch to the open circuit spiral, the exact number of turns to be found later by trial. The other end of the spiral is already connected to the counterpoise through the antenna ammeter.

In tuning the circuits the two spirals should be swung apart from 8 to 10 inches. After the two circuits have been brought into resonance, as indicated by the greatest deflection of the hot wire ammeter, the coupling of the two circuits should be increased or made tighter by gradually swinging the spirals closer together until the ammeter deflection just begins to decrease. If a wave meter is available or a distant station assists in the test, a single wave length or "hump" should be radiated and a clear note obtained, the number of gaps being adjusted if necessary as previously described. Care should be taken not to have too close a coupling.

When the standard closed-circuit condenser and oscillation transformer are used the wave lengths are very approximately given in the following table:

Wave lengths of primary or closed oscillating circuit.

Wave lengths in meters:	Number of primary turns.
300	2
400	3½
500	5
600	6½
700	8½
800	10
1,000	15
1,200	22

NOTE.—Turns counted from the outside turn inward.

RECEIVING SET, TYPE C

In the earlier sets, types A and B, the two circuits were magnetically coupled, that is, the current in the primary (open or antenna) circuit induced currents in the secondary (closed detector) circuit by means of magnetic lines which passed from the primary coil through the turns of the secondary coil. In the present set the two circuits are *statically* coupled; that is, the current in the primary circuit induces current in the secondary circuit by means of static lines in two coupling condensers connected in the leads between the circuits. The transfer of the energy from the primary to the secondary circuit for the operation of the detector and telephones is as efficient in this type of connection as in the other. By choice of suitable values of the coupling condensers *no movement of the coils or changes in coupling* is necessary for the reception of any wave lengths within the range of the set, as is the case in the former sets. This reduces the number of adjustments for tuning from 4 to 3, and at the same time the set is much more rugged, as there are

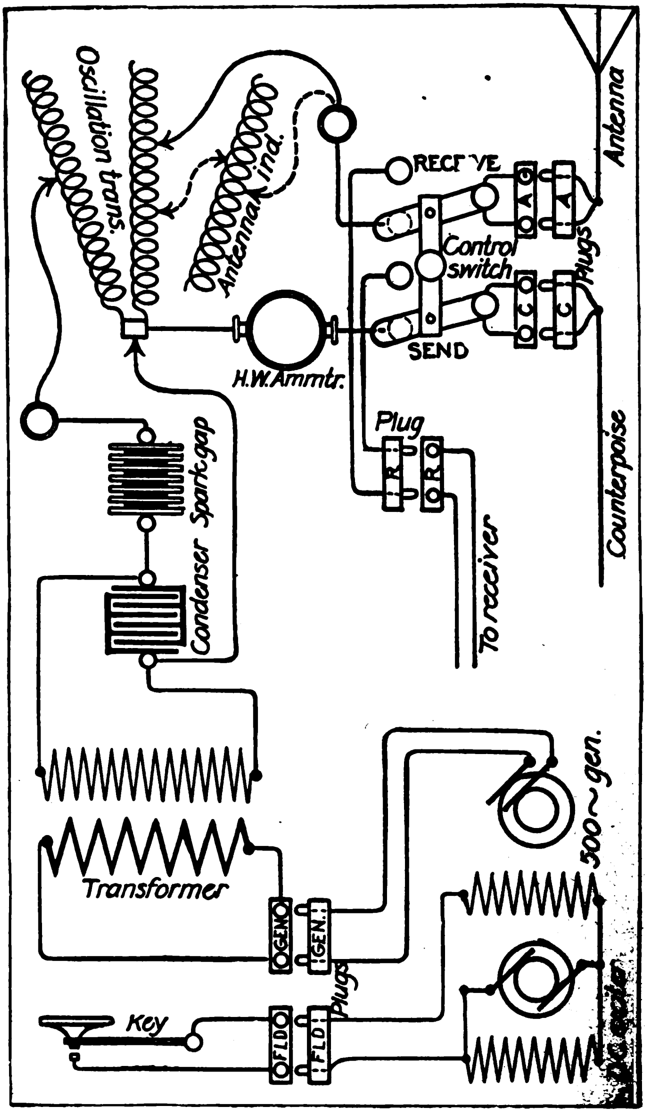


FIG. 7.—WIRING DIAGRAM, RADIO PACK SET, MODEL 1915

no moving parts. The values of the coupling condenser have also been so chosen as to make the set much more selective than the others; that is, it can receive signals from a station on one wave length and cut out signals from another station on a different wave length more completely than before. In addition to the above advantages, the set as a whole has been found to be more efficient than the previous types.

The type C receiving set consists of two statically coupled circuits, high-resistance telephones, stopping condenser, fine wire-galena detector, switch for short and long wave lengths, three dial switches for tuning, etc. The circuits are shown diagrammatically in Figure 8.

The primary circuit consists of: (1) The antenna, which when the control switch in the cover of the chest is thrown to the "Receive" position, is connected by a double plug with flexible wires to the binding post on the set marked "A"; (2) two primary coils in series, one large and the other small, the number of turns in both of which is variable by means of two dial switches marked "Primary." On each coil there are contacts, 0 to 24, for tuning to different wave lengths, the dial nearest to the binding post "A" being connected to the large primary for large changes in wave length and the other to the small one for small changes and fine tuning; (3) counterpoise which is connected to the binding post marked "C" through the double plug and control switch. There is no series condenser in the antenna circuit for the reception of wave lengths shorter than the fundamental wave length of the antenna, as in types A and B, as it has been found not to be generally useful.

When comparatively short wave lengths are to be received, as from 300 to 700 meters, the double-pole double-throw switch on top of the set should be thrown to the position marked "Short." This makes no changes in the primary circuit, but connects into circuit (1) the secondary coil with the dial switch marked "Secondary," with contacts 0 to 24 for tuning to different wave lengths; (2) detector and telephones.

Short wave signals should be picked up by adjustments of the large primary and the secondary dials and fine adjustments made later on the small primary dial.

When longer wave lengths are to be received, as from 500 to 2,400 meters, the D-P D-T switch should be thrown to the "Long" position. This makes no changes in the primary circuit, but disconnects the secondary coil, which in this set is most useful only at short wave lengths, and connects the circuits as shown in the second print. As the secondary coil is not in circuit, only the two primary dials are effective in tuning.

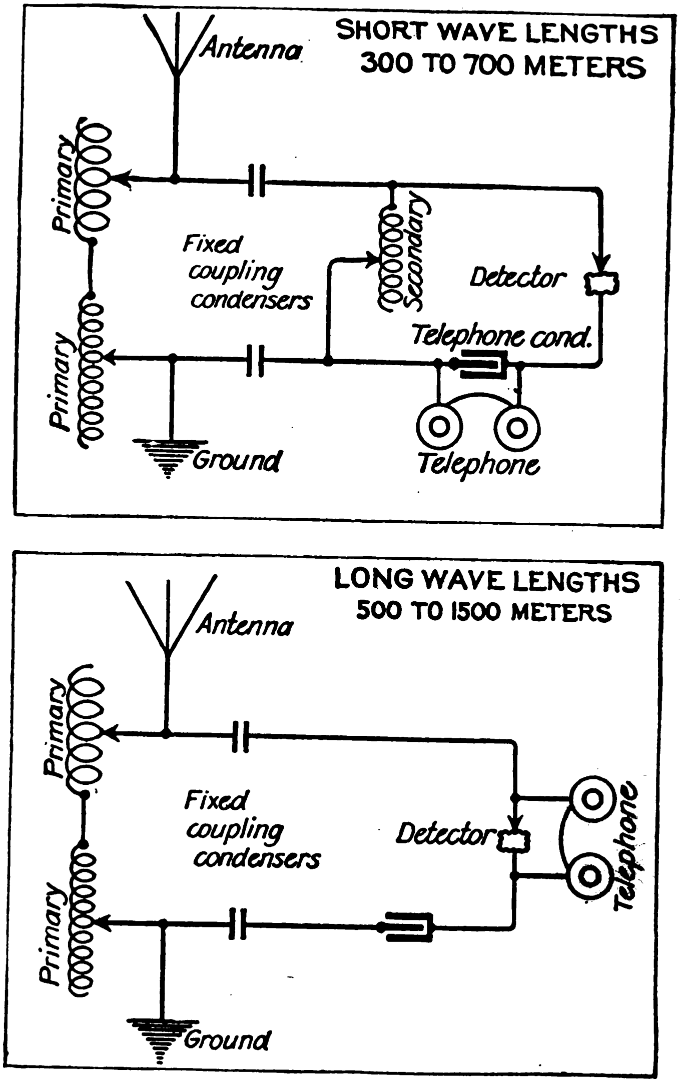


FIG. 8.—CIRCUIT DIAGRAM, TYPE C, RECEIVING SET

Long wave signals should be picked up only by adjustment of the large primary dial and fine adjustments made later only on the small primary dial.

Receiving Set, Type D

This set is practically the duplicate of the type C, except that the number of studs in the three dials has been increased so as to give finer tuning.

Tractor Sets

The Signal Corps has designed and built two sizes of automobile radio sets, or tractor sets, as they are called—(*a*) a "divisional" tractor of 1 k. w. size; (*b*) an "Army" tractor of 2 k. w. size.

The 1 k. w. set, complete with supplies and detachment of seven men, weighs about 6,700 pounds, and on an average road is capable of making a speed of from 20 to 25 miles per hour. It carries a 60-foot sectional mast, which can be raised in a few minutes by means of guides on the roof of the tractor. The antenna is of the umbrella type, with 16 radiating wires each 75 feet long. The counterpoise is likewise of the umbrella type, laid on the ground with 8 wires, each 75 feet long. The transmitting set is of the quenched spark type, with inductively coupled circuits adjusted to radiate waves of 600, 800, 1,000, and 1,200 meters. The receiving set is of the statically coupled type similar to that in use in the 1915 radio pack sets, but of larger size and capable of reception of much longer wave lengths.

The 2 k. w. set, complete with supplies and detachment of eight men, weighs about 9,000 pounds, and on an average road is capable of making a speed of at least 15 miles per hour. It carries an 80-foot sectional mast, which is raised in a manner similar to that in the 1 k. w. set. The transmitting and receiving sets are likewise similar to those in the previous set, but capable of using much longer wave lengths.

VISUAL SIGNALING EQUIPMENT

The Wand

The wand is a stick of light wood about 18 inches long and one-half inch in diameter. It is held loosely between the thumb and forefinger and waved rapidly to the right or left to indicate the elements of the alphabet. It is used for practice purposes and the signals made by it are only intended to be read at very short distances.

Flag Kits, General Service and Semaphore

Five kinds of flag kits are issued by the Signal Corps: The standard 2-foot kit, the infantry 2-foot kit, and the standard 4-foot kit, for use with the General Service Code, and two types of semaphore flag kits, one standard and the other of a pattern temporarily in service in the field and coast artillery, both for use with the Two-arm Semaphore Code.

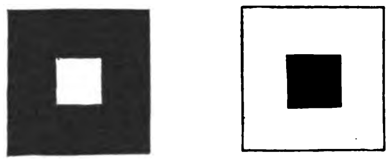
The 2-foot kit.—The standard 2-foot kit consists of one white and one red signal flag, one 3-jointed staff, and a suitable carrying case to contain the outfit. The white flag is made of white galatea 2 feet square, with an 8-inch turkey-red center. The red flag is of similar size and material, the only difference being an alternation of colors in the body and center. The means of attachment to the staff consists of a loop at the center and two ends of white tape at each edge of the back of the flag body. The staff is made of hickory in three joints, each 23 inches long, and is assembled by means of brass screw ferrules. Brass eyes are provided on the first and second joints to receive the tape ends at the edge of the flag. The olive drab carrying case is of convenient size and shape to contain two flags and staffs complete, and is bound with leather and fitted with a shoulder strap.

The combination infantry, 2-foot kit.—The combination, infantry, 2-foot kit is essentially the same as the combination, standard, 2-foot kit, except that 1 infantry flag, as prescribed by Infantry Drill Regulations, is substituted for the two 2-foot red and white flags described.

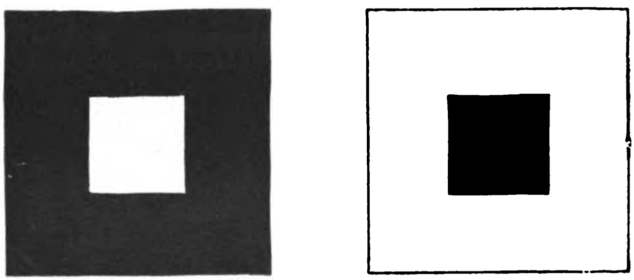
The standard 4-foot kit.—The standard 4-foot kit consists of 1 case, canvas; 1 staff, 3-joint, and 1 flag, red, white square;

and 1 flag, white, red square. The flags are 3 feet 9 inches square, with 12-inch centers, and the staffs are considerably heavier than those of the standard 2-foot kit, each joint being 36 inches long. The 4-foot kit is the standard field flag kit, and

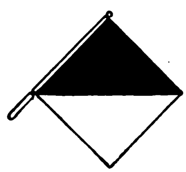
SIGNAL CORPS TWO FOOT FLAGS



SIGNAL CORPS FOUR FOOT FLAGS



SEMAPHORE HAND FLAGS



the range at which signals can be exchanged with it depends on a variety of factors, such as conditions of the weather, the location of stations, the proficiency of signalmen, etc. The speed for continuous signaling is seldom greater than five to six words per minute.

Powers and limitations of flag signaling.—The advantages which may be claimed for this method of signaling are portability of apparatus, adaptability to varied weather conditions, and great rapidity of station establishment. The disadvantages are the lack of celerity of the signals, their impenetrability to dust or smoke, and the comparatively short ranges at which they can be read. These ranges vary with the background, light, vision, and power of glasses if used.

Care of flag material.—Signal flags should be examined at the close of drill or practice and repairs made to any rents or loose ties discovered. Flags, when soiled, should be thoroughly washed and dried in the sun. Signals made by clean flags are much more easily read than those made by dirty ones. Staffs should be handled with care, especially when jointing or unjointing. Care should be taken not to bruise the ends of the brass ferrules. Ferrules fitting together so loosely as to permit separation of the joints in signaling must not be hammered or jammed, but should be tightened by wrapping one or more thicknesses of thin paper around the one which is inserted in the other. If a ferrule becomes loose on a staff it should be tightened without delay.

THE HELIOGRAPH

The heliograph is an instrument designed for the purpose of transmitting signals by means of the sun's rays.

Description.—The service heliograph equipment of the Signal Corps consists of:

A sole-leather pouch with shoulder strap containing—

1 sun mirror. } Inclosed in a wooden box.
1 station mirror. }

1 shutter, 1 sighting rod, 1 screw driver.

A small pouch, sliding by 2 loops upon the strap of the larger pouch, containing 1 mirror bar.

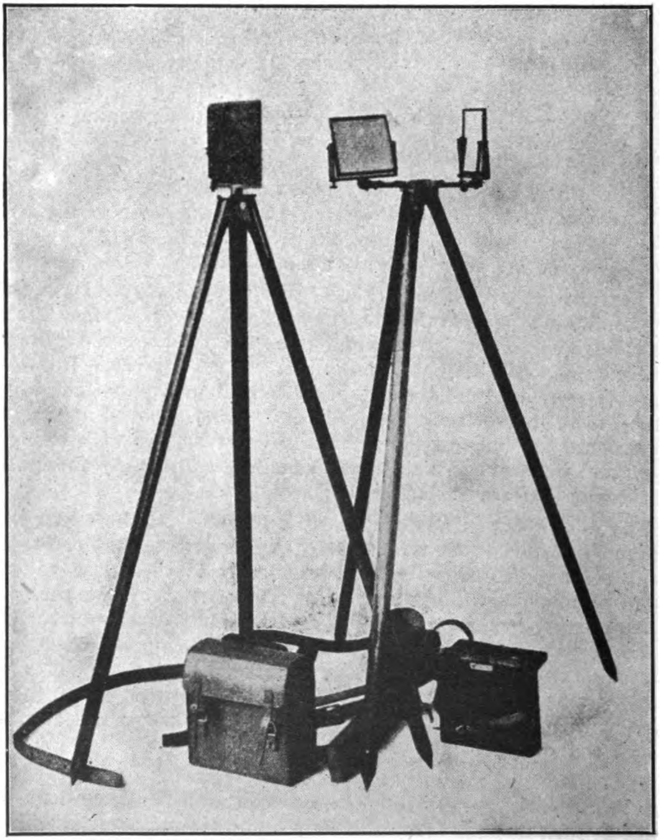
A skeleton leather case containing 2 tripods.

The mirrors are of plate glass, each 4½-inch square, supported by sheet brass and cardboard backings, and mounted in brass retaining frame The sun mirror has a paper disk covering the unsilvered spot in its center. The mirror frames are carried by brass supports provided at the bases with conical projections accurately turned to fit the sockets of the mirror bar and grooved at the ends to receive the clamping spring. Each support is fitted with a tangent screw and worm-wheel attachment functioned to control the motion of the mirror-frame about its horizontal axis.

The mirror bar is a bronze casting provided at the center with a clamp threaded to fit the screw of the tripod. By releasing the clamp the bar may be moved independently of the screw and adjusted to any desired position. Conical sockets for the reception of the mirror supports are provided at the ends of the mirror bar. These sockets work freely in the bar and, being actuated by a tangent screw and worm wheel, serve to regulate the motion of the mirror frame about its vertical axis. Clamp springs, for engaging and securing the ends of the mirror-frame supports, are attached at each end of the bar.

The shutter is 6½ inches square, six segments or leaves being mounted in such a way as to form a shutter. The leaves are designed to turn through arcs of 90 deg. on horizontal axes, unanimity of movement being secured by connections made with a common crank bar. The crank bar is operated by a key and retractile spring which serve to reveal and cut off the flash. A set screw and check nut at the lower edge of the screen frame limits the motion of the crank bar and the opening of the leaves. A threaded base support furnishes the means of attaching the screen frame to the tripod.

The sighting rod is a brass rod 6½ inches long, carrying at the upper end a front sight and a movable disk. About the rod is fitted a movable bronze collar, coned and grooved to take the socket and



THE HELIOGRAPH ASSEMBLED

clamping spring of the mirror bar. A milled-edged bronze washer serves to clamp the collar to the rod at any desired point.

The tripods are similar in all respects, the screw of either threading into the mirror bar or shutter frame. Each tripod is provided with a hook at the base of the head, allowing the suspension of a weight when great stability is required.

Assembling.—There are two ways of assembling the heliograph, and the position of the sun is the guide in determining which of the two should,, in any given case, be employed. When the sun is in front of the operator (that is, in front of a plane through his position at right angles to the line joining the stations) the sun mirror only is required; with the sun in rear of this plane both mirrors should be used. With one mirror the rays of the sun are reflected directly from the sun mirror to the distant station; with two mirrors, the rays are reflected from the sun mirror to the station mirror, and thence to the distant station.

With one mirror: Firmly set one of the tripods upon the ground; attach the mirror bar to the tripod; insert and clamp in the sockets of the sun mirror and sighting rod, the latter having the disk turned down. At a distance of about 6 inches, sight through the center of the unsilvered spot in the mirror and turn the mirror bar, raising or lowering the sighting rod until the center of the mirror, the extreme point of the sighting rod, and the distant station are accurately in line. Firmly clamp the mirror bar to the tripod, taking care not to disturb the alignment, and turn up the disk of the sighting rod. The mirror is then moved by means of the tangent screws until the "shadow spot" falls upon the paper disk in the sighting rod, after which the flash will be visible at the distant station. The "shadow spot" is readily found by holding a sheet of paper or the hand about 6 inches in front of the mirror, and should be constantly kept in view until located upon the disk. The shutter is attached to a tripod and established close to, and in front of, the sighting disk in such a way as to intercept the flash.

With two mirrors: Firmly set one of the tripods on the ground; clamp the mirror bar diagonally across the line of vision to the distant station; clamp the sun mirror facing the sun to one end of the mirror bar and the station mirror facing the distant station. Stooping down, the head near and in rear of the station mirror, turn the sun mirror by means of its tangent screws until the whole of the station mirror is seen reflected in the sun mirror and the unsilvered spot and the reflection of the paper disk accurately cover each other. Still looking into the sun mirror, adjust the station mirror by means of the tangent screws until the reflection of the distant station is brought exactly in line with the top of the reflection of the disk and the top of the unsilvered spot of the sun mirror; after this the station mirror must not be touched. Now step behind the sun mirror and adjust it by means of the tangent screws so that the "shadow spot" falls upon the center of the paper disk on the station mirror. The flash will then be visible at the distant station. The shutter and its tripod are established as described in the single mirror assembling.

Alternate method with two mirrors.—Clamp the mirror bar diagonally across the line of vision to the distant station, with the sun mirror and the station mirror approximately facing the sun and distant station, respectively.

Look through small hole in sun mirror and turn the station mirror on its vertical and horizontal axes until the paper disk on the station mirror accurately covers the distant station.

Standing behind sun mirror, turn it on its horizontal and vertical axes by means of the tangent-screw attachments until the shadow spot falls upon the paper disk on station mirror.

Adjustment.—Perfect adjustment is maintained only by keeping the "shadow spot" uninterruptedly in the center of the paper disk, and as this "spot" continually changes its position with the apparent movement of the sun, one signalman should be in constant attendance on the tangent screws of the sun mirror. Movement imparted by these screws to the mirror does not disturb the alignment, as its center (the unsilvered spot) is at the intersection of the axes of revolution. Extra care bestowed upon preliminary adjustment is repaid by increased brilliancy of flash. With the alignment absolutely assured and the "shadow spot" at the center of the disk, the axis of the cone of reflected rays is coincident with the line of sight and the distant station receives the greatest intensity of light. Remember the distant observer is unquestionably the better judge as to the character of the flash received; and if, therefore, adjustment is called for when the "shadow spot" is at the center of the disk, the alignment is probably at fault and should be looked after at once. In setting up the tripods always see that the legs have a sufficient spread to give a secure base, and on yielding soil press firmly into the ground. Keep the head of the tripod as nearly level as possible and in high wind ballast by hanging a substantial weight to the hook. See that the shutter completely obscures the flash; also that the flash passes entire when the shutter is opened. This feature of the adjustment is partially regulated by the set screw attached to the shutter frame. The retractile spring should sharply return all the leaves of the shutter to their normal positions when the key is released. Failure to respond promptly is obviated by strengthening or replacing the spring.

Operation.—It is of the utmost importance that uniformity in mechanical movement of the shutter be cultivated, as lack of rhythm in the signals of the sender entails "breaks" and delay on the part of the receiver Dark backgrounds should, when practicable, be selected for heliograph stations, as the signals can be most easily distinguished against them.

To find a distant station, its position being unknown, reverse the catch holding the station mirror and with the hand turn the mirror very slowly at the horizon over the full azimuth distance in which the distant station may possibly lie. This should be repeated not less than twice, after which, within a reasonable time, there being no response, the mirror will be directed upon a point nearer the home station and the same process repeated. With care and intelligence it is quite probable that, a station being within range and watching for signals from a distant station with which it may be desired to exchange messages, this method will rarely fail to find the sought-for station.

The exact direction of either station searching for the other being unknown, that station which first perceives that it is being called will adjust its flash upon the distant station to enable it when this light is observed to make proper adjustments. If the position of each station is known to the other, the station first ready for signaling will direct a steady flash upon the distant station to enable the latter to see not only that the first station is ready for work, but to enable the distant station to adjust its flash upon the first station.

Smoked or colored glasses are issued for the purpose of relieving the strain on the eyes produced by reading heliograph signals.

Care of apparatus.—Minor parts of the instrument should be dismounted only to effect repairs. Steel parts should be kept oiled and free from rust. Tangent screws and bearings should be frequently inspected for dust or grit. Mirrors should invariably be wiped clean before using. In case of accident to the sun mirror, the station mirror can be made available for substitution therefor by removing the paper disk. If the tripod legs become loose at the head joints, tighten the assembling screws with the screw driver.

Powers and limitations of the heliograph.—Portability, great range, comparative rapidity of operation, and the invisibility of the signals, except to observers located approximately on a right line joining the stations between which communication is had, are some of the advantages derived from using the heliograph in visual signaling.

The principal disadvantage results from the entire dependence of the instrument upon the presence of sunlight. The normal working range of the heliograph is about 30 miles, though instances of its having attained ranges many times greater than this are of record. The heliograph can be depended upon to transmit from 5 to 12 words per minute.

THE ACETYLENE LANTERN

The signal lantern is an instrument designed for the purpose of transmitting signals by means of intermittent flashes of artificial light. It is the standard night visual signaling equipment furnished by the Signal Corps and depends for its illumination upon the combustion of acetylene gas.

Acetylene.—Acetylene is a pure hydrocarbon gas, producible in various ways, the commoner of which are: (*a*) By dropping calcium carbide into water; (*b*) by dropping water upon calcium carbide. This gas gives, when burning, high penetrative power, and was first described by Mr. Edmund Davy, professor of chemistry to the Royal Dublin Society, in 1836.

Calcium carbide.—In the manufacture of calcium carbide for commercial purposes the best quality of coke and quicklime are used. These two substances are powdered thoroughly, mixed in proper proportions, and then placed in an electrical furnace. Under the action of the intense heat (5,500 deg. F.) these two refractory substances unite and form calcium carbide. Calcium carbide is of a grayish-white color, crystal in appearance, and is nonexplosive and noncombustible, being, except for its affinity for water, an absolutely inert substance.

When calcium carbide is brought in contact with water the following occurs:

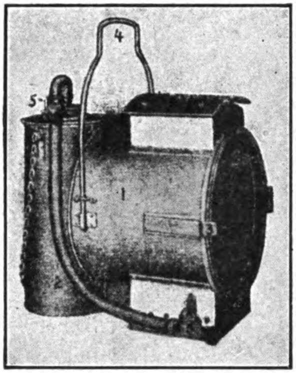
As is known, the principal components of water are oxygen and hydrogen, and calcium carbide is calcium and carbon. When brought in contact, the oxygen in the water decomposes the calcium in the carbide, and in this decomposition the hydrogen in the water is liberated and unites with the carbon of the carbide, forming a hydrocarbon gas, which is acetylene. It gives a pure white light of intense brilliancy and high candlepower. The spectrum analysis of acetylene shows that it is almost identical with sunlight, and in consequence delicate shades of color appear according to their true value as under the light of the sun, consequently it penetrates fog to a greater distance than other lights. Acetylene is like other gases—explosive when mixed with air in proper proportions, confined, and ignited—and the same precautions should therefore be taken in its use as would be in the handling of coal or water gas, gasoline vapor, etc. As acetylene is very rich in carbon, it will not burn in its pure state without smoking. To avoid this, burners have been constructed so that the gas is mixed with the proper proportion of air at the burner tip, to insure perfect combustion. The burners for acetylene are different from those for other gases. In order to get a flat flame, the gas is brought through two perfectly round holes at an angle which causes the two flames to impinge upon each other and thus form a flat flame.

Method of gas generation.—The method employed for producing acetylene in the signal lantern is by bringing water into contact with the calcium carbide. The disadvantage of this method is that when the water is not in excess and does not entirely surround and touch each piece of carbide the heat of generation will so change the chemical properties of the gas that combustion at the burners is not satisfactory.

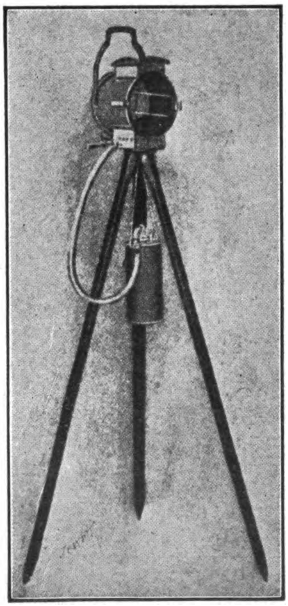
This change is technically known as "polymerization," or the breaking up of acetylene into other hydrocarbons, such as vapors of benzine, benzole, etc. These form a tarry substance which is apt to condense at the burner tip and clog the openings. Also they deposit carbon on the burners, as they require more air for perfect combustion than does pure acetylene. Another disadvantage of this system is that after the carbide and water are in contact, generation of gas will continue until all the water is absorbed. Where, however, portability of the generating apparatus is desired and resort to this method is necessary, the objections are not important, if the apparatus is well constructed and care is taken in its use.

Description.—This equipment consists of a signal lantern with cartridge generator attached. The lantern is fitted with a special aplanatic lens mirror, 5 inches in diameter and about 3 inches focus. The lantern is packed complete in a wooden case with shoulder straps and the following extra parts are included, each part having its own receptacle in the case: 2 burners, 1 cover glass, 3 cartridges of calcium carbide of 5 ounces each, 1 pair of gas pliers, 1 tube white lead, 1 extra filter bag, 1 screw driver.

The lantern is made of brass, all parts of which are riveted. The burner is of the double tip form. The lantern is fitted with a hood to provide proper ventilation and at the same time to prevent the flickering of the light by the wind. The front door of the lantern is hinged and fastens with a spring clasp; it is so arranged that it can be entirely removed if necessary. The cover glass is made in three sections and is not affected by the expansion and contraction of the metal due to changes in temperature. The glass is fastened by the aid of a spring wire, so that it can be readily removed if it is necessary to replace a broken section. In the base of the lantern is a key and the adjustment for regulating the height of the flame. The key is so arranged that when not depressed but little gas is admitted through to the burner, which gives a bright flash. At the back of the lantern there is an adjustable handle, so that the equipment can be used as a hand lantern if desired. This form of lantern can be used with the regular heliograph tripod, the generator being either attached to the back of the lantern or suspended, as shown in the photograph. When practicable it is better to attach the generator to the lantern, as shown in the smaller view. The candlepower of this lantern is about 1,900.



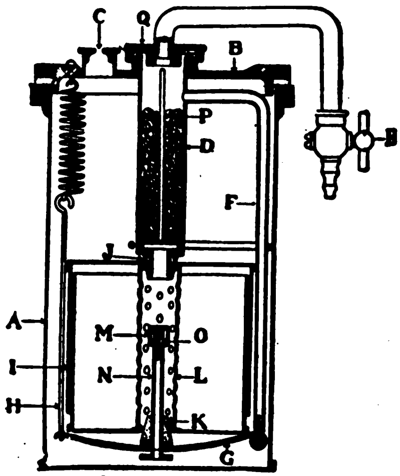
LANTERN WITH GENERATOR ATTACHED



SIGNAL LANTERN ASSEMBLED

The generator used is known as "the cartridge generator," and while constructed on the water-feed principle, the disadvantages incident to this method are eliminated as far as possible. It is constructed of brass and has a removable top. Attached to the inside of the top is a flexible frame with a spring latch, the spring latch being hinged. At the top of the frame is a tube or cylinder, the bottom of which is conical in shape and covered by a rubber plug. At the bottom of the frame is a hollow tube, which is the water inlet. The cartridge proper consists of a tin cylinder having an opening at either end a small cylinder of wire mesh extends from and connects these openings. The carbide lays around this mesh on the inside of the cartridge. The rubber plug before mentioned fits into the upper opening and the water tube into the lower opening. Inside the tube, at the top of the frame, is a filter, the function of which is to remove the dust and moisture from the gas. The outlet from this chamber is by a brass bent tube having a stopcock attached thereto.

The drawing gives a sectional view of the generator with the cartridge in place. *D F G H* represent the valve frame and *I* the cartridge attached. The reservoir *A* is filled with water, and when the frame is immersed, with the valve *R* closed, the air contained in the cartridge and tubing can not escape, the water seal preventing, while the confined air prevents the water from rising in the tube *N*. When the valve at *R* is opened and the air is allowed to escape, part of the water from the reservoir rises into the tube *N* and then out through the small hole *O* to the carbide. Gas is immediately generated, the pressure of which prevents further ingress of the water from the tube *N*, and the generation of gas is suspended.



SIGNAL LANTERN GENERATOR

As the gas passes out through the valve at *R* the pressure decreases, permitting the water to again rise in the tube and flow through *O*. Gas is again generated, which at once exerts its pressure and cuts off the supply of water. This is the automatic action by which water is brought in contact with the calcium carbide. Thus it will be observed that the use or escape of the gas regulates the generation by the simple device of the rise and fall of a water column. There is a cap *M* screwed over the tube *N*. This is used to deflect the course of the water downward, so that the carbide in the lower part of the cartridge is first attacked. There is a needle inside of cap *M*, which can be used for cleaning the hole *O*. When the gas is generated it passes through the filter *D* on its way to the burner through *R*. This filter consists of a tube loosely packed with ordinary nonabsorbent cotton, which should never cover the escape pipe leading to the valve *R*. In passing through this cotton filter moisture and dust are removed from the gas. In the latest model a felt filter is used instead of cotton.

The escape pipe *F* provides a means for the escape of gas generated and not used, or generated more rapidly than consumed. Should an excess be generated, it passes down through the tube *F*, and, finding its way through some small holes in the bottom of this tube, escapes through the water seal and the opening at *C*. It will be noted that if escaping gas at *C* should become accidentally lighted, the flame can not strike back into the filter and cartridge because of the water seal. The principal things to observe in the operation of this generator are the following:

(1) To see that the rubber plugs *fit tightly* into the openings of the cartridge.

(2) That the tube *N*, the cap *M*, and water hole *O* are not stopped up.

(3) That the cotton in the filter is changed frequently.

(4) That the *stopcock R is closed before inserting the frame in the water*. If this latter instruction is not complied with, it can be readily seen that the water will have free access to the carbide and excessive generation will occur.

When the charge is exhausted the entire cartridge is taken out and thrown away. This eliminates the handling of carbide and the disagreeable task of cleaning out the residuum after the gas has been extracted.

Connection is made from the stopcock *R* to the hose connection on the lantern proper, and this is the passageway of the gas from the generator to the burner. As soon as the stopcock is opened the water rises through the tube and flows to the carbide. The advantage of the cartridge being submerged in the water is to reduce and absorb as much of the heat liberated by generation as is possible.

Powers and limitations of the acetylene signal lantern.—As conditions are usually more uniform at night than in the daytime, the signal lantern is probably with the exception of the searchlight the most reliable of all means of visual signaling. The advantages of this apparatus are its portability, speed of operation, and comparatively great range. The principal disadvantages are due to the interference caused by rain, fog, and moonlight. The speed attainable with the lantern is about the same as that attainable with the heliograph. In emergency, and for distances not exceeding ½ to ¾ mile, the lantern can, on dark or cloudy days, be employed for day signaling. These lanterns have been tested up to a distance of 10 miles with the naked eye; and under favorable conditions can be used over a range somewhat in excess of this. With a 30 power telescope, the flash can be read at 30 miles.

TECHNICAL EQUIPMENT OF PERSONNEL

The technical equipment for men of a field company, Signal Corps, is as follows:

(a) Each enlisted man carries on the person 1 electrician's knife, 1 pair of 5-inch pliers.

(b) **Chiefs of sections** carry, in addition to (a), 1 field glass, Type D, a wrist watch, map case and map, a field message book, a pencil and a compass.

(c) **Operators** carry, in addition to (a): Of wire sections—1 field buzzer (when not carried on the wire cart), 1 connector, buzzer, 1 ground rod, 1 wrist watch, 1 field message book, and 25 message envelopes, 2 pencils, 1 small roll of tape, 1 cipher disk. Of wireless stations—1 wrist watch, and also field message books, 25 message envelopes, 2 pencils, cipher disk and tape in the pack chests.

(d) **Linemen** carry, in addition to (a), 1 wire pike, 1 cavalry buzzer, 1 connector, buzzer, 1 ground rod, 1 carrier with buzzer wire, 1 small roll of tape. The pike is not carried at ceremonies except at mounted inspection.

(e) **Messengers** carry, in addition to (a): Of wire sections—1 field message book, 1 pencil, 1 small roll of tape, 1 box of wind matches, and, when not carried on the wire cart, a lantern, 3 candles, and box of wind matches. Of wireless sections—1 field message book, 1 pencil.

(f) **Horseholders (dismounted: line guards)** carry, in addition to (a): Of wire sections—1 small roll of tape, and, when not carried on the wire cart, a lantern, 3 candles, and a box of wind matches.

PART IV—TRANSMISSION.

TRANSMISSION OF MILITARY INFORMATION

Many as have been the changes that applied science has effected in civilized life during the past hundred years, no single one has been more revolutionary, perhaps, than that which has taken place in the transmission of human thought. A century ago the great semaphore system of France marked probably the farthest advance in the world's telegraphy, whereas to-day we put a girdle of thought around the earth in the twinkling of an eye; our uttered words pass beyond the range of sight or sound and reach beyond the limit of years. Space and time have in this sense been annihilated.

That the change has been due to electricity is known to us all; yet who stops to realize that until the first message of the Morse telegraph passed from Washington to Baltimore thought was conveyed much as it had been between men since the dawn of history. That the influence of this change has been as extended in war as it has in peace is perhaps too much to say, since peace is long construction, war speedy destruction; but that the value of the change is the greater in war is as sure as that the need is greater. If proof of this value is necessary, we have only to recall Shafter's communication at a critical moment with the White House from the field at Santiago which the Signal Corps had placed by cable within five minutes of Washington, or, more recently, the events abroad, of which we have but a glimmer of knowledge, but yet sufficient evidence to show the vital, almost transcendent, importance in war of the transmission of information, so signally illustrated in many actions.

But in war, as in peace, changed methods of intelligence communication—with all that this implies—have been due to many agencies; chemistry and the mechanical arts have, of themselves, done their share in improvement and given us aircraft in varying forms, the searchlight, the heliograph, the acetylene light, pyrotechnics, and many other useful devices. But other agencies have played their part, and the fighting world no longer moves only on the surface of land and water. Indeed, advances in the arts of peace have vastly increased fighting power in war, and the application of science to the usual business of life, while it has multiplied the comforts of man and perhaps increased his welfare, has also enormously augmented his killing powers.

There are still people of intelligence who in practice think that the transmission of military thought is summed up in the use of notebook, the orderly and his horse. But these are passing and the trained soldier and educated volunteer understand the vital importance of time in military operations and the need for the immediate transmission of information. Hence, the necessity for a

WHEREAS HALF A CENTURY AGO RAPIDITY OF TRANSMISSION OF INFORMATION WAS MEASURED BY THE SPEED OF COURIERS, MODERN ARMIES EMPLOY ELECTRICITY FOR DISSEMINATION OF MILITARY INTELLIGENCE, USING INSTRUMENTS SIMILAR TO THE EFFICIENT LITTLE BUZZER, HERE ILLUSTRATED

signal corps or its equivalent; for without its aid modern armies can no more be controlled than can great railway systems; the commander in the field remains blind and deaf to the events occurring around him, incapable of maintaining touch with conditions, and out of reach of his superiors or those under his authority, upon whom he depends for the execution of his plans. The brain lacks the power to control because the nerves are wanting. Time is the main factor in war; to arrive first with the greatest number of men, and with the clearest understanding of the situation, is to succeed. The last, and often the first, of these conditions depends upon the lines of information of the army.

Half a century ago rapidity of transmission of information in campaigns was in general measured by the speed of the couriers; distant movements were left to take care of themselves or neglected, since, if discovered, they could only be reported after the event; immediate operations were limited; the chessboard was small. Now all this is changed, and if everything concerned in war and with the efficiency of armies should be of the best, certain it is that the nerves extending from the controlling brain to the striking arm—that is, the lines of thought transmission—should be the most perfect, the most rapid, and the most certain that science can give. Only the best should find a place. Air service, the radio, telegraph, telephone, and visual signaling apparatus, all must be supreme of their kind lest a club be placed in the enemy's hands, to our own destruction.

If a commander's service of information is better than that of his adversary he posseses wider knowledge and superior control; he selects with certainty his objective and arrives at it first; he perceives weakness before his own is discovered or strength before his weakness is known; he anticipates movements, alters dispositions, executes plans unknown to his enemy; in short, the successful soldier commands the situation by force of superior knowledge. Never is it more true than in war, that knowledge is power.

But the kind of knowledge commended by the adage is not merely that acquired by stress of effort; it should embrace that knowledge which comes from information regarding passing conditions, which alters with them and changes from moment to moment as the shadows change. It is the comprehension upon which successful action depends and without which few of the undertakings of war can be brought to a successful conclusion. The means of securing this knowledge of events as they occur and conditions as they exist are vital in warfare. The commander inferior to his enemy in the character and service of his intelligence communication is like a blind man fighting one who can see.. His information service must be of the best, and also that he must be able to use it to the fullest extent. Two great means to this end have been placed in the hands of the modern general—electricity and the airplane.

GENERAL INSTRUCTIONS FOR ARMY SIGNALING

To each signal station in a military unit is assigned a call, consisting of one or two letters, as Washington, "W"; and each operator or signalman also has his personal signal of one or two letters as Jones, "J." These being once adopted they cannot be changed without due authority.

To lessen the liability of error, numerals which occur in the body of the message a e spelled out in full.

In receiving a message the man at the telescope calls out each letter as received, and does not wait for the completion of a word.

A record of the date, and time of the receipt or transmission of every message must be kept.

Duplicate manuscripts of messages received at, or the original sent from, a station must be carefully filed.

In receiving messages nothing is taken for granted, and nothing considered as seen until it has been positively and clearly in view. Signalmen must not anticipate what will follow from the signals already given. The communicating station must be watched until the last signals are made, and the receiver must be very certain that the signals for the end of the message have been given.

Every addres must contain at least two words and be sufficient to secure delivery.

All that the sender writes for transmission after the word "To" is counted.

Whenever more than one signature is attached to a message, all initials and names are counted as part of the message.

Dictionary words, initial letters, surnames of persons, names of cities, towns, villages, states and territories, or names of the Canadian provinces are counted as one word; thus: New York, District of Columbia, East St. Louis should each be counted as one word. The abbreviation of the names of cities, towns, villages, states and territories, and provinces are counted the same as if written in full.

Abbreviations of weights and measures in common use, figures, decimal points, powers of division, and in ordinal numbers the affixes "st", "d", "nd", "rd", and "th" will each be counted as one word. Letters and groups of letters, when such groups do not form dictionary words and are not combinations of dictionary words, are counted at the rate of five letters or fraction of five letters to a word. When such groups are made up of combinations of dictionary words, each dictionary word so used is counted.

The following are exceptions to the preceding paragraph, and are counted as shown: A.M., 1 word; P.M., 1 word; O.K., 1 word; Per cent, 1 word.

Order of Transmission of Sealed Messages

The sending operator enters the time, *when the message is handed him for transmission* in the left hand corner at the bottom blank opposite the word "Received." He then enters in the proper places, at the head of the blank, the number of the message, the call letter of the transmitting station, the operator's personal signal, the check (the number of words or groups of ciphers contained in the message, *counting address and signature*), and after "R" or "OK" has been received he enters the time the message is sent and the call letter of the receiving station, with the personal signal of the receiving operator.

In transmitting a message the operator sends (1) the number of the message and call letter of his station; (2) his personal signal; (3) the check; (4) "fm," followed by the name of the sending detachment; (5) "at," followed by the location of the sending detachment and date; (6) "ho", followed by the hour (a.m. or p.m.) message was written; (7) "to" followed by the address in full; (8) Period (. . - - - . .); (9) body or text of the message; (10) "sig," followed by the signature of the message.

The following message is an example:

First Army Corps, San Antonio, Tex.
10 a.m., June 31, 1916.

General Blanke,
El Paso, Tex.

The Deming force will return at once to Ysleta and protect the bridge. I will cover Laredo.

A. B. Usher, Major General.

This would be sent:

No. 1 K Jo ck 26 OFM fm 1st Army Corps at San Antonio Tex 6 ho 10 am to General Blanke El Paso Tex . . - - - . . (period) The Deming force will return at once to Ysleta and protect the bridge I will cover Laredo sig A B Usher Major General

Note—Above example illustrates the method of transmitting messages over field lines by operators using the American Morse Code.

Where the International Morse Code is used as means of transmission, the double dash (- . . . -) is inserted in the place of "to," "period," and "sig."

THE AMERICAN MORSE CODE

The American Morse code is used officially by the Army only for electrical signaling on telegraph lines, on short cables, and field lines. It is written as follows:

Alphabet.

A	.—	N	—.
B	—...	O	. .
C	.. .	P	.....
D	—..	Q	..—.
E	.	R	. ..
F	.—.	S	...
G	——.	T	—
H	....	U	..—
I	..	V	...—
J	—.—.	W	.——
K	—.—	X	.—..
L	——	Y	.. ..
M	— —	Z	... .
		&	. ...

Numerals.

1	.——.	6	......
2	..—..	7	——..
3	...—.	8	—....
4	....—	9	—..—
5	———	0	————

Punctuation.

Period		..——..
Comma		.—.—
Interrogation		—..—.
Hyphen	(HX)	.... .—..
Dash	(DX)	— .—..
Parenthesis (begin)	(PN)	..... —.
Parenthesis (end)	(PY)	....
Quotation marks (begin)	(QN)	..—. —.
Quotation marks (end)	(QJ)	..—. —.—.

Punctuation—(Continued)

Dollar mark	(SX)	... .—..
Decimal point	...	Spell **"dot."**
Capitalized letter	(CX)	.. . .—..
Semicolon	(SI)	... ..
Underline (begin)	(UX)	..— .—..
Underline (end)	(UJ)	..— —.—.
Colon dash	(KX)	—.— .—..
Colon followed by quotation.	(KQ)	—.— ..—.
Exclamation point	(!)	———.
Fraction bar	(/)	.
Paragraph mark	(¶)	————
Pounds, sterling	(£)	(PX)..... .—..
Shilling mark	(UT)	..— —

Abbreviations.

af	after	nite	night
ahr	another	nl	night letter
b	be	npr	night press rate
bf	before	ob	official business
bn	been	pd	paid
ck	check	r	are
cn	can	t	the
da	day	u	you
dl	day letter	ur	your
dpr	day press rate	w	with
fm	from	wrd	word
gn	good-night	x (in check)	get a reply to this message
govt	government	5	Have you anything for me?
hr	hear or here	13	understand
hv	have		
msg	message		

Conventional Signals for Use With the American Morse Code.

The following conventional signals will be used on military telegraph lines, short cables, and field lines:

Attention, all operators	(9)	— . . —
Please start me (or) where shall I start	(4)	. . . . —
Wait a moment	(MIN)	— — . . —.
Official message	(OFM)	. . . — . — —
I understand	(OK)	. . — . —
Busy on other wires	(25)	. . — . . — — —
No more	(NM)	— . — —
Test, give away	(WIRE)	. — — . . . . . .
Break	(BK)	— . . . — . —
Go ahead	(GA)	— — . . —
Error	(DN)	— . . —.
Signature follows	(SIG)	. . . . . — — .

THE INTERNATIONAL MORSE OR GENERAL SERVICE CODE

The international Morse Code is the General Service Code for use by the Army of the United States and between the Army and Navy of the United States. It is employed in all visual signaling apparatus using the wig-wag, radio telegraphy, and on cables using siphon recorders. There is but one modification in its use, that is, when the Ardois night system is used numerals shall be spelled out and punctuation marks shall be eliminated. The use of the International Morse code, however, does not prohibit the employment between the Army and Navy of such other systems of signaling as may be useful under special conditions, such as the International Code, the two-arm semaphore system, pyrotechnics of any description, including rockets, the Very pistol, or any other method of communication not adapted to the dot-and-dash code, but which at times may become serviceable and which may be temporarily agreed to by the senior officer of the two services. The international Morse, or General Service Code, is written as follows:

Alphabet.

A . —
B — . . .
C — . — .
D — . .
E .
F . . — .
G — — .
H . . . .
I . .
J . — — —
K — . —
L . — . .
M — —
N — .
O — — —
P . — — .
Q — — . —
R . — .
S . . .
T —
U . . —
V . . . —
W . — —
X — . . —
Y — . — —
Z — — . .

Numerals.

1 . — — — —
2 . . — — —
3 . . . — —
4 . . . . —
5 . . . . .
6 — . . . .
7 — — . . .
8 — — — . .
9 — — — — .
0 — — — — —

Punctuation.

Period	. . . . . .
Comma	. — . — . —
Interrogation	. . — — . .
Hyphen or dash	— . . . . —
Parenthesis (before and after the words)	— . — — . —
Quotation mark (beginning and ending)	. — . . — .
Exclamation	— — . . — —
Apostrophe	. — — — — .
Semicolon	— . — . — .
Colon	— — — . . .
Bar indicating fraction	— . . — .
Underline (before and after the word or words it is wished to underline)	. . — — . —
Double dash (between preamble and address, between address and body of message, between body and signature, and immediately before a fraction)	— . . . —
Cross	. — . — .

Conventional Signals for Use by Radio Stations with the International Morse Code

The following conventional signals will be used by radio stations of the United States Army with the International Morse Code:

Distress signal (ship stations only)	**SOS (··· ——— ···)**
Attention (or call)	**The call is composed of the attention signal KA (—·— ·—) followed by the call letters of the station called, repeated three times [if unknown use CQ (—·—· ——·—) in place of call letters of station called], followed by DE (—·· ·) and then the call letters of the calling station, repeated three times.**
Have you anything for **me**	QRU (——·— ·—· ··—)
How many words have you to send	QRJ (——·— ·—· ·———)
Invitation to transmit (go ahead)	K (—·—)
Signal separating preamble from address, address from text, and text from signature	BT (—··· —)
End of message	RN (·—· —·)
End of work	SK (··· —·—), followed by the call letter of sending station and K (—·—)
Received (acknowledgment of receipt of message)	R (·—·), followed by the call letter of the receiving station and personal signal of the receiving operator.
Here is another message	KA (—·— ·—) attention call.
Understood (or I understand)	SN (··· —·), followed by the call letter of station.
Not understood (or repeat)	Signal interrogation ? (··——··) and the last word received.
Error (or mistake)	Signal eight dots (········)
Wait	·— ···
Official message	OFM (——— ··—· ——)

(First word of preamble on all radiograms) ....RADIO (·—· ·— —·· ·· ———)
Faster ....QRQ (——·— ·—· ——·—)
Slower ....QRS (——·— ·—· ···)
Stop sending ....QRT (——·— ·—· —)
Interference ....XX (—··— —··—)
Use International Code of Signals.....PRB (·——· ·—· —···)
General inquiry call (when call of station is not known)......................CQ (—·—· ——·—) (see attention call)

How do you receive me..................QRK (——·— ·—· —·—)

Transmission of Messages by International Morse

EXAMPLE

WVB sending to WVA a plain commercial message filed at 4 p. m., of the 12th, after receiving ——

—·—·—
RADIO
Circle City ....Office of destination.
De.
Fairbanks ....Office of origin.
2 ....Number of message.
L ....Operator's sign.
8 ....Check.
Twelfth 4 p. m.......................................Date and hour of filing
—··— ....Break or double dash.
Brown, 175 King Street.
Circle City ....Address.
—··— ....Break.
Arrive tomorrow..Text.
—··— ....Break.
Jones ....Signature.
·—·—·
KMO
—·—

INSTRUCTION IN GARRISON

Visual Stations

The alphabet and conventional signals with the flag should be thoroughly mastered by means of wand drill, instruction in which is to be given regularly at such time as prescribed by the company commander.

Signal parties should consist of four men, equipped with the necessary visual signal equipment for the operation of one station. The instructor selects the point where the station is to be established and gives the location of the station or stations with which communication is to be conducted.

At the command *open station,* the signal equipment is made ready for use.

One man is designated to record incoming messages and to call off the words of the message being sent.

A second man manipulates the sending equipment and reads and calls off incoming messages for the recorder.

A third man watches the distant station for breaks.

A fourth man is messenger.

The signal party is made familiar with the various duties by frequently changing about the four men to execute each other's tasks.

Outside or field work is conducted by sections, which may be divided into convenient squads of four, chiefs of sections and their assistants being the instructors. These units lend themselves readily to the use of the flag, heliograph, and lantern, as well as for convenience in camping.

Telegraphy

Ability to telegraph by means of the American Morse code is a most important qualification for members of the Signal Corps. Only those who have adaptability for operating and are sufficiently educated should be given this instruction.

The instruction should be conducted in classes, under the direction of the company commander, by competent noncommissioned officers, and, when practicable under the personal supervision of a commissioned officer. The buzzer is used for this instruction and the men classified according to ability and progress. Instruction indoors is to be continued until the operator is sufficiently advanced to work to advantage on field lines, that is, when he has acquired ability to send and receive about 15 words per minute under service conditions.

Instruments should be provided in company headquarters so that they are accessible to the members at all times, encouraging the ambitious to rapid progress. Opportunity should also be given to use typewriters when members have progressed sufficiently.

The standard instruction of the United States Army for telegraphy serves as an excellent guide and is given here for the information of all instructors.

The Morse code as used in the Signal Corps consists of seven elements: (1) the dot; (2) the dash; (3) the long dash; (4) the ordinary space; (5) the letter space; (6) the word space; and (7) the sentence space. It is important to remember that the value of the spaces in the code is as great as that of the dots and dashes. The complete code is shown in the accompanying plates.

The arbitrary unit of time in this code, which, when written down becomes a unit of length, is technically termed the dot. An appreciable time is required for the production of signals by electricity, in the magnetization of the electromagnet, and in the movement of clockwork. The formation of a dot, therefore, necessarily involves time. Assuming, therefore, that—

(1) the dot is the unit of time.
(2) The dash is equal to two dots.
(3) The long dash is equal to four dots.
(4) The ordinary space between the elements of a letter is equal to one dot.
(5) The letter space is equal to two dots.
(6) The word space is equal to three dots.
(7) The sentence space is equal to six dots.

The recruit will first thoroughly commit to memory the groups of signs representing the letters of the alphabet, the numerals, and the principal punctuation points, viz., the period, the comma, and the point of interrogation. The remaining characters can be learned afterwards, as they will be little needed by the beginner.

The most approved manner of grasping the key, and one which has been employed by some of the most successful, experienced, and rapid operators, is shown in the illustration. Curve the forefinger, but do not hold it rigid. Let the thumb press slightly in an upward direction against the knob. Keep the wrist well above the table. No better general direction can be given than that the key will be grasped, held, and controlled with the same flexible but perfectly controlled muscular action of the fingers, wrist, and forearm with which the skilled penman holds his pen. Carefully avoid tapping upon the knob of the key; the raising spring should assist the upward motion of the key, but should never be permitted to control it.

CORRECT MANNER OF GRASPING KEY IN TELEGRAPHING

By constant drill, as hereinafter directed, the habit of making dots with regularity, uniformity and precision must first be acquired; then dashes, and lastly, in order, group of dots and dashes, letters and words. In commencing, the habit should at once be acquired of making the dots like short, firm dashes. The recruit should learn to form the conventional characters accurately and perfectly; speed will come in good time, but only as a result of constant and persistent drill.

ELEMENTARY PRINCIPLES

As a basis for practice, the code may be regarded as comprising six elementary principles, viz.:

First principle—Associated dots.

I	S	H	P	6
..	...	....	.....	......

Second principle—Associated dashes.

M	5	¶
--	---	----

Third principle—Isolated dots.

E

.

Fourth principle—Isolated dashes.

L or cipher	T
—	-

Fifth principle—Dot followed by dash.

A

.-

Sixth principle—Dash followed by dot.

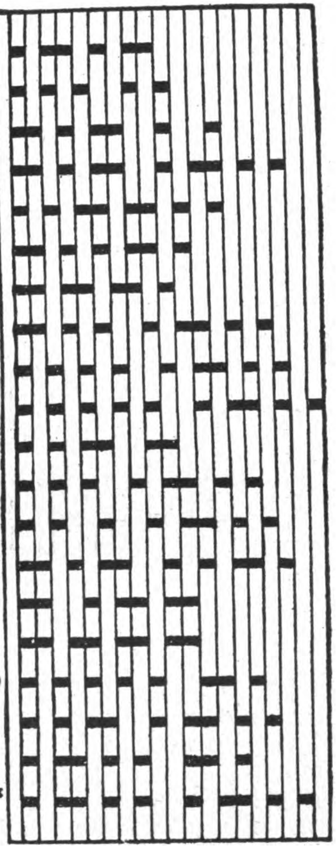
N

-.

The learner's first practice is upon these elementary principles.

PUNCTUATION AND MISCELLANY

Comma,	,
Semicolon,	;
Colon,	:
Colon Dash,	:—
Period,	.
Interrogation,	?
Exclamation,	!
Dash,	—
Hyphen,	-
Pounds,[2]	£
Shillings,[2]	/
Dollars,[2]	$
Capitalized Letter,[2]	
Colon-Quotation,	: "
Decimal Point,	.
Paragraph,	¶
Parenthesis,[3]	( )
Underline,[3]	
Quotation,[3]	"
Quotation within Quotation,[3]	" '



(3) The *long dash* is equal to 4 dots;
(4) The *ordinary space* between the elements of a letter is equal to 1 dot;
(5) The *letter-space* is equal to 2 dots;
(6) The *word-space* is equal to 3 dots;
(7) The *sentence-space* is equal to 6 dots.

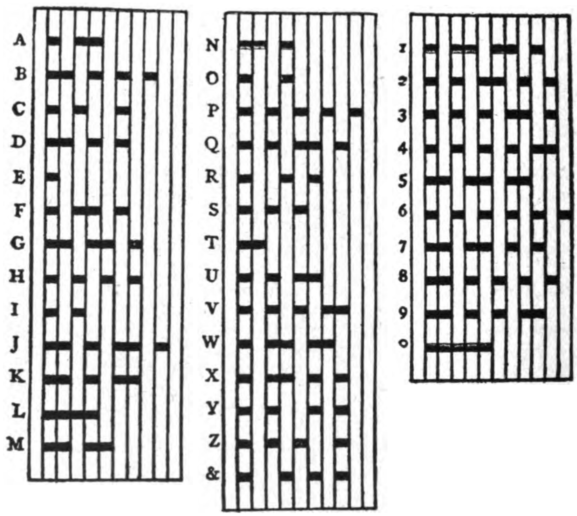
[2] To be used before the characters to which it refers.
[3] To be used before and after the words to which it refers.

Make dots with the key at uniform and regular intervals, until they can be produced with the precision of a machine and of definite and uniform dimensions.

Next make dashes, first at the rate of about one per second, which speed may be increased by degrees, as skill is acquired by practice, to three per second. Make the space interval between successive dashes as short as possible. If the upward movement which forms the space be made full, it can not be made too quickly.

The third principle occurs but once, and needs no specific directions.

ALPHABET AND NUMERALS



The fourth principle will be found somewhat more difficult to execute. The usual tendency is to make T too long and L too short. Theoretically, the cipher is one-half longer than L, but in fact it is always made the same, as the practice has been found to occasion no inconvenience. Occurring alone or among other letters, it is translated as L, but when found among figures it is read as 0.

The fifth principle forms the letter A. The usual tendency is to separate the two elements too much.

The dash followed by a dot (N) is usually found to be somewhat difficult. Time the movement by pronouncing the word ninety, sounding the first syllable fully. Guard especially against the usual tendency to separate the elements by too great a space.

Having become thoroughly familiar with the principles, the following exercises may with advantage 1 taken up in order:

E I S H P 6

. .. .

These should be practiced repeatedly until the correct number of dots in each character can be certainly made at every trial. A habit once formed of making the wrong number, usually one or two too many in the case of H, P, and 6, is almost impossible to eradicate. Guard especially against the objectionable habit of shortening or clipping the final dot, a vice which leads to innumerable and vexatious errors and misreading of signals.

T M 5 ¶

— —— ——— ————

The faults to guard against particularly in this exercise are shortening or elongating the terminal dash, and separating the successive dashes by too great a space interval.

A U V 4

.— ..— ...— ....—

The usual tendency to allow too much space between the dot and dash in the above letters may be overcome by forming them as by an elongation of the final dot in I, S, H, and P.

I A S U H V

.. .— ... ..— ....—

Practice these characters in pairs, that the distinction between them may be more firmly impressed upon the mind.

N D B 8

—. —.. —... —....

The student who has mastered the sixth principle will find no difficulty with the above characters.

A F X ,

.— .—. .—.. .—.—

W 1

.—— .——.

U Q 2 Period

..— ..—. ..—.. ..——..

3

...—.

These are similar to preceding exercises, and present no new difficulties.

K J 9 7

— · — — · — · — · · — — — · ·

J and K are usually considered the most difficult letters in the code. Avoid the tendency to separate J by a space into double N, and be careful that the dashes are of equal length. The numerals 7 and 9 require some care to insure correct spacing.

O R & C

· · · · · · · · · · · ·

Z Y

· · · · · · · ·

These are termed the space letters, and the utmost care and diligent practice are necessary in order to form them accurately. The ability to transmit the spaced letters with absolute correctness is the test of a strictly first-class sender. The space should be just enough in excess of that ordinarily used between the elements of a letter to enable the letters intended to be made to be distinguished with certainty from I, S, and H. The most usual tendency is to make the space too great, even in some cases as great as the space between letters. This is a most fruitful source of misapprehension and error, and too much pains can not be taken to acquire and maintain correct habits in this particular.

Methods of Practice

In transmitting words containing groups of two or more spaced letters, careful operators are accustomed to slightly increase the spacing between successive letters of the group.

Practice in transmission from miscellaneous manuscript is strongly recommended. The ability to read all kinds of copy—good, bad, and indifferent—correctly at sight is a most valuable one, and it is not difficult to acquire by attention and experience.

If the principles here laid down be firmly adhered to, the learner will find much reason for encouragement not only at the rapidity with which he will master what at first sight appears to be a very difficult undertaking, but the extreme accuracy with which he will be able to manipulate his instrument after a fair amount of practice.

This art can only be acquired by constant and persevering practice, keeping in mind the principles above given.

In learning to read by sound, it is advisable for two persons to practice together, taking turns at reading and writing, and each correcting the faults of the other. The sounds of the code characters must first be learned separately and then short words chosen, which must be written very slowly and distinctly and well spaced, the speed of manipulation being gradually increased as the student becomes more proficient in reading.

When the operator has made sufficient progress, he will be given instruction in checking messages, the conduct of offices, the care, adjustment, and repair of instruments.

Checking the Message

In preparing the "check" of the message, all words and figures written in the address, body of the message, and the signature will be counted. That is, count all words after *to* to the end of the signature. The word "sig." is sent merely to indicate that the signature follows, and is not counted in the check.

In counting the check of a message, all words, whether in plain English, code, or cipher, pronounceable or unpronounceable, or initial letters, will be counted each as one word. The abbreviations for the names of places, cities, towns, villages, States, Territories, and Provinces will be counted as if written in full. In the names of towns, counties, countries, or States all of the words will be counted.

Abbreviations of weights and measures in common use and cardinal points of the compass will be counted each as one word.

Figures, decimal points, and bars of division, and letters will be counted each separately as one word.

In ordinal numbers, the affixes st, d, nd, rd, and th will each be counted as one word.

Practice in Receiving

Ability to read messages, land telegraph or wireless, is probably best acquired by group study, a proficient operator sending to a class by means of individual instruments connected to the instructor's transmitter. Receiving is much more difficult than sending and acquiring proficiency is a long and laborious process, in comparison with the comparatively simple mastery of sending. The Government in many of its examinations for operators uses a small machine known as the Omnigraph, a clock-work mechanism which sends messages by rotating aluminum disks with cut edges which break the circuit into dots and dashes.

This device has many advantages for instructing signalmen, notably that perfect sending is assured and elasticity of subject matter extended by the slide changers to innumerable combinations. Morse and International may be sent at speeds from 5 to 100 words a minute. Recruit instruction should be arranged so that the signalmen can use all odd hours for practice, and every encouragement should be given to men showing aptitude and ambition.

The receiving operator adds to the message after it is received the month and year and, after satisfying himself that the checked number of words corresponds, gives "R" followed by the call letter of his station and his own personal signal.* The operator then enters in the proper places at the head of the blank call letter of his own station, with his personal signal and the time the message was received.

Communications transmitted by telegraph or signals are always confidential and are revealed only to those officially entitled to receive them.

Whe.ı everal messages are to be sent in succession "end of message" signal is made after the signature of each, to be followed by the abbreviation "ahr," meaning "another," after which the sending of the next me sage is begun.

No message is considered sent until its receipt has been acknowledged by the receiving station.

* On military telegraph lines, short cables, and field lines the receipt of a message is acknowledged by the signal "OK."

VISUAL SIGNALING IN GENERAL

Methods of visual signaling are divided as follows:

(*a*) By flag, torch, hand lantern, or beam of searchlight (without shutter). (General Service Code.)

(*b*) By heliograph, flash lantern, or searchlight (with shutter). (General Service Code.)

(*c*) By Ardois. (General Service Code.)

(*d*) By hand flags or by stationary semaphore. (Two-arm semaphore Code.)

(*e*) By preconcerted signals with Coston lights, rockets, bombs, Very pistols, small arms, guns, etc.

(*f*) By flag signals by permanent hoists. (International Code.)

The following conventional signals, with exceptions noted, will be used in the first four classes.

		Exceptions Ardois and semaphore.
End of word.	Interval.	
End of sentence.	Double interval.	
End of message.	Triple interval.	
Signal separating preamble from address; address from text; text from signature.	—···—	Double interval, signature preceded also by Interval.
Acknowledgment.	R.	
Error.	········	A.
Negative.	K.	
Preparatory.	L.	
Annulling.	N.	
Affirmative.	P.	
Interrogatory.	··——··	O.
Repeat after word.	Interrogatory, A (word).	
Repeat last message.	Interrogatory three times.	
Send faster.	QRQ	
Send slower.	QRS	
Cease sending.	QRT	
Wait a moment.	—···	None.
Execute.	IX, IX	
Move to your right.	MR	
Move to your left.	ML	
Move up.	MU	
Move down.	MD	
Finished (end of work)	···—·—	None.

Note.—In order to differentiate these signals from important battle signals, the Navy uses certain distinguishing variations which are not necessary in signaling in the Army. In making the conventional signal for "A," Error, and "O," Interrogatory, in Ardois, the Navy indicates them by pulsating the upper light, in making them in semaphore, by agitating the arms or flags. "K," Negative; "L," Preparatory; "N," Annulling; "O," Interrogatory; and "P," Affirmative, in the Navy are secondary meanings, and are used only in connection with Navy Code Books. They should not be used in communication between the Army and the Navy.

In communicating with the Navy, by all methods, numerals are spelled out.

"Intervals" are expressed as follows in the various systems:

	Interval	Double Interval	Triple Interval
Radio Flashing Occulting light Sound	— space	.. .. ..	.—....
Wigwag	Front	(Twice)	(3 times)
Semaphore	Flags crossed or machine closed	2 chops	3 chops, withdraw flags or close machine and indicator arm.
Ardois	.—.—	(Twice)	(3 times)

SIGNALING BY FLAG, TORCH, AND LANTERN, OR BEAM OF SEARCHLIGHT (WITHOUT SHUTTER)

General Service Code

For the flag used in the General Service Code there is one position and there are three motions. The position is with the flag held vertically, the signalman facing directly toward the station with which it is desired to communicate. The first motion (a dot) is to the right of the sender, and embraces an

SOLDIERS OF THE FORT WOOD SIGNAL CORPS SCHOOL WIG-WAGGING MESSAGES IN THE FIELD

arc of 90 deg. starting with the vertical and returning to it; it is made in a point at right angles to the line connecting the two stations.

The second motion (the dash) is a similar motion to the left of the sender.

The third motion (front) is downward directly in front of the sender and instantly returned upwards to the first position. Front is used to indicate an interval.

The beam of the searchlight, though ordinarily used with shutter like the heliograph, may be used for long-distance signaling, when no shutter is suitable or available, in a similar manner to the flag or torch, the first position being a vertical one. A movement of the beam 90 deg. to the right of the sender indicates a dot, a similar movement to the left indicates a dash; a beam is lowered vertically for front.

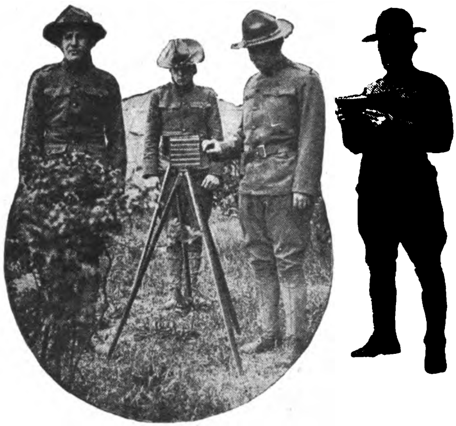
In the use of torch or hand lantern, a footlight must be employed as the point of reference to the motion. A lantern is most conveniently swung out upward to the right of the footlight for a dot, to the left for a dash, and raised vertically for front.

SIGNALING WITH HELIOGRAPH, FLASH LANTERN, OR SEARCHLIGHT (WITH SHUTTER)

GENERAL SERVICE CODE

The first position is to turn a steady flash on the receiving station. The signals are made by short and long flashes. Use a short flash for dot and a long steady flash for dash. The elements of a letter should be slightly longer than in sound signals.

To call a station make its call letter until acknowledged.



If the call letter of a station be unknown, signal A until acknowledged. Each station will then turn on a steady flash and adjust. When the adjustment is satisfactory to the called station, it will cut off its flash, and the calling station will proceed with its message.

If the receiver sees that the sender's mirror or light needs adjustment, he will turn on a steady flash until answered by a steady flash. When the adjustment is satisfactory the receiver will cut off his flash and the sender will resume his message.

To break the sending station for other purposes, turn on a steady flash.

It may be noted that in the daytime and in ordinary weather the searchlight with shutter can be readily used for distances up to 10 miles at sea.

THE ARDOIS SYSTEM

General Service Code

The Ardois system, used in both Army and Navy, is a display of four lights, each of which may be made either red or white. These lights are incandescent lamps, operated by a keyboard and marked with the appropriate signal letters or signs.

The red lamp indicates a dot and the white lamp a dash.

If the lights are placed vertically they are read from the top downward.

When it is necessary to place the lamps horizontally, they are read from the sender's right to his left, and consequently from the receiver's left to his right.

Example: red-white, or dot-dash, represents the letter A, and white-red-red-red, or dash-dot-dot-dot, represents the letter B.

For numerals in the Ardois system the last ten letters have been assigned for army use, Q being 1, R being 2, and so on, Z being 0. These secondary meanings apply only to Army communications; when communicating with the Navy the numerals of the international Morse Code must be spelled out in full.

When letters of the alphabet are to be used to indicate the meaning set opposite them in the following tabulation, the upper light of the display is pulsated. This is effected by means of a special pulsating key.

Ardois System of Conventional Signals

(Used especially in correspondence with the Navy)

Steady Display		Upper light pulsated
A	R W	Error
C	W R W R	Repeat
H	R R R R	Execute
K	W R W	Negative
L	R W R R	Preparatory
N	W R	Annulling
O	W W W	Interrogatory
P	R W W R	Affirmative
Interval	R W R W	Designator

Interval takes the place of front. It is made once for end of word, twice for end of sentence, and three times for end of message. "Designator" means that the following signal designates the call of some ship or station.

Numerals—Secondary Meaning

(Not to be used in communicating with the navy)

Steady Display		Upper light pulsated
Q	W W R W	1
R	R W R	2
S	R R R	3
T	W	4
U	R R W	5
V	R R R W	6
W	R W W	7
X	W R R W	8
Y	W R W W	9
Z	W W R R	0

Rules for Using the Ardois System

The general call to attention is the Cornet, W W W W.

A station desiring to exchange signals displays the call letters of the station wanted, which is answered by a similar display from the station, or from each station successively called.

When the call letters of a station are not known the Cornet is displayed.

The call answered, the message proceeds, or if a special or preconcerted code is to be used, it is so indicated and acknowledged before the message is begun.

SIGNALING BY TWO-ARM SEMAPHORE

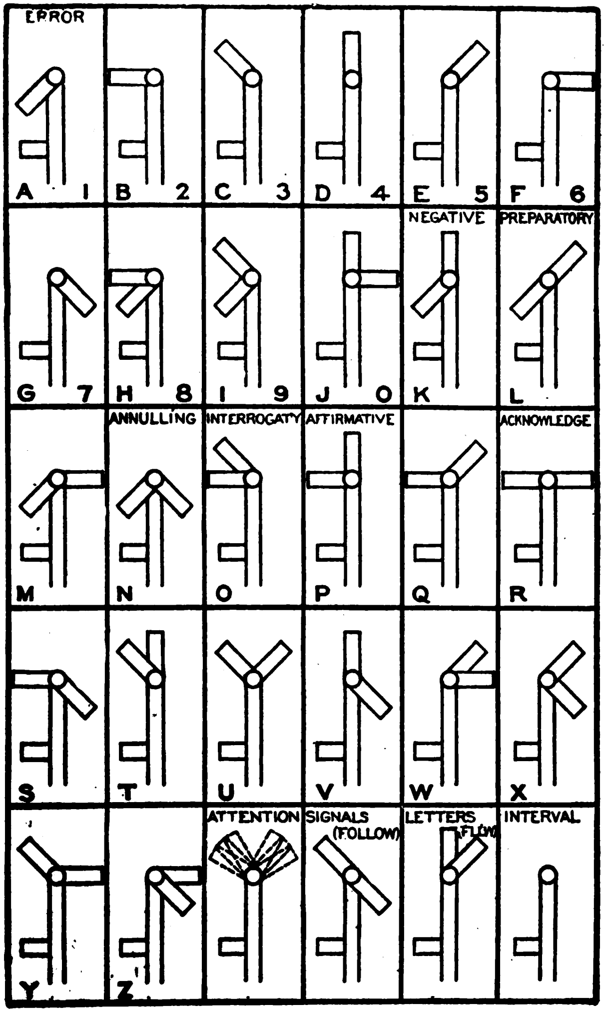
The machine or stationary semaphore is authorized for general use by the Army at the present time. This machine has two arms or vanes for forming signals, and a third arm or "indicator" displayed on the right of the sender, the left as viewed by the receiver. At night a red light screened to the rear indicates the direction of sending. Electric lights are installed on the vanes for night signaling.

Signaling by the two-arm semaphore is the most rapid method of sending spelled-out messages. It is, however, liable to error if the motions are slurred over or run together in an attempt to make speed. Both arms should move rapidly and simultaneously, but there should be a perceptible pause at the end of each letter before making the movements for the next letter. Accuracy is considered far more important than rapidity of operation.

Communications with the navy require numerals to be spelled out.

The alphabet is given in the accompanying plate.

The "interval," as shown on the plate, is the machine closed, but with the indicator showing; "double interval" is the "chop-chop" signal made twice, both arms being placed at the right horizontal and then moved up and down in a cutting motion, the indicator being displayed. The "triple interval" is indicated by the "chop-chop" signal made three times.


ERROR
A 1
B 2
C 3
D 4
E 5
F 6
NEGATIVE
PREPARATORY
G 7
H 8
I 9
J 0
K
L
ANNULLING
INTERROGATY
AFFIRMATIVE
ACKNOWLEDGE
M
N
O
P
Q
R
S
T
U
V
W
X
ATTENTION
SIGNALS (FOLLOW)
LETTERS (FLOW)
INTERVAL
Y
Z

SIGNALING BY HAND FLAGS

Hand flags are authorized for general use by the Army, though on account of their small range they are of limited application and are chiefly serviceable for use within organizations, within fixed positions, or for incidental signaling. The range with flags of the usual size is of course dependent upon light and background, but it is seldom more than one mile with the naked eye. This system of signaling has been highly developed in the Navy, and on account of its rapidity and simplicity is of use to the Army and should be familiar to all soldiers. It is limited to visual signaling work and not adapted to general signaling as is the General Service Code. It will be found useful under many circumstances and is adapted to special work when rapid communication for short distances is needed. This method is also used to advantage for interior signaling within batteries of the field artillery and within regiments of infantry, and at times is convenient to the cavalry.

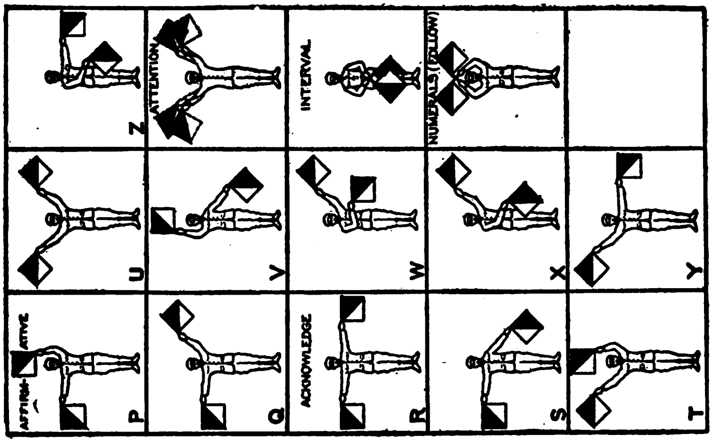
The semaphore hand flags for service use are 18 inches square divided diagonally into two parts. one of red and the other of white;* the staffs are 24 inches long.

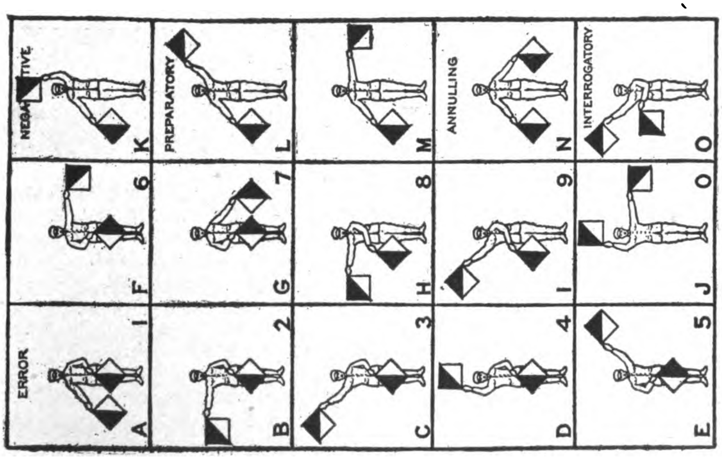
The hand flags of the Navy are from 12 to 15 inches square, of blue with a white square, or red and yellow diagonally, the colors to be used depending upon the background. The flags are usually attached to a light wooden staff about two feet in length.

Hand flags are used in the same manner as the semaphore machine, except that in making the intervals the flags are crossed downward in front of the body (just above the knees); the double interval is the "chop-chop" signal made twice. The triple interval is the "chop-chop" signal made three times, withdrawing the flags

* For the field and the coast artillery there has been temporarily issued a semaphore hand flag of orange with a scarlet center and scarlet with an orange center, one of each constituting a kit. The flags are 18 inches square, the centers 9 inches square, and the staffs 24 inches long.

THE TWO-ARM SEMAPHORE CODE WITH HAND FLAGS





from view. In calling a station, the signalman faces it squarely and makes its call. If there is no immediate reply he waves the flag over the head to attract attention, making the call at frequent intervals. When the sender makes "end of the message" the receiver, if the message is understood, extends the flags horizontally and waves them until the sender does the same, when both leave their stations.

A PRACTICAL ILLUSTRATION OF TWO-ARM SEMAPHORE SIGNALING; A SIGNAL MAN CALLS "ATTENTION" TO INFORM A DISTANT VISUAL STATION THAT WIRE CONNECTIONS HAVE BEEN MADE WITH THE FIRST REGIMENTAL HEADQUARTERS AND THE DIVISION COMMANDER

GENERAL INSTRUCTIONS FOR LOCATING AND OPERATING VISUAL STATIONS

The selection of the site for a visual signal station is governed by choice of a point perfectly in view of the communicating station, the exact position in which the flagman is to stand being arranged, if possible, so that he will have behind him for every signal a background of the same color.

A PORTABLE TOWER CARRIED BY FIELD TROOPS IN SECTIONS AND ERECTED IN A FEW MINUTES, PROVIDING AN ELEVATION FOR OBSERVATION AND VISUAL SIGNALING

Secrecy in communication is vitally important. Even though the code used may not be known to the enemy, the waving flag or other means of visual signaling will inform the enemy that he has probably been observed; stations should therefore be located where they will be most difficult of discovery. If there is reason to believe that signals are seen by the enemy, they should be made in cipher and extraordinary care be taken in transmitting messages. Where practicable, they should be repeated.

In wig-wagging, the color of the flag should contrast as strongly as possible with that of the background. With green or dark, or with earth-covered background the white flag should be used. The distant station is the best judge of background, and it should indicate the color of flag wanted.

The following table shows how far an object at sea level can be seen:

Height of the eye above sea level (in feet)	Distance (in statute miles)
10	4
15	5
20	6
30	7
40	8
50	9
60	10
70	11
85	12
100	13
115	14
130	15
150	16
200	18
230	20
300	23
350	25
500	30
700	35
900	40

Hence, an observer whose eye is 30 feet above the sea can distinguish an object 7 miles distant, providing it is at the sea level; but if the object itself is 15 feet above the sea he can make it out $7 + 5 = 12$ miles off.

In visual signaling over a distance the telescope is used. In locating the signalman at any known station, some prominent landmark is noted with the unaided eye and the telescope then directed upon the place and the country near the marker scaled until the signalman is found. When the compass bearing is known the telescope is aligned with the proper compass bearing and the telescope moved slowly from side to side until the whole country in that direction has been scrutinized.

The magnetic bearing of all communicating visual stations is always carefully noted. In addition, guide lines may be established by driving two stakes firmly into the ground and close to each other. A line through the center of these should point the direction of the distant station. If more than one station is being communicated with, the various names should be written under the lines which mark each one.

A signal officer should provide himself and those working under him with the latest and most accurate topographic maps of the country. The location and call letters of all stations and the personal signals of his subordinates should be recorded and made known to all under his jurisdiction.

The called station should respond at once when its particular signal is shown.

A continuous watch for signals should be kept and assignments recorded so that responsibility for neglect to promptly answer calls may be determined.

When a station has sent all messages on hand, the signal "Cease signaling" should invariably be made. When nothing more is to be sent from either station, both make "Cease signaling."

If a signal station asks another to move its station to the right or left, both stations appoint a signalman to hold a flag (or lighted torch) above his head. The station asking for the change lowers its flag immediately when the proper background is found.

Attempts to attract the attention of a station must be persistent. They should never be abandoned until every device has been exhausted, and should be renewed and continued at different hours of the day and night.

LETTER CODES

Infantry

For use with General Service Code or semaphore hand flags.

Letter of alphabet	If signaled from the rear to the firing line	If signaled from the firing line to the rear
A M	Ammunition going forward	Ammunition required
C C C	Charge (mandatory at all times)	Am about to charge if no instructions to the contrary
C F	Cease firing	Cease firing
D T	Double time or "rush"	Double time or "rush"
F	Commence firing	
F B	Fix bayonets	
F L	Artillery fire is causing us losses	
G	Move forward	Preparing to move forward
H H H	Halt	
K	Negative	Negative
L T	Left	Left
O (Ardois and semaphore only)	What is the (R N, etc.)? Interrogatory	What is the (R N, etc.)? Interrogatory
..——.. (All methods but ardois and semaphore.)	What is the (R N, etc.)? Interrogatory	What is the (R N, etc.)? Interrogatory
P	Affirmative	Affirmative
R N	Range	Range
R T	Right	Right
S S S	Support going forward	Support needed
S U F	Suspend firing	Suspend firing
T	Target	Target

Cavalry

For use with General Service Code or semaphore hand flags.

AAA—Ammunition going forward (if signaled from the rear to the front).
—Ammunition required (if signaled from the front).
CCC—Charge (if signaled from the rear to the front).
—About to charge, if no instructions to contrary (if signaled from the front).

CF—Cease firing.
DT—Double time, rush, or hurry.
F—Commence firing.
FL—Artillery fire is causing us losses.
G—Move forward (if signaled from the rear to the front).
—Preparing to move forward (if signaled from the front to the rear).
HHH—Halt.
K—Negative.
LT—Left.
M—Bring up the horses (if signaled from front to rear).
—Horses going forward (if signaled from rear to front).
O—What is the (R N, etc.)? Interrogatory (Ardois and semaphore only).
..——..—What is the (R N, etc.)? Interrogatory (all methods but Ardois and semaphore).
P—Affirmative.
R—Acknowledgment.
RN—Range.
RT—Right.
SSS—Support going forward (if signaled from the rear to the front).
—Support needed (if signaled from the front to the rear).
SUF—Suspend firing.
T—Target.

Field Artillery

For use with General Service Code or Semaphore Hand Flags.

.... —Error (all methods but ardois and semaphore).
A—Error (ardois and semaphore only).
AD—Additional.
AL—Draw ammunition from limbers.
AKT—Draw ammunition from combat train.
AM—Ammunition going forward.
AMC—At my command.
AP—Aiming point.
B (numerals)—Battery (so many) rounds.
BS (numerals)—(Such.) Battalion station.
BL—Battery from the left.
BR—Battery from the right.
CCC—Charge (mandatory at all times). Am about to charge if not instructed to contrary.
CF—Cease firing.
CS—Close station.
CT—Change target.
D—Down.
DF—Deflection.
DT—Double time. Rush. Hurry.
F—Commence firing.
FCL (numerals)—On 1st piece close by (so much).
FL—Artillery fire is causing us losses.
FOP (numerals)—On 1st piece open by (so much).
G—Move forward. Preparing to move forward.
HHH—Halt. Action suspended.
IX—Execute. Go ahead. Transmit.
JI—Report firing data.
K—Negative. No.
KR—Corrector.
L—Preparatory. Attention.
LCL (numerals)—On 4th piece close by (so much).
LOP (numerals)—On 4th piece open by (so much).
LT—Left.
LL—Left from the left.
LR—Left from the right.
LE (numerals)—Less (so much).
MD—Move down.
ML—Move to your left.
MR—Move to your right.
MU—Move up.

MO (numerals)—Move (so much).
N—Annul, cancel.
O—What is the (R N, etc.)? Interrogatory. (Ardois and semaphore only.)
..——.. —What is the (R N, etc.)? Interrogatory. (All methods but ardois and semaphore.)
P—Affirmative. Yes.
PS—Percussion. Shrapnel.
QRQ—Send faster.
QRS—Send slower.
QRT—Cease sending.
R—Acknowledgment. Received.
RS—Regimental station.
RL—Right from the left.
RR—Right from the right.
RN—Range.
RT—Right.
S—Subtract.
SCL (numerals)—On 2d piece close by (so much).
SOP (numerals)—On 2d piece open by (so much).
SH—Shell.
SI—Site.
SSS—Support needed.
T—Target.
TCL (numerals)—On 3d piece close by (so much).
TOP (numerals)—On 3d piece open by (so much).
U—Up.
Y (letter)—Such battery station.

Coast Artillery

FOR SHORE-TUG SIGNALING

1.	Range correct, ready to fire	K
2.	Commence towing	C
3.	Go out	O
4.	Come in	I
5.	Distress	D
6.	Hold stationary	S
7.	Turn	T
8.	Incline to port	L
9.	Incline to starboard	R
10.	Close practice	Z

EXPLANATION OF SHORE-TUG SIGNALS

Range correct, ready to fire—This signal is supplementary to the firing signal displayed at the battery firing. At mortar subcaliber practice this signal may be sent as each shot is fired.

Commence towing—This signal means that the towing vessel will at once take up the bearing course prescribed. It is understood that in every case the course on which the target is to be towed is to be indicated by compass bearings furnished to the officer in charge of the towing vessel. By this means it will only be necessary to get the target on any one point of the course and then send the signal "commence towing."

This signal may be given at any time, with the towing vessel stationary or moving in any direction, and means that the vessel will at once take up the prescribed bearing course.

Go out—This signal directs the vessel to move straightway from the battery firing.

Come in—This signal directs the vessel to move straight toward the battery firing.

Distress—This signal sent by a tug indicates either that the tug is unable to proceed, due to fouling, breakdown, shoals, or other cause; or that, at night practice, a shore searchlight is interfering with a patrol boat. After the trouble passes, Signal No. 1 is given by the tug. If the searchlight can not be used, distress signals should be made by whistle. In any case, the nature of the trouble should be immediately communicated by shutter and radio, using the General Service Code.

Hold stationary—This signal indicates that the vessel is to lie to until further orders are given.

Turn—This signal indicates that the vessel is to go about, or make a turn of 180 deg. If given after No. 6 (hold stationary), it means that the vessel will run a course of 180 deg. from that on which she was proceeding when No. 6 was given.

Incline to port.—Given when the vessel is on a course, it indicates that the vessel will incline to port two points. Given after No. 6 (hold stationary), it directs the vessel to run on a course two points to starboard of that on which she was proceeding when No. 6 was given.

Close practice—This signal means that firing is over for the day and that the towing vessel will proceed to carry out such special directions as may have been given relative to securing and bringing in the targets.

TELEGRAPH CODE BOOKS AND CIPHERS

Code books, which have become familiar to all users of the telegraph and cable in ordinary business transactions, are intended for economy and to insure secrecy. The War Department has its official telegraph code adapted especially to military needs, but this is of course available only to those enlisted in the service of the Government. The training of citizen-soldiers in Signal Corps transmission by code need not be handicapped by lack of this equipment, however, since for purposes of familiarizing themselves with the method of employing the code book, any available telegraph or cable book may be used.

When used solely for economy the words or phrases of the message are coded by direct reference to the books' equivalents—usually words of five letters each—and are easily translated by reference to the code book. When secrecy is desired, however, some method of enciphering is employed which can be translated only by those in possession of the "key," or the secret of the method of transcription.

Ciphers are nearly infinite in number and, though probably no one is absolutely unreadable, the simplest cipher has the advantage of delaying the reading of the message should it be intercepted by the enemy. Another value in the cipher is that it requires more or less expertness in use. The Signal Corps of the United States Army considers only two cipher codes necessary for study; these are the cipher disk and the route cipher.

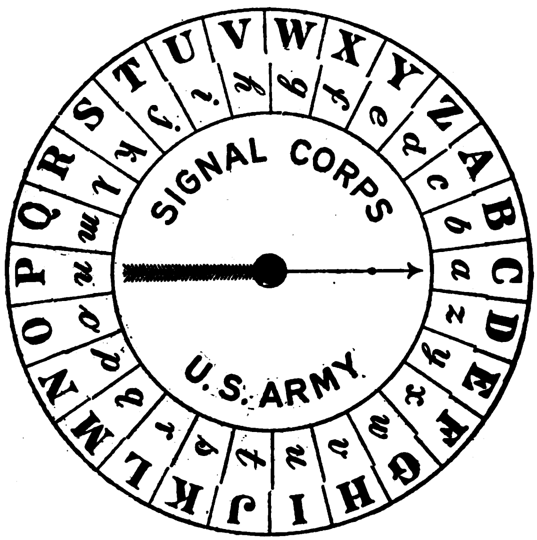
THE CIPHER DISK

The cipher disk is the simple but useful device pictured in the accompanying illustration. It is composed of two circles of cardboard, celluloid, or other material joined through the centers, the upper disk revolving on the lower. The alphabet, reading from left to right, is printed around the circumference of the lower disk in upper case, or capital, letters. On the upper disk is printed the alphabet reading from right to left, in lower case, or small, letters.

When it is desired to encipher a message, the "key" letter, or the first letter of the key word or words, is set opposite the letter "a." For illustration, assume it to be "E." The cipher letters to be written are those opposite the text letter when the letter "a" on the upper disk is set opposite "E" on the lower disk. For example, the message "Send powder" would be written "marb pqiban."

Numbers are spelled out when enciphered with the cipher disk.

In the method of enciphering just described it is obvious that the mere transposition of letters would delay but a short



THE CIPHER DISK USED FOR SECRECY IN MESSAGE TRANSMISSION

time the deciphering, or translation, of a message by the enemy, even if the key letter were not known. It would only be necessary to place, in turn, opposite "a," each of the letters of the alphabet, beginning with "B" and noting the letters until the right arrangement made the meaning of the message clear.

But when this simple disk is used with code book, or cipher, word or words, known only to the sender and receiver of the message, it is entirely improbable that the message could be deciphered in time to be of any value to the enemy.

To illustrate the use of key words in this connection, we will assume that the key words "permanent body" are the equivalent cipher for the message: "Reenforcements will reach you at daylight". The procedure would then be as follows: The message would first be written:

Reenforcementswillreachyouatdaylight

Then over the message would be written the key words, letter over letter, thus:

PERMANENTBODYPERMANENTBODYPERMANENTB
r e e n f o r c e m e n t s w i l l r e a c h y o u a t d a y l i g h t

Now bring "a" of the upper disk under the first letter of the key word on the lower disk, in this case "P". The first letter of the message to be enciphered is "R," in the position of the disks at this time "y" will be found opposite to "R", and it is put down as the first cipher letter. The letter "a" is then brought under "E", which is the second letter of the key word. "E" is to be enciphered and "a" is found to be the second cipher letter. Then bring "a" to "R" and the cipher letter "n" will represent 'E," the third text letter of the message. Proceed in this manner until the last letter of the cipher words is used, and, beginning again with the letter "P", continue until the entire message has been enciphered, letter by letter. The result will then be:

PERMANENTBODYPERMANENTBODYPERMANENTB
r e e n f o r c e m e n t s w i l l r e a c h y o u a t d a y l i g h t
y a n z v z n l p p k q f x i j b p w a n r u q p e p l o m c c w h m i

These last letters will then be divided, for convenience in sending, into groups of five letters and transmitted thus:

"yanzv znlpp kqfxi jbpwa nruqp eplom ccwhm i"

Employment of the Cipher Disk

The importance of using cipher words in manipulating the disk to insure absolute secrecy, over an effective period of time, is shown by the ease with which a message enciphered by the mere transposition of the letters of the alphabet may be quickly deciphered by use of the disk. This the following message will show:

Assume that "a" is used to represent "F," "b" to represent "E," "c" to represent "D," "d" to represent "C," "e" to represent "B," etc., in regular sequence, and the message to be enciphered is: "We are short of rifle ammunition send 20,000 rounds at once."

This would be enciphered, if divided into groups of five letters, as follows:

"jbfob nyron raoxa ubftt lsxmx rsnbs cmjbs mhmyr lnfsc orlsc nfmrs db"

Place "a" of the upper cipher disk opposite "B" of the lower disk and notice whether the cipher letters "jbfob"—the first group—are intelligible. They give "SAWNA"; continue this, for "SAW," the first three letters may be the text word. Now the next group is "nyrom," and these give "ODKNP." Together the first ten cipher letters give the meaningless letters "SAWNAODKNP" and we know therefore that "a" does not represent "B." Turn "a" to "C" and we have the first group "TBXOB," which is without meaning. Turning "a" to "D" we get "UCYPC" a meaningless jumble. Turn "a" to "E" and we get "VDZQD," which is meaningless. Now turn "a" to "F" and we find that "jbfob" means "WEARE," which gives us the two words "We are." We continue with the next group, "nyrom," which gives us "SHORT." We now have these letters "WEARESHORT," which at a glance we read "We are short." It would appear that we have now found the key letter and after deciphering several additional groups we are certain that the information hidden in the cipher is ours. Continue deciphering with "a" opposite "F" until the end of the message. Sometimes the key letter is changed after two, three, or four letters. It is a matter of minutes only to run through the alphabet and learn the meaning of a message so enciphered.

Improvised Substitute for Cipher Disk

Cut vertical strips, each about one-half inch wide, from lined writing paper. Paste these end to end so that two strips will be made up, one with 26 spaces and the other with 52 spaces. Write the alphabet twice, beginning with letter "A", down the 52-spaced strip, and write it once backwards, beginning with the letter "Z", down the 26-spaced strip. These two strips, when laid side by side, may then, by sliding the 26-spaced strip up and down to the appropriate letter on the 52-spaced strip, be made to perform the functions of a cipher disk.

The Route Cipher

This is a cipher in which the words of a message are retained unchanged, but are so disarranged by preconcerted rules that the sense becomes unintelligible. The message as received seems to be a number of disconnected words without meaning, but by arrangement in proper order in accordance with certain rules can be easily read. Messages enciphered in this manner may be translated by persons not in possession of the key, and therefore the information contained therein should *only be of such a character as to be of little value to the enemy unless acted upon immediately*. The usual method employed by the Army in arranging a message for this cipher is to write the words in vertical columns. The number of words in each column should always equal the number of columns, being made so, if necessary, by the addition of sufficient "blind" words. A preconcerted route is agreed upon, as up the first column, down the third, up the second, etc. The message is then transmitted without reference to the columns, but is deciphered at the receiving station by column arrangement and perusal along the original route.

For example, to encipher the message "Move daylight. Enemy approaching from north. Prisoners say strength one hundred thousand. Meet him as planned," arrange as follows:

Move	strength	planned	say
daylight	one	as	prisoners
enemy	hundred	him	north
approaching	thousand	meet	from

Here the route for translation is down the first column, up the fourth, down the second, and up the third.

CONVENTIONAL AND PRECONCERTED SIGNALS WITH ROCKETS, BOMBS, SMALL ARMS, AND GUNS

In applying the dot and dash code to rockets, bombs, small arms, and cannon, use should be made of preconcerted signals, or of the International Code of Signals or other conventional code book. These signals are not adapted to general use with the dot and dash code.

Throughout, red may indicate a dot, white or green a dash. In cases where the colors of signals are not visible, as may be with the use of the Very pistol by day, one may indicate a dot, two fired simultaneously, a dash.

The receiving station should promptly acknowledge receipt of each message.

When a line of several stations is established, care should be taken that each station is supplied with copies of instructions and codes exactly alike.

COSTON LIGHTS

These lights are made of a slow-burning composition and are usually held in a socket and displayed by hand.

ROCKETS

Rockets used by the Army are of two kinds, viz, sequence rockets, showing red and white stars, and yellow-smoke rockets. With the sequence rockets there is included a dummy element. These rockets are packed in water-tight cases and are plainly labeled.

BOMBS

Bombs used by the Army are of two kinds, white or red for night use and smoke bombs for day use. They, like rocket signals, are not adapted for general use with the dot-and-dash code, but should be used with preconcerted signals, or to indicate letters of the International Code of Signals or other conventional code book.

Like rockets for night signaling, the red bomb indicates a dot, the white a dash.

VERY PISTOL

The Very system is used by the Navy only to transmit flag-code signals contained in the Battle or General Signal Book.

The Very pistol is a breech-loading, single-shot pistol, with an 8-inch steel barrel chambered to receive a 12-gauge commercial shotgun shell. Brass shells are used, and are packed in boxes colored to indicate an element of any alphabet or any special signal which may be desired. The stars rise to a height of about 200 feet and remain visible for some time.

The Very pistol projects red, white, and green stars for use at night and the streamer of smoke for use in daytime. The stars can readily be seen several miles at night, and the smoke streamer can be picked up by glasses for over a mile in daytime.

In making a signal the stars are projected deliberately, one by one, from the first to the last, without regard to time intervals. It is desirable, however, that the stars should be projected vertically or so as to fall in the direction of the receiver of the message, and that they should appear without very unequal intervals between them; at the same time, through some unforseen cause, a long interval may elapse between two stars of a message, but no account of this shall be taken unless the interval is prolonged to about a minute.

A star may be broken by the shock of discharge and show several stars of the same color in the air. This will be recorded as one star.

When, after waiting about one minute, the receiver of the signal sees no more signal stars, he will consider the signal finished.

SOUND SIGNALS[1]

Sound signals made by the whistle, foghorn, bugle, trumpet, and drum may well be used in a fog, mist, falling snow, or at night. They may be used with the dot and dash code.

In applying the General Service Code to whistle, foghorn, bugle, or trumpet, one short blast indicates a dot and one long blast a dash. With the drum, one tap indicates a dot and two taps in rapid succession a dash. Although these signals can be used with a dot-and-dash code, they should be so used in connection with a preconcerted or conventional code.

With small arms, field, siege, or seacoast guns, one shot may indicate a dot, two shots a dash; but in this case the signals are not adapted to the general use of a dot-and-dash code, but should be employed in connection with a preconcerted or conventional code.

[1]See also Emergency signals.

FLAG SIGNALS BY PERMANENT HOIST

INTERNATIONAL CODE

The term "flag signals" or "flag code signals," as used by the Navy, applies to signals made by hoists of flags, and should not be confused with the use of the expression by the Army to indicate what is known to the Navy as wigwag signals.

The only flag signals by permanent hoist and corresponding code books authorized for use by the Army are the International Code of Signals and Code List of American Vessels.

The International Code of Signals will be used by the Army when such use may appear desirable, as on Army transports and at seacoast fortifications, and between the Army and Navy, in accordance with recommendations of the Army and Navy Board. Sets of International Code Flags, the International Code of Signals, and the Code List of American Vessels will be issued by the Signal Corps in cases where the application therefor is approved by proper authority.

The International Code of Signals consists of 26 flags—one for each letter of the alphabet—and a code pennant. The flags are used in connection with the International Code Book of Signals. Explanation for the proper use of this code is given in the Code Book.

Night signals to boats will be made by the two-arm semaphore, torch, portable lantern, or electric system in the same manner as other signals of the Navy. In the Navy the Very system is not contemplated for signaling to boats, being too cumbersome. The electric system used should be either the Ardois or the blinker, using the dot-and-dash code for either. It is provided that boats shall acknowledge by day with the Navy code hand answering pennant, and by night with a hand lantern or torch or Very's red star.

Code List

The Code List of American Vessels is a publication of the Bureau of Navigation, Department of Commerce, setting forth the names of United States vessels, their flags, signal letters, official numbers, etc.

The General Signal Book of the Navy, being confidential, will not be issued to or used by the Army.

Codes to be used with rockets, bombs, etc., are not specifically included in the system agreed upon for use between the Army and Navy. They are not prescribed for use by the Navy.

The International Code of Signals, List of Radio Telegraph Stations of the World, and the Code List of American Vessels, with the proper code flags, will be kept on hand at radio or other coastal stations of the Army where authorized.

EMERGENCY SIGNALS

In the Army special emergency signals are authorized for use when circumstances permit and conditions justify their authorization by officers in command.

They are given here only as information which may be of value in time of national emergency. Under no condition are they to be used by the citizen soldier, or their use authorized by commanding officers of troops not regularly enlisted in the Army.

These signals are designed to secure the attention of persons within their radius; they may indicate distress; ask assistance; give a general alarm in case of riot, attack, flood, or conflagration, or other urgent reasons.

Emergency Cable and Telegraph Signals

The emergency signal for use on cable or land telegraph lines is the numeral "9."

Emergency Signals for Radiotelegraphy

The radio distress signal for use at sea is the international signal SOS. An Army operator aboard ship, upon receiving an SOS signal, immediately ascertains the exact position, in latitude and longitude, of the vessel sending the signal and delivers the information to the officer in charge of the ship.

Signals of Distress on Army Transports

The signals of distress, used either together or separately, on Army transports are as follows:

In the daytime:—

First. A gun or other explosive signal fired at intervals of about one minute.

Second. The International Code signal of distress indicated by NC.

Third. The distance signal, consisting of a square flag having either above or below it a ball or anything resembling a ball.

Fourth. A continuous sounding with any fog signal apparatus.

At night:—

First. A gun or other explosive signal fired at intervals of about a minute.

Second. Flames on the vessel (as from a burning tar barrel, oil barrel, etc.)

Third. Rockets or shells throwing standard Army transport night signals, fired one at a time, at short intervals.

Fourth. A continuous sounding with any fog signal apparatus.

These signals require no answer, but any station hearing or seeing them is expected to make every effort to assist the ship in distress.

On Army transports the fire signal is the continuous and rapid ringing of the ship's bell for a period of not less than 20 seconds. This signal is not used for any other purpose whatsoever.

Emergency Signals With Bombs, Small Arms, or the National Ensign

A general attention or alarm signal is indicated by one discharge of a cannon, rifle, pistol, or *smoke* bomb by day. followed by a smoke rocket at half-minute intervals. At night, by one discharge of cannon, small arm, or *light* bomb, followed by a red rocket at half-minute intervals. This signal requires no answer. Used as an emergency signal it calls all troops to attention, the smoke bomb followed by a rocket indicating riot or attack and requiring troops to fall into ranks under arms. Should the first rocket be followed by a second, the signal indicates a conflagration or other danger, and troops fall into ranks prepared to fight fire or meet other danger, such as flood.

When no bombs or rockets are at hand the general-alarm signal is made by a rapid discharge of shots.

With the national flag, the universally understood distress signal is made by flying the ensign union down.

The long roll of the drum is also recognized in the Army as a general-alarm signal and requires all troops to fall into ranks.

CONVENTIONAL TELEPHONE SIGNALS

There are certain letters of the alphabet which are at times confused with other letters of similar sound. Such is particularly true when using the telephone. This condition gives rise to delays and errors, especially when transmitting cipher.

To provide a ready means of phonetically distinguishing similar sounding letters, the following is authorized:

A—Able
B—Boy
C—Cast
D—Dock
E—Easy
F—Fox
G—George
H—Have
I—Item
J—Jig
K—King
L—Love
M—Mike
N—Nan
O—Opal
P—Pup
Q—Quack
R—Rush
S—Sail
T—Tare
U—Unit
V—Vice
W—Watch
X—X-ray
Y—Yoke
Z—Zed

Example: If the operator receives "buy" as "vie," and difficulty is experienced in distinguishing "B" from "V," "buy" may be spelled "boy-u-y."

PART V—FIELD SERVICE

SIGNAL TROOPS IN THE FIELD

In defining the exact duties of Signal Corps in the field it may be said that it exists for the speedy dissemination of military information. It is the nerve system of the army by which information is transmitted to the brain. Unlike other branches of the service there are no fixed rules for its operation which could be condensed into a tactical manual such as exists for other fighting units.

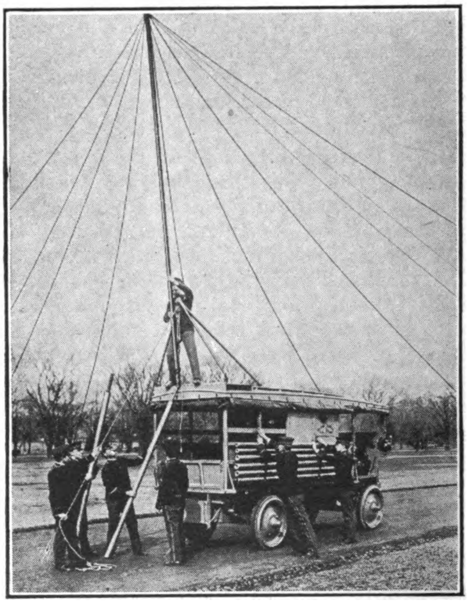
An official bulletin from the office of the chief of staff, U. S. Army, deals with conditions in field service by stating that the Signal Corps is specially organized, trained, and equipped for the collection and transmission of military information, and only the most general instructions should be given to officers and men as to the manner of performing their duties. It is inadvisable, especially in brief field orders, to attempt detailed instructions; it will suffice in such orders to state the commands to be joined, their location, and a broad statement of the object desired. It is assumed that the signal officer, acting under his general instructions and the orders of his immediate commander, possesses the knowledge, the initiative, and the energy to meet conditions as they arise.

The signal officer at headquarters, in addition to caring for the technical administration and supply of the signal troops, will keep himself informed as to the location of commands, the time and character of projected movements; in short, regarding all actual and probable happenings, so that he may make due provision in advance. He must arrange for the prompt transmission of information received, and for the delivery of all messages. He also makes certain that the military intelligence contained in messages to the commanding general and chief of staff is properly recorded on the map or otherwise graphically so as to be instantly available, and for this purpose should establish a central station at division headquarters, equipped to properly file all messages sent and received, in chronological order and by organizations. This station should also be able to furnish at all times exact information, as to signal stations and location of troops.

The commander, aided by his chief signal officer, must plan and direct, but the signal officers and the men under them must execute; on their energy and ability will depend the value and success of the lines of information.

ESTABLISHING LINES OF INFORMATION—THE DIVISION

Since the Signal Corps is considered as auxiliary troops attached to a division it is best to define its field duties in this connection. While definite rules cannot be laid down for the



TYPE OF RADIO TRACTOR WHICH TRAVELS WITH DIVISION HEADQUARTERS AND IS FIRST PUT IN COMMISSION

establishment of lines of information for a division in the field, there are certain fundamental considerations or general principles to be observed.

The division may be considered under three conditions: in camp, on the march, and in contact with the enemy.

When a division is to be assembled in a certain locality and camp established, an officer is sent ahead to select sites for the encampment of the various units of infantry, cavalry and artillery. Quartermaster officers locate their depots and medical officers the field hospitals. It is then the duty of the signal officer to proceed with the installation of lines of information.

A wireless, or radio set, of the cart or tractor type travels with division, corps and army headquarters and is first put in commission. A central station is next established at division headquarters and connected with the most convenient telegraph and telephone offices through which communication may be established with commercial systems or the base.

The Signal Corps camp is then established with a depot for storing all material needed for the service to be required. Corps or army headquarters are connected by wire or radio, telephone lines carried to the chief quartermaster and surgeon and the various hospitals, depots, and corrals.

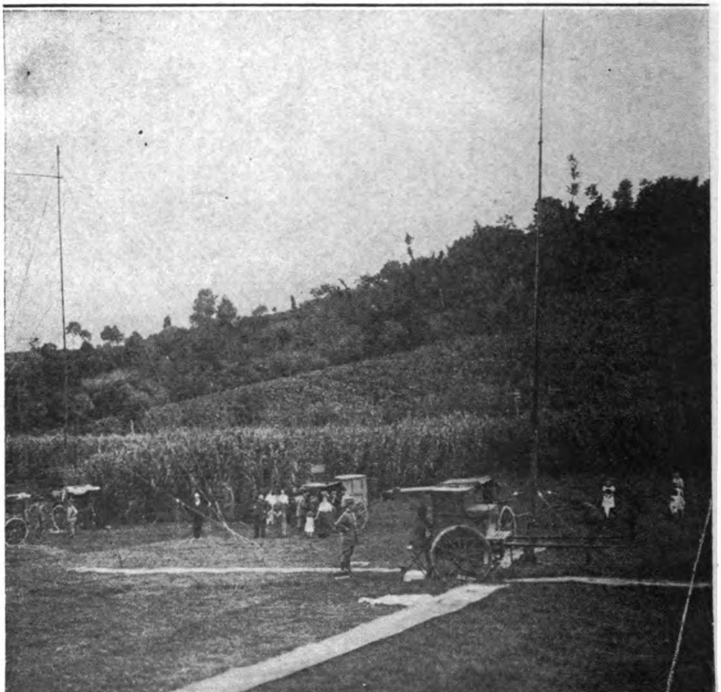
The object to be attained is the connection of every important point with division headquarters, to link the whole command together and connect with the base by wire or radio. As the various units arrive at their camps, telephone or buzzer lines are run from division central to brigade headquarters, through regimental to battalion headquarters.

Between fixed stations within the limits of the divisional camp the telephone is the ordinary means of communication, telegraph and radio being reserved for more distant work. Telephone and telegraph lines are usually carried by lances. In addition to the more permanent lines, temporary buzzer or field wires are usually laid to changing positions, such as outlying observation points, to the outposts and to aero stations.

In camp there should be little difficulty in using fully the lines of information, since the extent and direction of the system are known and the stations are easily found On the march, however, the lines of information become fewer and the stations more difficult to reach. Some general considerations may be noted.

A division on the march must at no time lose electrical connection with its base, through the last station occupied, and for this purpose the pack radio is especially useful. As the advance continues the commanding general designates some position as his own during the day or night and lines are extended forward or communication is maintained by radio with this position, it becoming, so far as the lines of information are concerned, the headquarters.

As radio stations, the buzzer, or field wire advance they should be followed, if practical, by the telegraph train with the necessary material for a lance line to replace the field or buzzer wire, which, if exposed, is liable to injury from passing troops and transport. At times, with good roads and open country the advance is so rapid where a lance line is being erected by trained men, that little, if any, cable need be used on the march. Buzzer wire may follow the general line of advance of the commander by extending from one conspicuous station to another designated by him. The field line, or radio, is used only for rapid work. Radio, when used on the march, is advanced by the leap-frog method; that is, three sections are used, the rear station passing the two preceding and thus constantly maintaining two stations in operation.



A FOREIGN FIELD WIRELESS STATION OF THE CART TYPE, USING TWO MASTS AND HORIZONTAL AERIAL WITH WIRE MATTING COUNTERPOISE

In the advance the units of a command should, so far as possible, be kept in touch with each other; but as these units frequently move by different routes, and as cross lines are impracticable except at halts, field or buzzer wires must stretch from the last field station maintained at the rear to corps headquarters and to brigade and to important commands, as the ribs of a fan expand; here, too, the radio may best be used. If possible, wire communication between the general and detached commands, or cavalry at the flanks, is also maintained in this way, or communication established by means of visual signaling or radio. Visual signaling may be used to advantage during halts when wire lines can quickly be thrown out; and radio, especially of the wheel type, is particularly useful.

When the day's march is over and the division eats and rests, the work of the signal men begins anew. Radio stations must be established and buzzer lines run from the advance guard, from the flank, from the corps headquarters, and from the rear to division headquarters, and still others laid out as already described in a preceding paragraph.

When a retiring movement is begun the lines of information are as few as possible and mainly used to connect the rear guard, probably by radio, with the general commander. Provision is made, however, to recall the flanking parties thrown out at intersecting roads when the rear of the marching columns pass. It is well also to connect retreating columns moving by different roads, and this can be done by wire and radio more readily than in the advance, since lines extending to the front of the retreating force will not ordinarily be in danger of interruption. In the retreat, therefore, central stations may be thrown out far ahead and wires led back like the ribs of a fan to the marching column, as in the advance, to be taken up as the columns pass.

As the period of actual contact with the enemy approaches the most serious of the problems of the lines of information arise. The general commanding must know the terrain and the best means of sending messages across it; he must know the probability of success of the attempts of the enemy to cut the wires, or "jam" a radio, and it is when difficulties arise that every possible means of signaling that offers a chance of success is employed.

As the division approaches the enemy, the commander makes as certain as possible that his lines of information with corps and army headquarters, with supporting and reserve troops, and with the rear, are in order and when actual contact comes, buzzer lines will be carried to brigades, to regiments, and some times to the outposts. For the troops engaged, buzzer lines are carried forward to the firing line, where trained observers with buzzers or the field telephone are placed to send back important information for control of fire.

It may be practicable at the beginning of the action to maintain touch by radio or even by wire between the smaller reserves, the supports, and the main bodies, but the latter is doubtful, since a great multiplicity of wires on the field of battle is hazardous.

When the division is actually engaged against the enemy the commander extends his field or buzzer line to the positions occupied by the infantry and artillery commands. Radio is in general depended upon to keep him in touch with his cavalry. The artillery, in addition to its other lines of information, establishes between batteries a system of fire control, the information being transmitted from fixed stations, captive balloons or airplanes, by radio, field telephone or buzzer, or by visual signals.

The radio is of greatest importance in the field and especially when used at the larger headquarters. Together with the increasingly greater use of the field telephone in directing the fire of heavy artillery, the large scope of the tactical requirements in modern warfare has enormously increased the work of the Signal Corps.

Communication problems are easier with the smaller bodies of troops, but not less important. When operating in an enemy's country, especially if the movements are connected with a boat expedition or with the navy, somewhat less weight must be given to wire communications, and more reliance be placed upon visual signaling and on the portable radio units. With all such expeditions the field acetylene lantern is extremely useful, for its range under favorable conditions is easily 20 miles, and it can be used by hand from a boat if on quiet water.

THE HEADQUARTERS WIRELESS SET ESTABLISHED BY THE JUNIOR AMERICAN GUARD FOR ITS SEMI-PERMANENT CAMP

RECONNAISSANCE, PATROLLING AND SCOUTING

A patrol is a small body of infantry or cavalry sent out from the command at any time to secure information of the enemy and of the country, also to drive off small hostile bodies bent upon observing forces, or blowing up bridges or destroying railroad tracks.

The size of a patrol depends upon its mission; if it is to gain information only it is made as small as possible, allowing two men for each probable message to be sent.

Patrol leaders, usually non-commissioned officers, are selected for their endurance, keen eyesight, ability to think quickly and good military judgment. A patrol leader should be able to read a map, make a sketch and send messages that are easily understood. The leader should have a map, watch, field glass, compass, message blank and pencil.

It is often said that more battles are lost through lack of information about the enemy than from any other cause, and it is the patrols led by non-commissioned officers who must gather almost all this information. A battalion or a squadron stands a very good chance of defeating a regiment if the battalion commander knows all about the size, position and movements of the regiment and his adversary knows but little about the battalion.

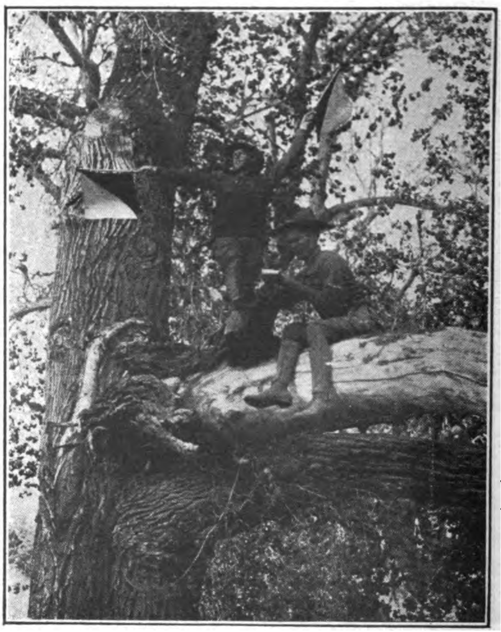
Patrols are usually sent out from the advance party of an advance guard, the rear party of a rear guard, the outguards of an outpost and the flank (extreme right or left) sections, companies or troops of a force, but they may be sent out from any part of the command.

It is of the greatest importance for Signal Corps men to transmit to commanding officers with accuracy and dispatch the information secured by the patrols. A signalman is made doubly efficient by the possession of knowledge required for successful reconnaissance.

ORDERS OR INSTRUCTIONS

The orders or instructions for a patrol must state clearly, whenever possible:

1. Where the enemy is or is supposed to be.
2. Where friendly patrols or detachments are apt to be seen or encountered and what the plans are for the body from which the patrol is sent out.
3. What object the patrol is sent out to accomplish; what information is desired; what features are of especial importance; the general direction to be followed and how long to stay out in case the enemy is not met.
4. Where reports are to be sent.



A QUICK RELAY OF INFORMATION BROUGHT IN BY A SCOUT PATROL

MESSAGES

The skillful patrol leader is particularly adept in preparing his information for transmission; he fully understands when to send a message and how to write it.

Messages should be short and clear, resembling a telegram. If the accounts are long, it takes too much time to write them and they may be easily misunderstood.

The essential information invariably includes when and where things are seen or reported. If haste is required valuable moments should not be lost in writing down the day of the month and minor details. While data of this type is essential as a matter of future reference for formal messages it may be left out if its inclusion should mean slighting the essential points of information of great value to the commanding officer.

The exact location of the enemy should be stated; also whether deployed, marching or in camp; the strength, whether cavalry, infantry or artillery, in fact full details of the information secured. Locations are given by direction and distance from some point which the commanding officer in the rear has knowledge of; reference should not be made to houses or streets which he probably knows nothing of.

It is essential that messages be accurate. Information given should not be reported as a fact, but as a statement made by somebody else; particulars regarding the informant are often added, such as his apparent honesty and the probabilty of his information being correct.

Messages from patrol leaders always end with a short statement of what he is going to do next. For example: "will remain in observation," "will continue north," "will work around to their rear."

It is frequently just as important to send messages that the enemy is not in a certain locality as it is to report his actual whereabouts.

HOW INFORMATION IS SECURED

The patrol leader always tries to discover if one hostile detachment is followed by another; that is, if what can be seen appears to be an advance guard of a larger body not yet in view. The distance between the detachments and their relative size is always important.

The strength of a column may be estimated from the length of time it takes to pass a selected point. An infantry *in column of squads* occupies half a yard per man, cavalry one yard per horse, and artillery in single file twenty yards per gun or caisson (ammunition wagon), a selected point would be passed in one minute by 175 infantry; 110 cavalry at a walk; 200 cavalry at a trot and five guns or caissons. Half of these figures are taken if the force is marching in column of twos.

The direction of march and composition of a column, whether infantry, cavalry or artillery, can be estimated from the length and character of the cloud of dust it makes. Dust from infantry hangs low; from cavalry it is higher, disperses more quickly, and if the cavalry moves rapidly, the upper part of the cloud is thinner; from artillery and wagons, it is of unequal height and disconnected. The effect of the wind blowing the dust must be considered.

The trail of a column also leaves significant signs. Evenly trodden ground indicates infantry; prints of horseshoes mean cavalry, and deep and wide wheel-tracks indicate artillery. If the trail is fresh, the column passed recently; if broad they expected an action and were prepared to deploy. A retreating force makes a broad trail, especially at the start.

The smallest or most insignificant things, such as the number of a regiment on a discarded canteen or collar ornament, may give the most valuable information to a higher commander. For example, these markings might prove to a field general that a certain hostile division, corps, or other force, was in front of him when he thought it had not been sent into the field.

If the reflection of weapons is brilliant the troops are marching toward the observer, otherwise they are probably marching away from him.

Camp noises, such as the rumble of vehicles, cracking whips, neighing horses, braying mules and barking dogs often indicate the arrival or departure of troops.

In abandoned camps indications are found in the remains of camp fires. They show, by their degrees of freshness, whether much or little time elapsed since the enemy left the place, and the quantity of cinders will give an indication of the length of time it was occupied, as well as furnishing a means of estimating the force approximately, ten men being allowed to each fire.

A knowledge of the limits of vision is valuable. On a clear day a man with good eyesight can see:

At a distance of 9 to 12 miles, church spires and towers.
At a distance of 5 to 7 miles, windmills.
At a distance of 2 to 2½ miles, chimneys of light color.
At a distance of 2000 yards, trunks of large trees.
At a distance of 1000 yards, single posts.
At 500 yards, the panes of glass in a window.

Troops are visible at 2000 yards, at which distance a mounted man looks like a mere speck; at 1200 yards infantry can be distinguished from cavalry; at 1000 yards line of men looks like a broad belt; at 600 yards the files of a squad can be counted, and at 400 yards the movements of arms and legs can be plainly seen.

FACTS TO OBTAIN

Roads. Their direction, their nature (macadamized, corduroy, plank direct, etc.), their condition of repair, their grade, the nature of crossroads, and the points where they leave the main roads; their borders (woods, hedges, fences or ditches), the places at which they pass through defiles, cross heights or rivers, and where they intersect railroads, their breadth (whether suitable for column of fours or platoons, etc.)

Railroads. Their direction, gauge, the number of tracks, stations and junctions, their grade, the length and height of the cuts, embankments and tunnels.

Bridges. Their position, their width and length, their construction (trestle, girder, etc.), material (wood, brick, stone or iron), the roads and approaches on each bank.

Rivers and Other Streams. Their direction, width and depth, the rapidity of the current, liability to sudden rises and the highest and lowest points reached by the water, as indicated by drift wood, etc., fords, the nature of the banks, kinds, position and number of islands at suitable points of passage, heights in the vicinity and their command over the banks.

Woods. Their situation, extent and shape; whether clear or containing underbrush; the number and extent of "clearings" (open spaces); whether cut up by ravines or containing marshes, etc.; nature of roads passing through them.

Canals. Their direction, width and depth; condition of towpaths; locks and means of protecting or destroying them.

Telegraphs. Whether they follow railroads or common roads; stations, number of wires.

Villages. Their situation (on a height, in a valley or on a plain); nature of the surrounding country; construction of the houses, nature (straight or crooked) and width of streets; means of defense.

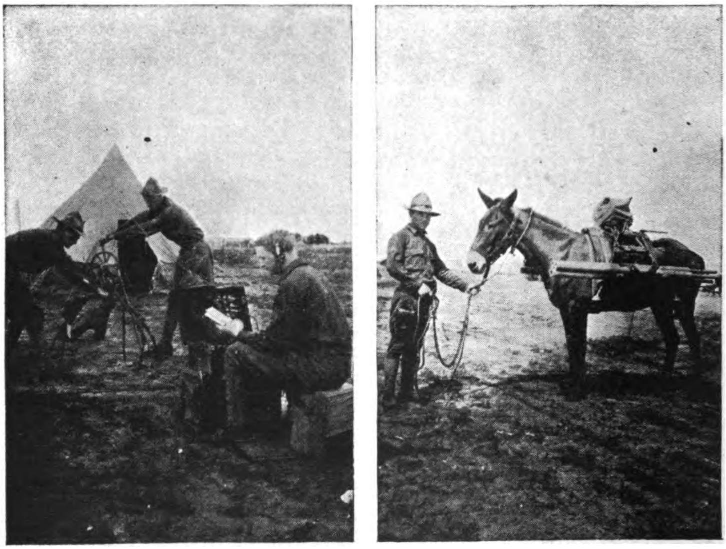
Defiles. Their direction; whether straight or crooked; whether heights on either side are accessible or inaccessible; nature of ground at each extremity; width (frontage of column that can pass through.)

Ponds and Marshes. Means of crossing; defensive use that might be made of them as obstacles against enemy; whether the marshy grounds are practicable for any or all arms.

Springs and Rivulets. Nature of approaches; whether water is drinkable and abundant.

Valleys. Extent and nature; towns, villages, hamlets, streams, roads and paths therein; obstacles offered by or in the valley, to the movement of troops.

Heights. Whether slopes are easy or steep; whether good defensive positions are offered; whether plateau is wide or narrow; whether passages are easy or difficult; whether the ground is broken or smooth, wooded or clear.



THE PACK STATION OPEN AND WORKING, AND THE GENERATOR MULE WITH MAST SECTION

MILITARY MAP READING

When you pick up a map, the first question is: Where is the north? This can usually be told by an arrow (see fig. 1) which will be found in one of the corners of the map, and which points to the true north—the north of the north star.

On some maps no arrow is to be found. The chances are a hundred to one that the north is at the top of the map, as it is on almost all printed maps. But you can only assure yourslf of that fact by checking the map with the ground it represents. For instance, if you ascertain that the city of Philadelphia is due east of the city of Columbus, then the Philadelphia-Columbus line on the map is a due east-and-west line, and establishes at once all the other map directions.

Let it be understood that the map represents the ground as nearly as it can be represented on a flat piece of paper. If you are standing up facing the north, your right hand will be in the east, your left in the west, and your back to the south. It is the same with a map; if you look across it in the direction of the arrow—that is, toward its north—your right hand will be toward what is east on the map; your left hand to the west; the south will be at the bottom of the map.

There is another kind of an arrow that sometimes appears on a map. It is like the one in figure 2, and points not to the true north, but to the magnetic north, which is the north of the compass. Though the compass needle, and therefore the arrow that represents it on the map, does not point exactly north, the deviation is, from a military point of view, slight, and appreciable error will rarely result through the use of the true north in the solution of any military problems.

Should you be curious to know the exact deviation, consult your local surveyor or any civil engineer.

Both arrows may appear on your map. In that case disregard the magnetic arrow unless you are using the map in connection with a compass.

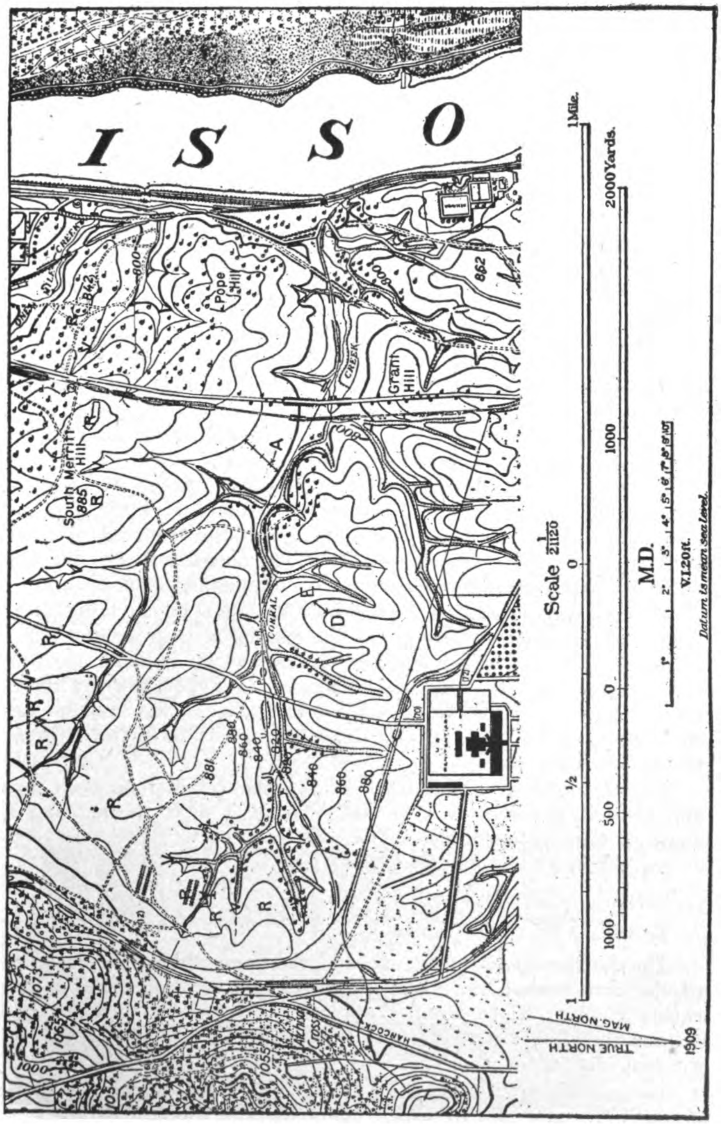
If a map is being used on the ground, the first thing to be done is to put the lines of the map parallel to the real outlines of the ground forms, and roads, fences, railroads, etc., that the map shows; for the making of a map is no more than the drawing on paper of lines parallel to and proportional in length to real directions and distances on the ground.

For instance, the road between two places runs due north and south. Then on the map a line representing the road will be parallel to the arrow showing the north and will be proportional in length to the real road. In this way a map is a picture, or, better, a bare outline sketch; and, as we can make out a picture, though it be upside down, or crooked on the wall, so we can use a map that is upside down or not parallel to the real ground forms. But it is easier to make out both the picture and the map if their lines are parallel to what they represent. So in using a map on the ground the lines are always placed parallel to the actual features they show. This is easy if the map has an arrow.

If the map has no arrow, you must locate some objects or features on the ground, and on the map, their representations. Draw on the map a line connecting any two of the features; place this line parallel to an imaginary line through the two actual features located, and your map will be correctly placed. Look to it that you do not reverse on the map the positions of the two objects or features, or your map will be exactly upside down.

When the map has been turned into the proper position—that is to say, "oriented"—the next thing is to locate on the map your position. If you are in the village of Easton and there is a place on the map labeled Easton, the answer is apparent. But if you are out in the country, at an unlabeled point that looks like any one of a dozen other similar points, the task is more complicated. In this latter case you must locate and identify, both on the map and on the ground, other points—hills, villages, peculiar bends in rivers, forests—any ground features that have some easily recognizable peculiarity and that you can see from your position.

Suppose, for instance, you were near Leavenworth and wanted to locate your exact position, of which you are uncertain. You refer to the map, and, looking about, you see southwest from where you stand the United States Penitentiary; also, halfway between the south and the southeast—south-southeast a sailor would say—the reservoir (rectangle west of "O" in "Missouri"). Having oriented your map, draw on it a line from the map position of the reservoir toward its actual position on the ground. Similarly draw a line from the map position of penitentiary toward its actual position.



MILITARY MAP OF THE VICINITY OF FORT LEAVENWORTH, USED HERE FOR REFERENCE

Prolong the two lines until they intersect; the intersection of the lines will mark the place where you stand—south Merritt Hill.

This method consists merely in drawing on the map lines that represent the lines of sight to known and visible places. The lines pass through the map position of the places you see and are parallel to the actual lines of sight; therefore they are the map representations of the lines of sight, and their intersection is the map position of the eye of the observer.

After this orientation and location of position, one can deduce from the map everything there is to know in regard to directions. In this respect, study of the ground itself will show no more than will study of the map.

After "What direction?" comes "How far?" To answer this, one must understand that the map distance between any two points shown bears a fixed and definite relation or proportion to the real distance between the two points.

For instance: We measure on a map and find the distance between two points to be 1 inch. Then we measure the real distance on the ground and find it to be 10,000 inches; hence the relation between the map distance and the real distance is 1 to 10,000 or 1-10000. Now, if the map is properly drawn the same relation will hold good for all distances, and we can obtain any ground distance by multiplying by 10,000 the corresponding map distance.

This relation need not be 1-10000, but may be anything from 1-100 that an architect might use in making a map or plan of a house up to one over a billion and a half, which is about the proportion between map and real distances in a pocket-atlas representation of the whole world on a 6-inch page. Map makers call this relation the "scale" of the map and put it down in a corner in one of three ways.

For the sake of an illustration, say the relation between map and ground distances is 1 to 100; that is, 1 inch on the map is equal to 100 on the ground. The scale may be written:

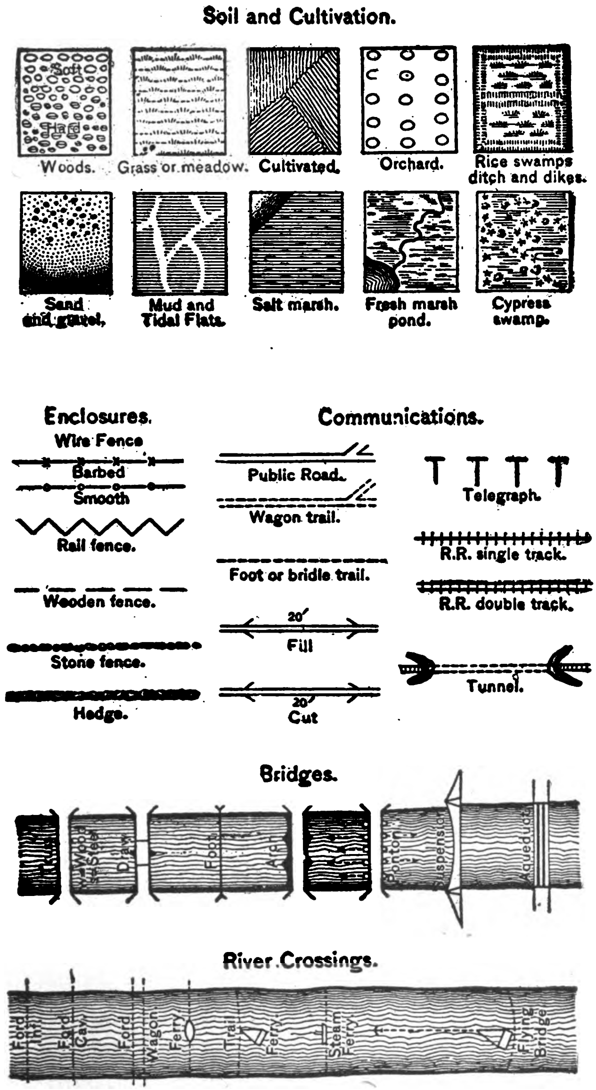
First. 1 inch equals 100.

Second. 1-100.

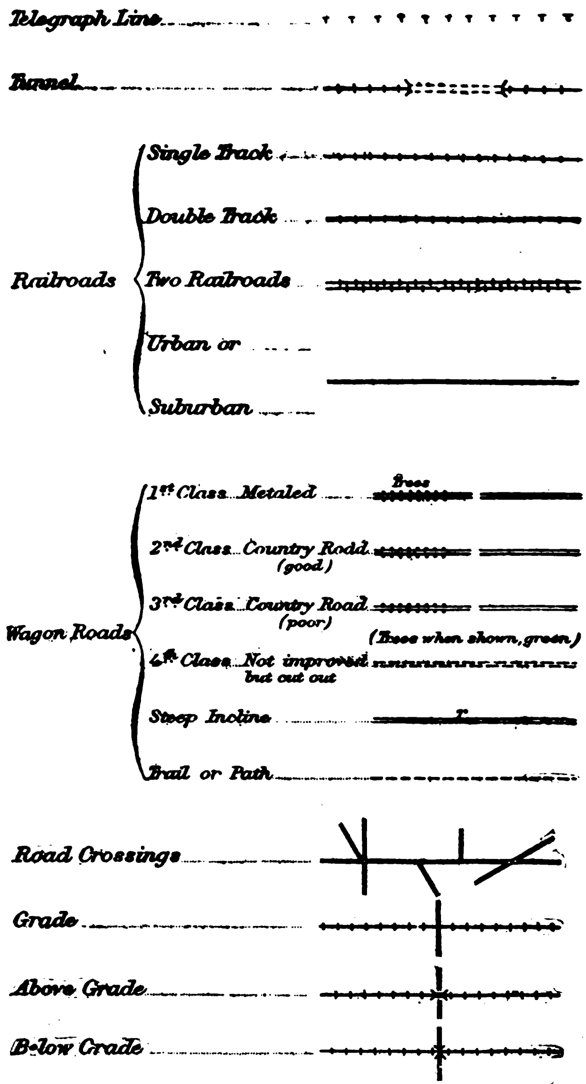
Third. As shown by figure 3.

These expressions mean one and the same thing. A variation of the first method on a map of different scale might be: 1 inch equals 1 mile. Since a mile contains 63,360 inches, then the real distance between any two points shown on the map is 63,360 times the map distance.

To find the ground distance by the third kind of scale, copy it on the edge of a slip of paper, apply the slip directly to the map, and read off the distance; and so we answer the question, "How far?"

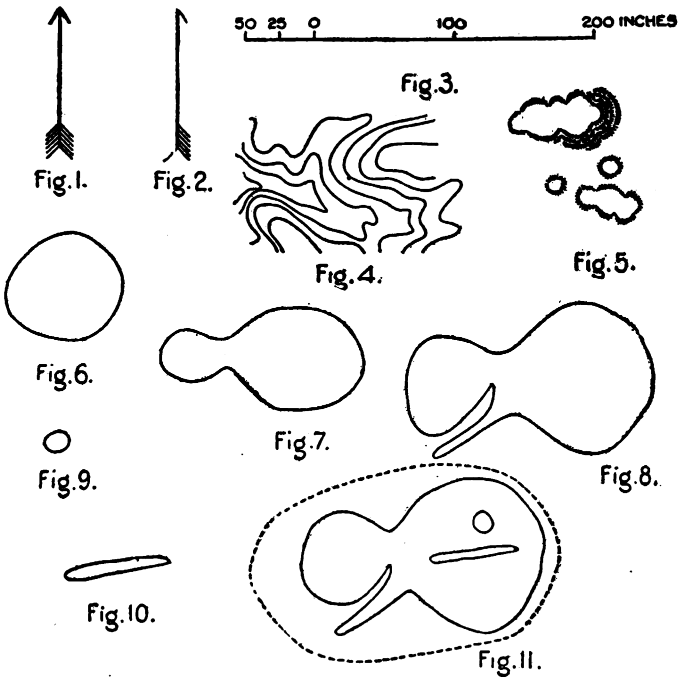


CONVENTIONAL SIGNS FOR MILITARY MAPS



CONVENTIONAL SIGNS FOR MILITARY MAPS

After direction and distance comes the interpretation of the signs, symbols, and abbreviations on the map. Those authorized are given, but there are a good many other conventional signs in common use. A key to them is published by the War Department and is called "Conventional Signs, United States Army." From these you read at once the natural and artificial features of the country shown on your map. It should be borne in mind that



ELEMENTARY GUIDE FOR THE STUDY OF MAP CONTOURS

these conventional signs are not necessarily drawn to scale, as are the distances. They show the position and outline of the features, rather than the size. This, for the reason that many of the features shown, if drawn to scale, would be so small that one could not make them out except with a magnifying glass. If the exact dimensions are of any importance they will be written in figures on the map. For instance, bridges.

In addition to the conventional signs, we have *contours* to show the elevations, depressions, slope, and shape of the ground.

Abroad, ***hachures*** are much used, but they serve only to indicate elevation, and as compared to contours are of little value. Contours resemble the lines shown in figure 4.

Hachures are shown in figure 5, and may be found on any European map. They simply show slopes and, when carefully drawn, show steeper slopes by heavier shading and gentler slopes by the fainter hachures. The crest of the mountain is within the hachures. (See fig. 5.)

Contours

A certain student when asked by his instructor to define "space" said: "I have it, sir, in my head, but can not put it into words." The instructor replied: "I suppose that under those circumstances, Mr. ———, the definition really would not help much."

And so it is with contours; the definition does not help much if you know a contour when you meet it on a map. For examples of contours turn to the map and, starting at the United States Penitentiary, note the smooth, flowing, irregular curved lines marked 880, 860, 840, 860, etc.

The only other lines on the map that at all resemble contours are stream lines, like "Corral Creek," but the stream lines are readily distinguished from contours by the fact that they cross the contours squarely, while the contours run approximately parallel with each other. Note the stream line just to the west of South Merritt Hill.

The contours represent lines on the ground that are horizontal and whose meanderings follow the surface, just as the edge of a flood would follow the irregularities of the hills about it. Those lines that contours stand for are just as level as the water's edge of a lake, but horizontally they wander back and forth to just as great a degree.

The line marked 880 at the penitentiary passes through, on that particular piece of ground, every point that is 880 feet above sea level. Should the Missouri River rise in flood to 880 feet, the penitentiary would be on an island, the edge of which is marked by the 880 contour.

Contours show several things; among them the height of the ground they cross. Usually the contour has labeled on it in figures the height above some starting point, called the ***datum plane*** —generally sea level. If, with a surveying instrument, you put in on a piece of ground a lot of stakes, each one of which is exactly the same height above sea level—that is, run a line of levels—then make a map showing the location of the stakes, a line drawn on the map through all the stake positions is a contour and shows the position of all points of that particular height.

On any given map all contours are equally spaced in a vertical direction, and the map shows the location of a great number of points at certain fixed levels. If you know the vertical interval between any two adjacent contours, you know the vertical interval for all the contours on that map, for these intervals on a given map are all the same.

With reference to a point through which no contour passes, we can only say the point in question is not higher than the next contour up the hill, nor lower than the next one down the hill. For the purposes of any problem, it is usual to assume that the ground slopes evenly between the two adjacent contours, and that the vertical height of the point above the lower contour is proportional to its horizontal distance from the contour, as compared to the whole distance between the two contours. For instance, on the map, find the height of point A. The horizontal measurements are as shown on the map. The vertical distance between the contours is 20 feet, A is about one-quarter of the distance between the 800 and the 820 contours, and we assume its height to be one-quarter of 20 feet (5 feet) higher than 800 feet. So the height of A is 805 feet.

The vertical interval is usually indicated in the corner of the map by the letters "V. I." For instance, V. I.=20 feet.

On maps of very small pieces of ground, the V. I. is usually small—perhaps as small as 1 foot; on maps of large areas on a small scale it may be very great—even 1,000 feet.

Contours also show *slopes*. It has already been explained that from any contour to the next one above it the ground rises a fixed number of feet, according to the vertical interval of that map. From the scale of distances on the map the horizontal distance between any two contours can be found. For example:

On the map, the horizontal distance between D and E is 90 yards, or 270 feet. The vertical distance is 20 feet the V. I. of the map. The slope then is $20/270 = 1/13.5 = 7\frac{1}{2}\% = 4\frac{1}{2}^\circ$ in all of which different ways the slope can be expressed.

On a good many contoured maps a figure like this will be found in one of the corners:

On that particular map contours separated by the distance

on the vertical scale show a slope of 1°. A slope of 1° is a rise of 1 foot in 57. To use this scale of slopes copy it on the edge of a piece of paper just as you did the scale of distances and apply it directly to the map.

You will notice that where the contours lie closest the slope is steepest; where they are farthest apart the ground is most nearly flat.

It has already been set forth how contours show height and slope; in addition to this they show the shape of the ground, or *ground forms.* Each single contour shows the shape at its particular level of the hill or valley it outlines; for instance the 880 contour about the penitentiary shows that the hill at that level has a shape somewhat like a horse's head. Similarly every contour on the map gives us the form of the ground at its particular level, and knowing these ground forms for many levels we can form a fair conception of what the whole surface is like.

A round contour like the letter O outlines a round ground feature; a long narrow one indicates a long narrow ground feature.

Different hills and depressions have different shapes. A good many of them have one shape at one level and another shape at another level, all of which information will be given you by the contours on the map.

One of the ways to see how contours show the shape of the ground is to pour half a bucket of water into a small depression in the ground. The water's edge will be exactly level, and if the depression is approximately round, the water's edge will also be approximately round. The outline will look something like figure 6.

Draw roughly on a piece of paper a figure of the same shape and you will have a contour showing the shape of the bit of ground where you poured your water.

Next, with your heel gouge out on one edge of your little pond a small round bay. The water will rush in and the watermark on the soil will now be shaped something like figure 7.

Alter your drawing accordingly, and the new contour will show the new ground shape.

Again do violence to the face of nature by digging with a stick a narrow inlet opening out of your miniature ocean, and the watermark will now look something like figure 8.

Alter your drawing once more and your contour shows again the new ground form. Drop into your main pond a round clod and you will have a new watermark, like figure 9, to add to your drawing. This new contour, of the same level with the one showing the limit of the depression, shows on the drawing the round island.

Drop in a second clod, this time long and narrow; the watermark will be like figure 10, and the drawing of it, properly placed, will show another island of another shape. Your drawing now will look like figure 11.

It shows a depression approximately round, off which open a round bay and a long narrow bay. There is also a round elevation and a long narrow one; a long, narrow ridge, jutting out between the two bays, and a short, broad one across the neck of the round bay.

Now flood your lake deeply enough to cover up the features you have introduced. The new water line, about as shown by the dotted line in figure 11, shows the oblong shape of the depression at a higher level; the solid lines show the shape farther down; the horizontal distance between the two contours at different points shows where the bank is steep and where the slope is gentler.

Put together the information that each of these contours gives you, and you will see how contours show the shape of the ground. On the little map you have drawn you have introduced all the varieties of ground forms there are; therefore all the contour forms.

The contours on an ordinary map seem much more complicated, but this is due only to the number of them, their length, and many turns before they finally close on themselves. Or they may close off the paper. But trace each one out, and it will resolve itself into one of the forms shown in figure 11.

Just as the high-tide round the continents of North and South America runs a long and tortuous course, but finally closes back on itself, so will every contour do likewise. And just as truly as every bend in that high-tide mark turns out around a promontory, or in around a bay, so will every bend in a contour stand for a hill or a valley pointing to the lowlands if it be a hill, and to the height if it mark a valley.

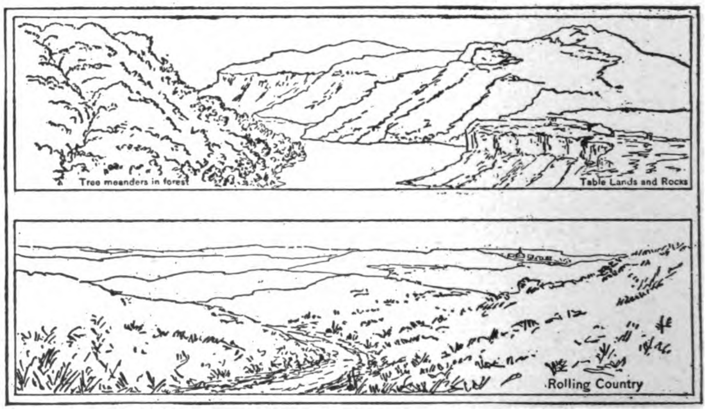
If the map embrace a whole continent or an island, all the contours will be of closed form, as in figure 11, but if it embrace only a part of the continent or island, some of the contours will be chopped off at the edge of the map, and we have the open form of contours, as we would have if figure 11 were cut into two parts.

The closed form may indicate a hill or a basin; the open form, a ridge or a valley; sometimes a casual glance does not indicate which.

Take up, first, the contour of the open type. If the map shows a stream running down the inside of the contour, there is no difficulty in saying at once that the ground feature is a valley; for instance, V, V, V, and the valley of Corral Creek on the map. But if there is no stream line, does the contour bend show a valley or a ridge?

First of all, there is a radical difference between the bend of a contour round the head of a valley and its bend round the nose of a ridge.

Compare on the map the valleys V and the ridges R. The bend of the contour round the head of the valley is much sharper than the bend of the contour round the nose of the ridge. This is a



OUTLINE LANDSCAPE PRACTICE SKETCHES USEFUL FOR GRASPING THE ESSENTIALS OF TERRAIN

general truth, not only in regard to maps, but also in regard to ground forms. Study any piece of open ground and note how much wider are the ridges than the valleys. Where you find a "hog back" or "devil's backbone," you have an exception to the rule, but the exceptions are not frequent enough to worry over.

To tell whether a given point is on a ridge or in a valley, start from the nearest stream shown on the map and work across the map to the undetermined point, keeping in mind that in a real trip across the country you start from the stream, go up the hill to the top of a ridge, down the other side of the hill to a watercourse, then up a hill to the top of a ridge, down again, up again, and so on. That is all traveling is—valley, hill, valley, hill, valley—though you wander till the crack o' doom. And so your map travels must go—valley, hill, valley, hill—till you run off the map or come back to the starting point.

On the map, follow the R-V line, V indicating valley and R ridge or hill. Note first the difference in sharpness in the contour bends; also how the valley contours point to the highland and the ridge contours to the lowland.

The streams flow down the valleys, and the sharp angle of the contour points always *UP* stream. Note also how the junction of a stream and its tributary usually makes an angle that points *down* stream.

"Which way does this stream run?"

Water flows down hill. If you are in the bed of a stream, contours representing higher ground must be to your right and to your left. Get the elevations of these contours. Generally the nearest contour to the bank of the stream will cross the stream and there will be an angle or sharp turn in the contour at this crossing. If the point of the angle or sharp turn is toward you, you are going downstream; if away from you, you are going upstream.

If the contours are numbered, you have only to look at the numbers to say where the low and where the high places are; but to read a map with any speed one must be quite independent of these numbers. In ordinary map reading look, first of all, for the stream lines. The streams are the skeleton upon which the whole map is hung. Then pick out the hilltops and ridges and you have a body to clothe with all the details that will be revealed by a close and careful study of what the map maker has recorded.

As to closed contours, they may outline a depression or a hill. On the map, "881" or "885" might be hills or ponds, as far as their shape is concerned. But, clearly, they are hills, for on either side are small streams running *away* from them. If they were ponds the stream lines would run *toward* the closed contours. The test of "hill, valley, hill," will always solve the problem when there are not enough stream lines shown to make evident at once whether a closed contour marks a pond or a hill. Look in the beginning for the stream lines and valleys, and, by contrast, if for no other reason, the hills and ridges at once loom up.

To illustrate in armories or drill halls the subject of contours to aid those who have difficulty in reading contoured maps the following is suggested:

1. Secure modeling clay and build a mound.

2. Use wire and slice this mound horizontally at equal vertical intervals into zones; then insert vertical dowels through the mound of clay.

3. Remove the top zone, place on paper, and draw outline of the bottom edge. Trim your paper roughly to the outline drawn Indicate where the holes made by the dowels pierce the paper.

4. Do the foregoing with each zone of your mound.

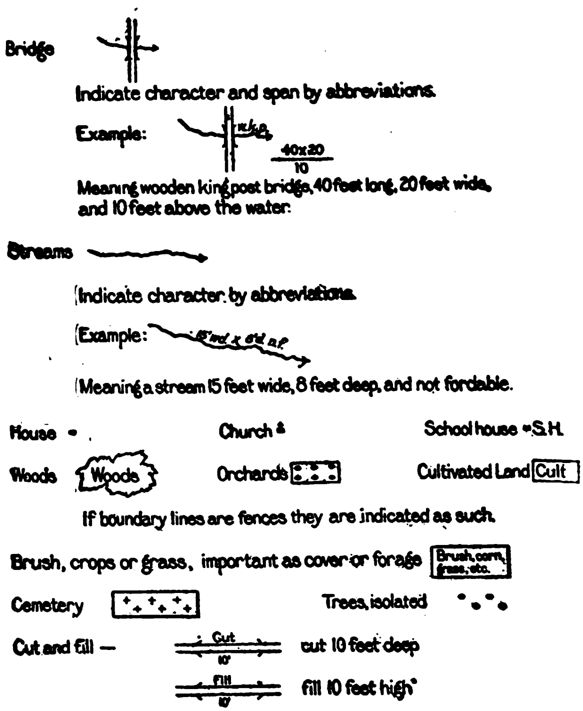
5. Place these papers in proper order on dowels similarly placed to those in original mound at, say, 1 inch vertical intervals. A skeleton mound results.

6. Replace the zones of the clay mound and form the original clay mound along the side of skeleton mound.

7. Now force all the paper sheets down the dowels onto the bottom sheet, and we have a map of clay mound with contours.

Note.—One-inch or 2-inch planks can be made into any desired form by the use of dowels and similar procedure followed.

It is frequently asked, "What should I see when I read a map?" and the answer is given, "The ground as it is." This is not true any more than it is true that the words, "The valley



of the Meuse," bring to your mind vine-clad hills, a noble river, and green fields where cattle graze. Nor can any picture ever put into your thought what the Grand Canyon really is. What printed word or painted picture can not do, a map will not. A map says to you, "Here stands a hill," "Here is a valley," "This stream runs so," and gives you a good many facts in regard to them. But you do not have to "see" anything, any more than you have to visualize Liege in order to learn the facts of its geography. A map sets forth cold facts in an alphabet all its own, but an easy alphabet, and one that tells with a few curving lines more than many thousand words could tell.

FIELD MAPS AND SKETCHES

The following abbreviations, and the signs on preceding page, are authorized for use on field maps and sketches. For more elaborate map work the authorized conventional signs as given in the manual of "Conventional Signs, United States Army Maps," are used.

Abbreviations other than those given should not be used.

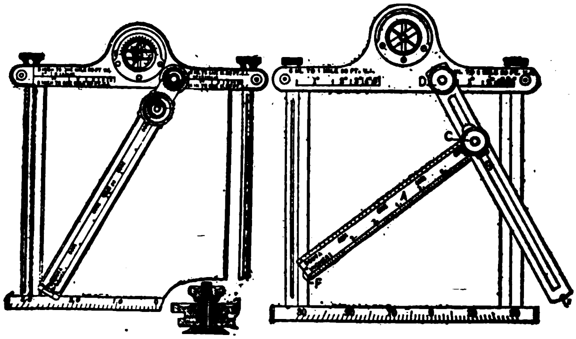
ABBREVIATIONS

A:	Arroyo	G. S.	General Store	Pt.	Point
abut.	Abutment	gir.	Girder	q. p.	Queen-post
Ar.	Arch	G. M.	Gristmill	R.	River
b.	Brick	I.	Iron	R. H.	Roundhouse
B. S.	Blacksmith Shop	I.	Island	R. R.	Railroad
bot.	Bottom	Jc.	Junction	S.	South
Br.	Branch	k. p.	King-post	s.	Steel
br.	Bridge	L.	Lake	S. H.	Schoolhouse
C.	Cape	Lat.	Latitude	S. M.	Sawmill
cem.	Cemetery	Ldg.	Landing	Sta.	Station
con.	Concrete	L. S. S.	Life-Saving Sta.	st.	Stone
cov.	Covered	L. H.	Lighthouse	str.	Stream
Cr.	Creek	Long.	Longitude	T. G.	Tollgate
d.	Deep	Mt.	Mountain	Tres.	Trestle
cul.	Culvert	Mts.	Mountains	tr.	Truss
D. S.	Drug Store	N.	North	W. T.	Water Tank
E.	East	n. f.	Not fordable	W.W.	Water Works
Est.	Estuary	P.	Pier	W.	West
f.	Fordable	pk.	Plank	w.	Wood
Ft.	Fort	P. O.	Post Office	wd.	Wide

MILITARY SKETCHING FOR BEGINNERS

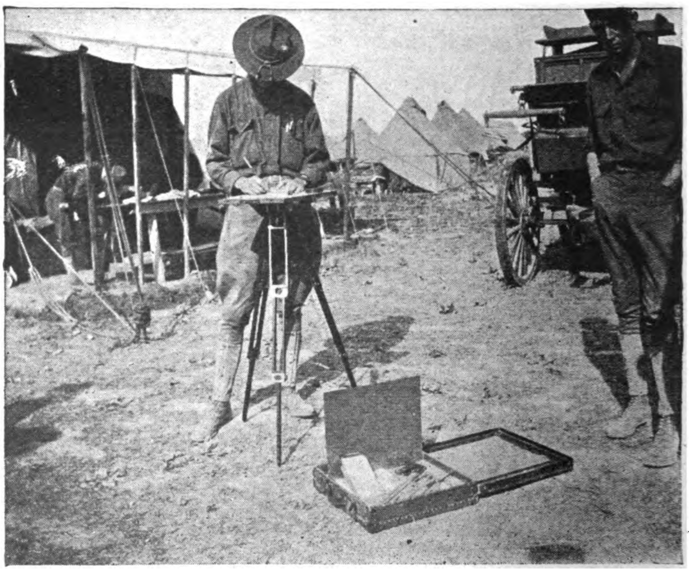
Pencils are to be sharpened and an eraser handy; only experts can sketch with dull pencils. Use hard pencils when learning to sketch.

Leave out of your sketch the minor details that are too small to be shown on the scale at which you are sketching. If you are making a sketch on a scale of 3 inches = 1 mile, do not try to show each house in a row; simply indicate the row of houses by putting down several distinct conventional signs for houses in a row. And don't try to show every little "cut" through which the road may run. Only use about one sign to the inch for telegraph or telephone lines, for wire fences, and similar details.



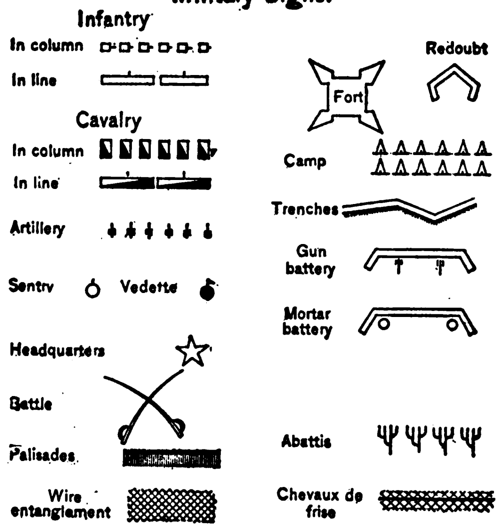
THE SKETCHING CASE USED IN THE ARMY

When practising, plot only the route over which you walk, indicating it by a single line. When you can do this with facil-



PREPARING AN ELEMENTARY MILITARY MAP OF A NEW CAMP LOCATION

Military Signs.



Miscellaneous.

Regimental Headquarters .... 23 I

Brigade " .... 2B 4D★3C

Division " .... 5D★3C

Signal Corps ....

Engineer Corps ....

Quarter-master .... ●

Commissary ....

ity, go back over one of these plotted routes and fill in the woods, houses, streams and the other large features.

As a beginner, sketch the same ground several times over—at least three or four times. Compare the result for practice in accuracy.

Always try to compare your finished sketch with an accurate map of the ground, if one is obtainable. Try to practice on ground of which you can obtain a map.

Make each course—that is, the distance you go between points where the direction of your route changes—as long as possible.

Do not try to contour until you are expert at making a sketch showing all the flat details (roads, streams, woods, houses, etc.).

Never try to "sketch in" the contours until you have plotted the stream lines or the direction of the valleys and ravines. The contours are sketched around or fitted to the drainage system; not the drainage system to the contours.

Always "size up" ground before you sketch it. Take a general view, noticing the drainage system (the direction in which the streams flow or ravines run), the prominent hills and ridges, the direction the roads run, and similar details.

SIGNAL TROOPS IN FIELD SERVICE

Position

The position of signal troops is governed by the tactical requirements of the situation. Detachments of signal troops must necessarily, whether on the march, in camp, or in combat, be near the commanding officer of the troops with whom communication must be maintained.

To this end commanding officers of signal troops will make such distribution of their command as will enable signal troops to best secure this result without interfering with the function of other troops.

The position of the signal officer is usually with the commanding general or with the commanding officer of the unit for which he is furnishing lines. From this point he can get a grasp of the situation and be able to direct the operations of his platoons and sections to the best advantage. All contemplated changes in the location of wire carts and stations are reported to him.

Marches

With new or untrained troops the process of hardening must be gradual. Marches should begin with a distance of 2 or 3 miles and increase as the men become accustomed to bearing arms and equipment without fatigue.

A long march should not be made with untrained troops.

Special attention should be paid to the fitting of shoes and the care of feet. Shoes should not be too wide or too short. Sores and blisters on the feet should be promptly dressed during halts. At the end of the march, feet should be bathed and dressed; the socks, and, if practicable, the shoes should be changed.

Drinking water on the march should be avoided; its use should in general be confined to gargling the mouth and throat or to an occasional small drink at most.

Marches should not begin before an hour after daylight.

A halt of 15 minutes should be made after the first half or three-quarters of an hour of marching, thereafter a halt of 10 minutes is made in each hour. The number and length of halts may be varied, according to the weather, the condition of the roads, and the equipment carried.

The position of companies in the battalion is ordinarily changed so that each company in turn leads, for the reason that marching at the rear of the column is more disagreeable and fatiguing than marching at the front.

An officer of each company marches in its rear to prevent undue elongation and straggling.

Chiefs of platoons and of sections, without waiting for express instruction, give such orders as may be necessary for helping a wagon out of difficulties. All men of the section may be used for this purpose if necessary.

When an accident happens to a wagon it is pulled out of the column, if possible, so as not to interrupt the march; otherwise, sections in rear pass it by on the most convenient flank, so as not to delay the march. Its place in the column is resumed when the damage is repaired, as soon as it is possible to pass the intervening sections. If a section wire cart or wagon is damaged, the chief of section, with the necessary number of men, remains with it until repaired, unless the damage is beyond repair.

Special attention should be paid to the rate of march. It is greater for trained than for untrained troops; for small commands than for large ones; for lightly burdened than for heavily burdened troops. It is greater during cool, than during hot weather. Highly trained troops seldom march at a rate greater than from 2¾ to 3 miles per hour.

Closing up during a halt, or changing gait to gain or lose distance should be prohibited.

Camping on the March

Camping, while on the march, is in line, column of platoons, or sections, according to the nature of the available camping space. The company is formed as desired, with proper intervals of distances, and the platoons or sections, as the case may be, turned over to the chiefs of the units into which the camp is established.

The wagons are parked with about 15 yards interval, on the most convenient flank. The wagons of the train are parked in a similar manner 15 yards in rear of them. The section picket lines are carried on the carts. While the men individually mounted are unsaddling the other men attach the picket lines. The horses of each section are tied in the space between the carts, commencing with the first section. This work is supervised by the company commander.

The harness is placed on the footboards and covered with the paulins used for protecting carts and instruments. Saddles are placed alongside the tongues under the paulins, and this equipment protected from the weather by the cart paulins.

Should it become necessary to camp in the road, the shelter tents can be placed to one side in line and the picket line extended from one flank. The officers' tents are placed in the locality most available and the kitchen in the most convenient place for the men. Tents are faced according to prevailing weather. Men not assigned to sections pitch tents with the train.

On arriving in camp, sinks are dug at once. If the march is to be resumed the following day, some sanitary arrangement may be made; ordinarily sinks with brush screens will be necessary.

Camp is broken in the following order: Immediately after reveille the men feed their horses and, if time permits, groom for 20 minutes, each man caring for his own horse.

Tents are struck and rolls made, which is followed by breakfast, then water call, followed by boots and saddles. The picket lines are placed upon the carts and the company formed in column of sections or as directed by the captain.

In maintaining extended lines, the men camp in pairs, squads, or sections, as the nature of the duty dictates.

For camps of any duration, or permanent camps, instructions contained in "Field Service Regulations" will be followed.

FIELD LINES

General Provisions

From instruction with the buzzer the work will be carried on in actually laying field lines on the drill ground or along such roads as are available. The units for this work will be the section, platoon, and company. Whether operating alone or in combined training each section lays, operates, and maintains its own line.

Two kinds of wire are provided for this work: The 11-strand field wire, which will be used when possible, and the 3-strand buzzer wire, which will be used only as hereinbefore prescribed.

The Wire Cart

The means provided for laying field lines is a wire cart, with drums and an automatic gear for picking up the wire when driving back over the line. This is supplemented by carriers for buzzer wire to be used by men on foot or mounted.

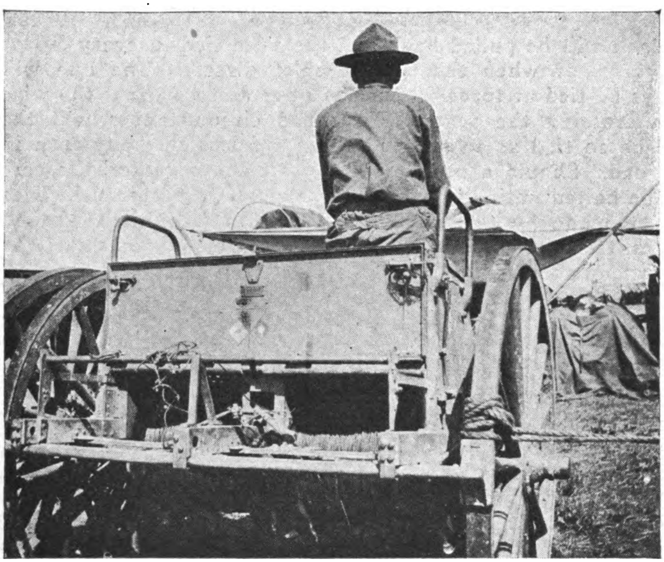
Immediately after each drill, maneuver, or other formation, the wire cart will be thoroughly inspected by the chief of section. Notes will be made of necessary repairs, and turned in by him to the company commander. An inspection will be made prior to each formation by the chief of section, to see that all the bearings of the cart are clean and oiled, except the clutch, which will be bright and free from oil. He will see that the axles are greased and the harness in repair; that oil cans are full, and that there is no sediment in the holes to prevent the oil from reaching the bearings.

To Clean the Wire Cart

Always after the cart has been used, after each formation, before the cart is parked, the drivers and cart operators will thorougly clean the chains, friction clutch, and sprocket wheels with a stiff brush and rough cloth, removing all dust, dirt, and hard oil. After cleaning, these parts will be gone over with a well-oiled cloth to prevent rust.

Once each week, or when directed by the company commander, the section will be assembled, and, under the supervision of the chief of section, the cart given a thorough washing and cleaning throughout. All dirt and dust will be removed from the woodwork with a broom or stiff brush, and dust and oil from the metal parts with a cloth. Hose will then be used to wash the cart, if available; otherwise pails and sponges will be used. The metal parts will be wiped dry before oiling.

Occasionally the friction clutch will be taken apart under the supervision of the chief of section and cleaned with gasoline. A light oil will be sparingly used before assembling to prevent rust.



THE WIRE CART SHOWING, IN THE SHADOW UNDERNEATH THE SEAT, THE DRUMS WHICH CARRY THE WIRE FOR FIELD COMMUNICATION

In the field paulins will be placed over the carts after use, and not removed until the cart is again used. These paulins will be folded and placed on the chest when the cart is in action.

Manipulation of the Wire Cart

The manipulation of the machinery of the cart for handling wire will be a part of the duty of the cart driver, unless an operator be placed on the cart, in which case the latter will do this. He will stop the cart at command or signal from the chief of section.

The reel will always be stopped before a march to the rear is taken up.

In spooling up wire the reel should be stopped when the loop gets too short and the clutch should be thrown in before the loop gets too long.

Laying the Lines

Slack will be pulled back and the wire tied in every 500 or 600 yards, or when the section chief directs. The line will always be tied at turns, in such manner as to prevent the wire from crossing the roads. Under no circumstances will the wire be so tied as to subtend the arc formed by any turn in the road. Should a number of turns come together, the cart will be halted until the work is satisfactorily performed. Ties will be made by two round turns and a half hitch, around bushes, trees, or anything fixed in the ground, and as close to the ground as possible.

At points where the line crosses roads or at crossroads the line will be raised overhead or buried, unless the road is little traveled, when it may be tied on each side with plenty of slack. When there is nothing to tie to, stones will be placed on the wire on either side of the road.

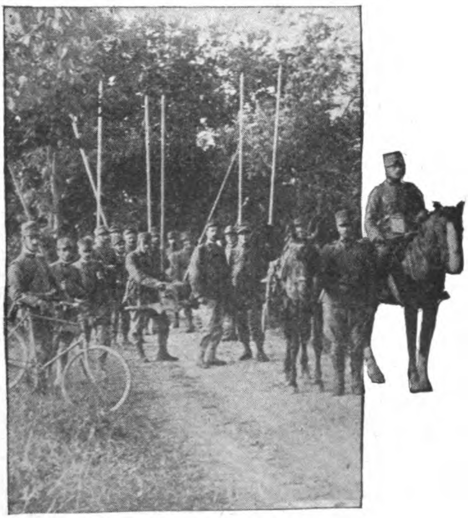
Generally the wire will be laid to one side of the roadbed to avoid unnecessary damage to the wire from wheels, etc., but in unfenced country, where mounted men and stock may approach the road from the adjacent fields, it will frequently be advisable to lay it in the road, so that it will be flat and also be more easily seen.

Plenty of slack wire always will be taken, so that it will drop off the feet of animals passing over it, without breaking the wire or throwing the animal.

In crossing railroads or trolley lines, the wire is cut and the ends run under the rails. To prevent delay, a man of the section will be dropped off at such crossings and connect the wire, then overtake the section at an increased gait.

To repair a break the ends will be first scraped, the scraped ends tied in a square knot, the loose ends twisted around the line wire, and all carefully insulated with tape. The knots should be pulled tight and made as small as possible, so that in reeling up the knots will not jerk the pike and glove from the hand.

Lines which have been hastily laid will be patrolled at once, the linemen proceeding from each end until they meet, reporting from there by wire to their sections for instructions. In thus patrolling the lines it will be with a view to placing the wire flat on the ground, should it have become taut after the section passed, and otherwise arranging it to lessen the likelihood of breaks. Should a line cross a macadamized road, heavily traveled by artillery and cavalry, with no means to



PHOTOGRAPH TAKEN DURING THE PROGRESS OF AN ENGAGEMENT IN THE GREAT WAR, SHOWING ITALIAN SIGNAL TROOPS WITH PIKES AND A WIRE CARRIER, ABOUT TO LAY A FIELD LINE

place it overhead, a lineman will be left at the point to repair any possible break. Should travel over the road practically cease, he will ask for instructions by wire.

Frequent patrols will be made over lines which pass over fields of grain, weeds, or underbrush in unfenced country, and can neither be placed flat on the ground nor overhead. Breaks are more apt to occur with lines thus laid.

On all occasions in handling wire, such as reeling it on to the reels in filling them or reeling it off for repairs, the section chief will have leaks in insulation repaired and all connections looked over. This aids materially in the working of the lines when the wire is laid.

Maneuvers of the Battalions

Wire will not be picked up at a faster gait than a trot. Should a more rapid gait become necessary to escape capture, the wire will be cut and abandoned. The real object is to lay wire and not to pick it up. Should wire have to be abandoned, the cart will refill its reel at the earliest possible moment from the reserve. Wire will only be temporarily abandoned at maneuvers. The section will return for it when the maneuver is completed. Under no circumstances will wire be reeled up on the reels or spools until any breaks in the metallic continuity of the wire have been repaired.

In passing through villages, the wire will be placed overhead on telegraph and telephone poles. The climbers carried with the cart will be used for this purpose. A man will be dropped for this work; when completed, he overtakes the section. Men left behind in laying the wire, for any duty, will follow the line in overtaking the section, looking for breaks.

The gait to be taken in laying lines will depend on the kind of troops the section is following and the speed made by them. In all cases the line will keep in touch with the element it is to transmit information for. When the last station is cut in, horses may be unhitched if the troops seem likely to remain in place any length of time.

On the care with which lines are laid will depend in no small degree their efficiency. Carelessly laid lines will need much attention to repair breaks, and will cause many delays in messages, and no end of annoyance to other troops.

Speed will always be sacrificed to carefulness in this work. Wire fences, telephone and telegraph lines may sometimes be used to advantage.

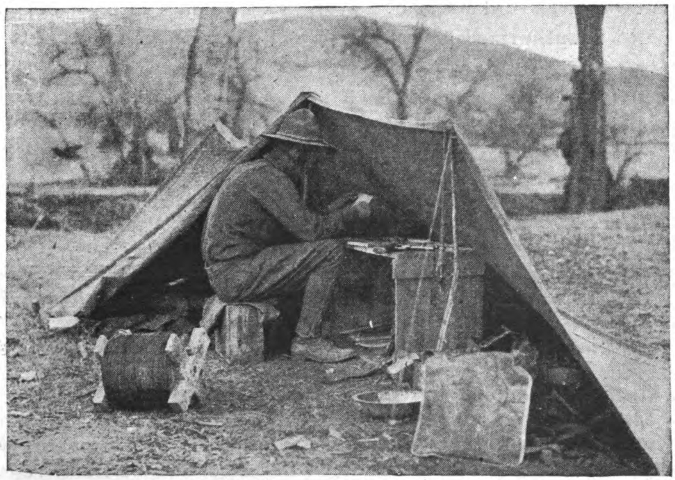
Stations and Call Letters

Each section will be assigned call letters for four stations, which in general should not exceed four. The first section will be given the letters A, B, C, and D; the second section the letters F, G, H, and K; the third section M, N, Q, and R; the fourth section, S, U, W, and X. The stations are assigned to call letters in order of establishment, not location, beginning with the first letters. The call of headquarters is KO, which will be its call whenever it may be on the line, suspending for the time being the letter of the station where it may be. This applies to the first station established as well as to the later ones.

Branch lines electrically connected with the main line have offices given calls as if on the main line.

An office on a branch line not connected with the main line will be assigned the call letters of the station where the branch goes out, adding J to it.

As soon as a station is established the operator will call up the initial station and report. The opening of all stations, including the initial station, will be reported to the officer or non-commissioned officer in charge of the line, and by the latter to the company commander and to the commanding officer for whose use the line was established.



A FIELD WIRE STATION OPEN AND IN OPERATION UNDER ACTUAL SERVICE CONDITIONS

Each operator will have a personal sign, as Smith "SM," Johnson "JO," etc.

To open station with buzzer the operator will attach the buzzer connector to the line wire and ground rod. Care will be taken that the teeth of the connector have penetrated the insulation of the line wire. Damp ground will be sought for the ground rod; if not available the ground will be dampened around it with water from the canteen.

The operators will not leave their buzzers unless properly relieved by higher authority.

At night, when lanterns are necessary at a station, the light must be so placed as to conceal it from hostile observation.

When it becomes necessary to move a station some distance from the line and it is not practicable to use field wire for extending the line, the buzzer carried by the lineman may be used.

The buzzer carried by the lineman may be used for opening stations on branch lines.

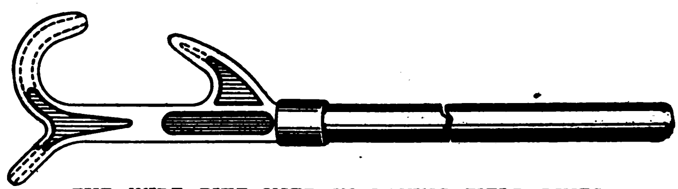
Stations will be conducted in a military manner. Silence will be preserved, except conversation relative to business. The lines will not be used for conversational purposes between operators.

Buzzers will be kept dry. In case of wet weather the shelter tents of messenger and operator will be made into an office.

No unauthorized person will be allowed around stations.

Maintaining the Lines

Each lineman will be equipped with a carrier with one-fourth mile buzzer wire and a buzzer for testing the line. This



THE WIRE PIKE USED IN LAYING FIELD LINES

will enable linemen to determine in what part of the line a break may be. Intermediate stations will assist in this, and when the section in which the break exists has been located the messenger or any available man will be sent to find and repair it if no lineman is at hand. In following the line to locate breaks the lineman will take up the gallop, following the line with his eye where it is raised from the ground, and with the pike where it is on the ground. He picks it up with the hook. In order to prevent a knot or splice from being caught in the hook and jerking the pole from his hand he raises the pike in a horizontal position, slips the wire out of the hook and on to the handle, and allows the wire to run on it near the hook, the shoulder of the hook keeping it from slipping off. By lowering the pike and turning it around in the hand the wire slips quickly to the ground.

CAMPS

There are two general classes of camps; semi-permanent camps and temporary camps.

Semi-permanent camps are used for troops in mobilization, concentration, or maneuver camps, and during such pauses in operations as permit the better care of troops.

Temporary camps are used on the march or during operation when halts are made only for the night or for a few days at most.

Semi-permanent Camps

GENERAL

Semi-permanent camps contemplate the use of pyramidal and wall tents, mess shelters, baths, latrines, raised picket lines on substantial posts, and corrals when practicable. The equipment therefor is classed as Equipment "B", and is not carried on division trains, but when required is brought up by other transportation.

The forms and dimensions of semi-permanent camps and the character and amount of tentage or other shelter used vary greatly with the conditions.

Every effort must be made to provide adequate shelter for both men and animals.

Animals constantly exposed to the sun in hot weather and to cold winds, rain, or snow in winter lose condition very rapidly.

Suitable tents or other shelter must be provided for workshops for mechanics and for kitchens. Condemned canvas can be utilized for these purposes in camps of a duration too short to justify suitable buildings.

When the camp is reached by rail the timbers used in securing the carriages on the cars are, if carefully removed, very convenient for such purposes.

The detailed arrangements of the normal semi-permanent camps are given in the illustration. Whenever practicable the width of the camps therein shown should be somewhat extended.

The picket line should be well drained by cutting ditches about 12 feet on either side of the line and throwing the earth to the center. Whenever practicable the ground should be covered with broken stone, sand, or cinders. Particular care must be taken to provide dry footing not only on the picket line but around the watering places in semi-permanent camps.

The requirements which semi-permanent camp sites should fulfill are given in Field Service Regulations.

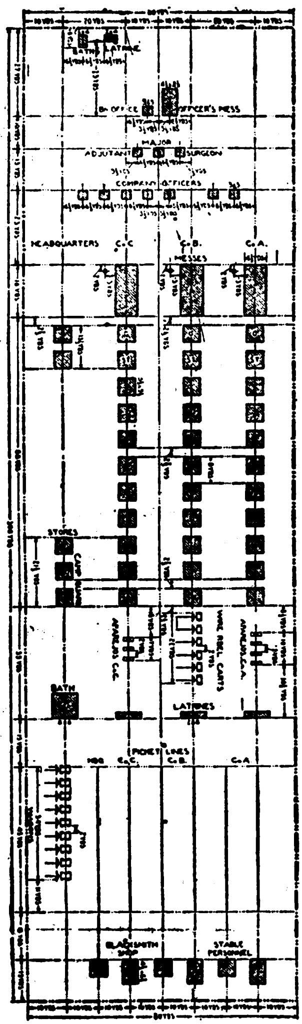
In semi-permanent camps guard and other duties follow closely the custom in garrison.

The camp is policed daily after breakfast and all refuse burned. Tent walls are raised immediately after breakfast and the bedding and clothing aired daily, weather permitting.

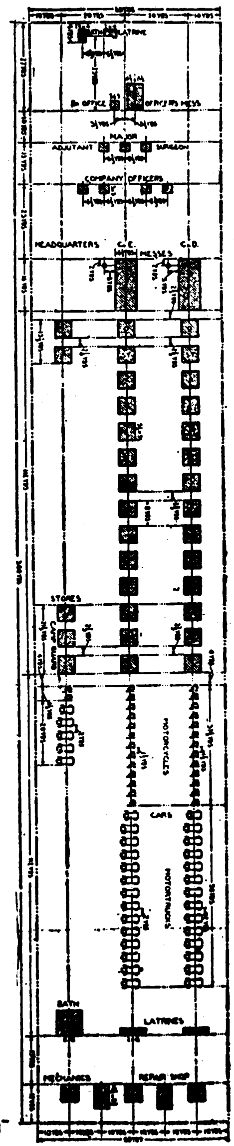
Shelter Tent Camps

GENERAL

The shelter tent or temporary camp is used in the field when halts are not to be of sufficient duration to justify the bringing up of semi-permanent camp equipage, or when same is not available. They will, of necessity, vary greatly in form, dimensions and area occupied and in the means available for the improvisation of camping expedients. The regulations and plates hereinafter prescribed are given as conforming to usual conditions and should govern in all instruction in the selection and occupation of shelter-tent camp sites. In actual service the dispositions in camp must be adapted to the ground and must be made so as to derive the maximum benefit from the meager camp equipment carried. The camp will in this latter instance, therefore, seldom be ideally regular. Whenever possible, battalions, companies, and platoons should be camped in column of sections (in outpost companies, column of platoons). The principal advantage accruing in camping in columns is the freedom afforded for withdrawing independent sections from camps when it is desired to send them on detached missions.



FIELD BATTALION



"TELEGRAPH BATTALION"

ARRANGEMENT OF SEMI-PERMANENT CAMP

Even in small commands, the commanding officer, or an officer designated, should precede the column to look over the camping ground and decide on the arrangement of the camp, so that on the arrival the command may immediately occupy the ground assigned it and commanders may be promptly informed as to arrangement for water, fuel, forage, and rations.

THE SELECTION OF SHELTER TENT CAMP SITES

In campaign, tactical necessity may leave little choice in the selection of camp sites, but under any conditions the requirements of sanitation should be given every consideration consistent therewith.

In general, the following principles govern:

The site should be convenient to an abundant supply of pure water.

Good roads should lead to the camp. Interior communication throughout the camp should be easy. A camp near a main road is undesirable on account of dust and noise.

Wood, grass, forage, and supplies should be at hand or easily obtainable.

The ground should accommodate the command without crowding and without compelling the troops of one unit to pass through the camp of another.

The site should be sufficiently high and rolling to drain off storm water readily, and, if the season be hot, to face the breeze. In cold weather it should preferably have a southern exposure, with woods to break the prevailing winds. In warm weather an eastern exposure, with the site moderately shaded by trees, is desirable.

The site should be dry. For this reason porous soil, covered with stout turf and underlaid by a sandy or gravelly subsoil is best. A site on clay soil, or where the ground water approaches the surface, is damp and unhealthful.

Alluvial soils, marshy ground, and ground near the base of hills or near thick woods or dense vegetation are undesirable as camp sites on account of dampness. Ravines and depressions are likely to be unduly warm and to have insufficient or undesirable air currents.

Proximity to marshes or stagnant water is undesirable on account of the dampness and mosquitoes and the diseases which the latter transmit. The high banks of lakes or large streams often make desirable camp sites.

Dry beds of streams should be avoided; they are subject to sudden freshet.

The occupation of old camp sites is dangerous, since these are often permeated by elements of disease which persist for considerable periods. Camp sites must be changed promptly when there is evidence of soil pollution or when epidemic disease threatens, but the need for frequent changes on this account may be a reflection on the sanitary administration of the camp.

A change of camp site is often desirable in order to secure a change of surroundings and to abandon areas which have become dusty and cut up.

THE FIELD BATTALION CAMP

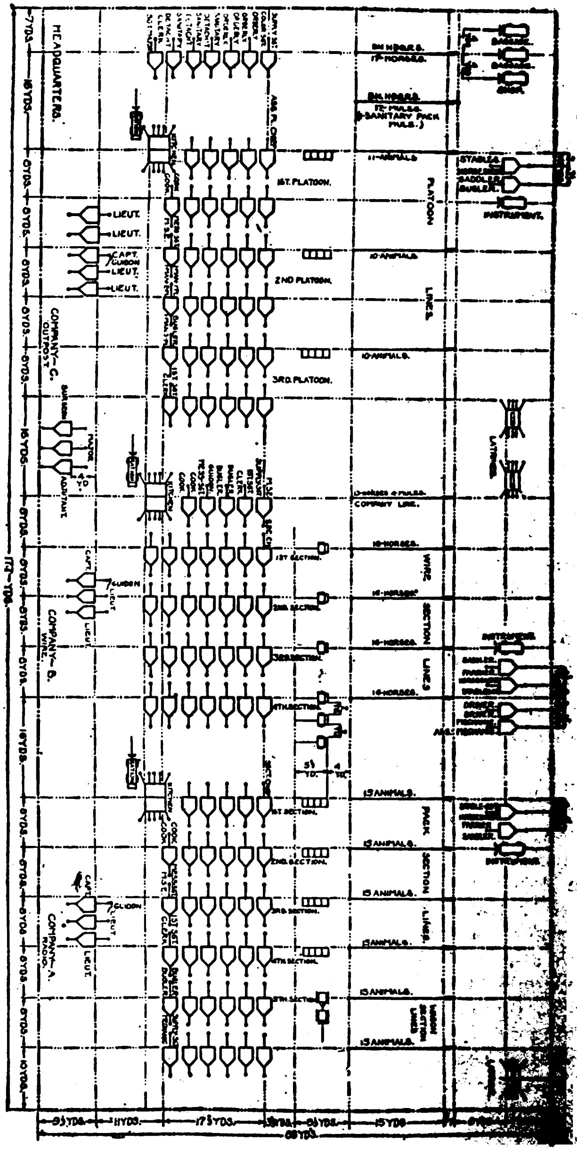
The field battalion, or any fraction thereof, will normally camp in accordance with the accompanying drawing.

Occupation of Camp Site

The command is normally conducted from left to right along the rear of the plot selected for the camp site. The location of the camp site of the leading section of the leading company is indicated to the captain of that company and the command **1. By company, 2. At camping interval, 3. LEFT INTO LINE** is given. The captain of each company commands: **1. At —— yards interval, 2. Left into line,** adding **3. MARCH,** at a time so that the leading section of the company in executing the movement ordered will find itself marching to the left over the ground to be occupied by the section picket line and with the center of the section in prolongation of the line of the front of the section line of shelter tents to be established. In giving the preparatory commands for forming **left** into line, each captain announces such interval as will give an interval of 8 yards between section picket lines when they are secured in prolongation of the center line of the sections, and gives the command of execution so that his right section picket line will be 16 yards from the left picket line of the company on the right. For the company on the left of the outpost company this distance will be increased to 24 yards.

Each captain halts his company when the rear of the leading section has reached a point 4 yards in advance of where the front pin of the section picket line is to be placed. The remaining sections halt with the rear elements aligned on that of the right section.

When the command is halted and rear elements aligned, the command **MAKE CAMP** is given. Each captain commands **SECURE PICKET LINES.** At this command, each chief of section takes charge of his section, causes the men to dismount and turn animals over to horseholders. The section picket line is then secured, the front picket pin being placed



A FIELD BATTALION SHELTER TENT CAMP

4 yards directly in rear of the center of the section and the rear pin 50 feet therefrom and in such a position that the picket line, when tightened, will be in continuation of the line formed by the front of the section line of shelter tents to be established and the tongue of the wire cart or the front edge of the aparejo park.

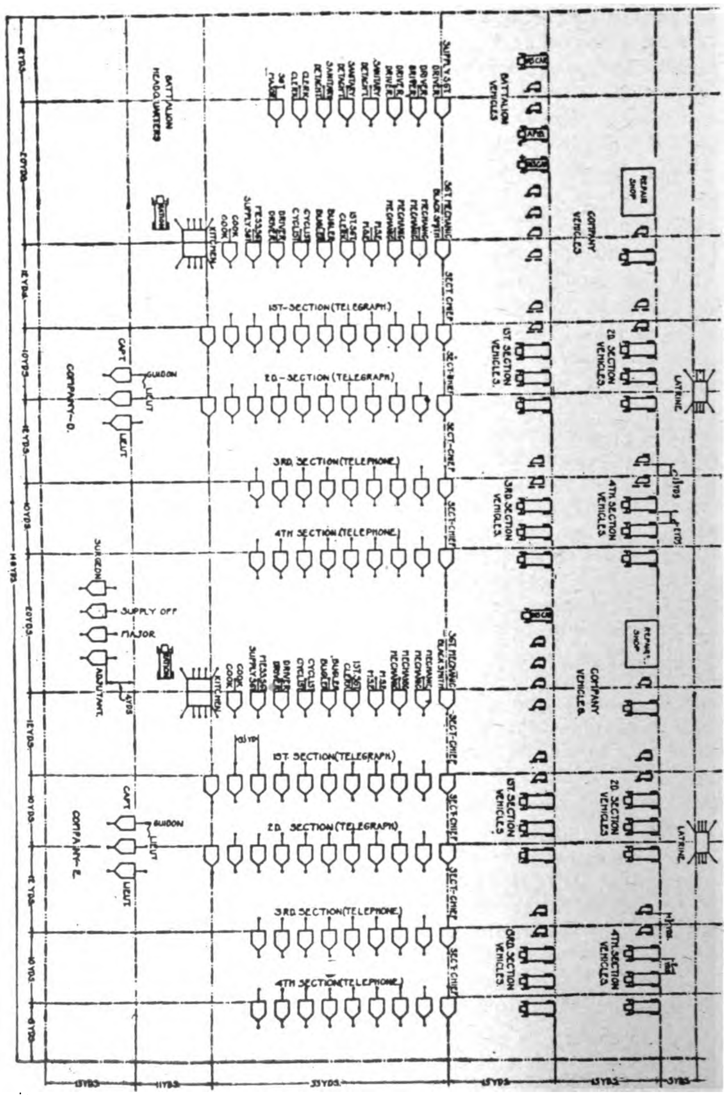
The wagon radio section and the platoons of the outpost company camp in two lines as indicated. The battalion and company lines are secured simultaneously and in a like manner by the appropriate personnel.

After section lines and the company line have been secured as above each captain commands: **TIE TO THE LINE.** Wire carts are unhitched and harness removed and disposed as before prescribed, bridles are removed from pack and riding animals, and all animals are tied to the line. Girths are loosened on pack and riding animals, saddles being left on until the backs are cooled. One or two men are left at each picket line at this time to watch animals and prevent them from lying down or rolling. Where no company lines are provided, company headquarters combat animals are distributed among section lines to the best advantage. Field-train animals except those drawing ration vehicles are tied to their wagons. Each section, less temporary picket-line guard, is formed in two ranks dismounted, as prescribed for forming the squad, facing to the right or left, as indicated, with the chief of section (in platoons of the outpost company, the assistant platoon chief) on the right (left) of the front rank directly in front of the section picket line and about 13 yards from the front picket pin. Assistant platoon chiefs in the outpost company and the chief of the wagon radio section take post on the right (left) of the front line of their sections. Men carry their blanket roll, saddlebags, canteens, and haversacks.

The chief of each section then causes his section to take interval to the left (right) as prescribed for the Squad and commands: **PITCH TENTS.** As each man faces to the front he places his blanket roll and other equipment on the ground. Members of the company and battalion staff not grouped into a provisional section pitch tents, and wagon transportation is disposed as indicated in the plate. Drivers of instrument, shop, and field train wagons sleep in or under them.

After tents are pitched sections return to picket lines, unsaddle the animals, take individual saddle equipment to the tents, and arrange the aparejos and other equipment in park.

Wood, water, and the necessary guard and fatigue details assume their duties.



TELEGRAPH BATTALION SHELTER TENT CAMP

THE TELEGRAPH BATTALION CAMP

The telegraph battalion, or any fraction thereof, will normlly camp in accordance with the accompanying drawing.

Occupation of Camp Site

The telegraph battalion will conform as nearly as practicable to the means and methods prescribed for the field battalion in the occupation of camp sites

TO PITCH SHELTER TENTS

At the command **PITCH TENTS** the men open their blanket rolls and take out the shelter half, poles and pins; the front man places one pin in the ground at the point where his right heel, kept in position until this time, was planted. Each then spreads his shelter half, triangle to the rear, flat upon the ground the tent is to occupy, rear man's half on the right. The halves are then buttoned together. Each front man joins his pole, inserts the top in the eyes of the halves, and holds the pole upright beside the pin placed in the ground; his rear rank man, using the pin in front, pins down the front corners of the tent on the line of pins, stretching the canvas taut; he the inserts a pin in the eye of the rope and drives the pin at such distance in front of the pole as to hold the rope taut. Both then go to the rear of the tent; the rear rank man adjusts the pole and the front rank man drives the pins. The rest of the pins are then driven by both men, the rear rank man working on the right.

The guy ropes, to have a uniform slope when the shelter tents are pitched, should all be of the same length.

TO STRIKE SHELTER TENTS

The men standing in front of their tents: **Strike tents.** Equipments are removed from the tents; the tents are lowered, rolls made up, equipments slung, and the men stand at attention in the places originally occupied after taking intervals.

DOUBLE SHELTER TENTS

The double shelter tent is formed by buttoning together the square ends of two single tents. Two complete tents, except one pole, are used. Two guy ropes are used at each end, the guy pins being placed in front of the corner pins.

The double shelter tents are pitched by Nos. 1 and 2 front and rear rank, and by Nos. 3 and 4, front and rear rank; the men falling in on the left are numbered, counting off if necessary.

The same commands are given as before for taking intervals, and the command **PITCH DOUBLE TENTS** is given.

Only the odd numbers of the front rank mark the line with the tent pin.

All the men spread their shelter halves on the ground the tent is to occupy. Those of the front rank are placed with the triangular ends to the front. All four halves are then buttoned together, first the ridges and then the square ends. The front corners of the tent are pinned by the front-rank men, the odd number holding the poles, the even number driving the pins. The rear-rank men similarly pin the rear corners.

While the odd numbers steady the poles, each even number of the front rank takes his pole and enters the tent where, assisted by the even number of the rear rank, he adjusts the pole to the center eyes of the shelter halves in the following order: First, the lower half of the front tent; second, the lower half of the rear tent; third, the upper half of the front tent; fourth, the upper half of the rear tent. The guy ropes are then adjusted.

WATER SUPPLY

Immediately on making camp a guard should be placed over the water supply. If the water be obtained from a stream, places should be designated, beginning upstream, (1) for drinking and cooking, (2) for watering animals, (3) for bathing and washing clothing.

If the stream be small, the water supply may be increased by building a dam. Small springs may be dug out and each lined with a gabion, or a barrel or box with both ends removed, or with stones, the space between the lining and the earth being filled with puddled clay. A rim of clay should be built to keep out surface drainage. The same method may be used near swamps, streams, or lakes to increase or clarify the water supply.

Water that is not known to be pure should be boiled 20 minutes; it should then be cooled and aerated by being poured repeatedly from one clean container to another, or it may be purified by approved apparatus supplied for the purpose.

Arrangements should be made for men to draw water from the authorized receptacles by means of a faucet. The dipping of water from the receptacles or the use of a common drinking cup should be prohibited.

On the march, including camps, the daily requirements of water may be estimated at 6 gallons per man or 10 gallons per horse. In permanent or semi-permanent camps the supply should be sufficient to provide from 25 to 30 gallons per man and 15 gallons per horse per day. This supply should be properly piped and delivered at convenient places in each organization camp.

KITCHEN

Camp kettles are hung on irons or on a support consisting of a green pole lying in the crotches of two upright posts of the same character.

A narrow trench for the fire, about 1 foot deep under the pole, protects the fire from the wind and saves fuel. A still greater economy of fuel can be effected by digging a similar trench in the direction of the wind and slightly narrower than the diameter of the kettles. The kettles are then placed on the trench and the space over it and between the kettles filled in with stones, clay, or mud, leaving the flue running beneath the kettles. The draft can be improved by building a chimney of similar material at the leeward end of the flue.

Four such trenches radiating from a common central chimney will give one flue for use whatever may be the direction of the wind.

A slight slope in the flue, from the chimney down, provides for drainage and improves the draft.

The lack of portable ovens can be met by ovens constructed of stone and covered with earth to retain the heat. If no stone is available, an empty barrel, with one head out, is laid on its side and covered with wet clay to a depth of 6 or more inches, and then with a layer of dry earth equally thick. A flue is constructed with clay above the closed end of the barrel, which is then burned out with a hot fire. This leaves a baked clay covering for the oven.

A recess can be similarly constructed with boards, or even brushwood, supported on a horizontal pole resting on upright posts, covered and burnt out as in the case of the barrel.

When clay banks are available, an oven may be excavated therein and used at once.

To bake in such ovens, first heat them and then close flues and ends.

Food must be protected from flies, dust, and sun. Facilities must be provided for cleaning and scalding the mess equipment of the men. Kitchens and the ground around them must be kept scrupulously clean.

Solid refuse should be promptly burned, either in the kitchen fire or in an improvised crematory.

In temporary camps, if the soil is porous, liquid refuse from the kitchens may be strained through sacking into seepage pits dug near the kitchen. Boards or poles, covered with brush or grass and a layer of earth may be used to prevent the access of flies. The strainer should also be protected from flies. Pits of this kind in clay soil will not operate successfully. All pits should be filled with earth when the camp is abandoned.

DISPOSAL OF EXCRETA

Immediately on arriving in camp sinks should be dug. This is a matter of fundamental sanitary importance, since the most serious epidemics of camp diseases are spread from human excreta.

One sink is usually provided for each company and one for the officers of each battalion. Those for the men are invariably located on the side of camp opposite the kitchens. All sinks should be so placed that they can not pollute the water supply or camp site as a result of drainage or overflow. To insure this, their localities and their distance from camp may be varied.

When camp is made for a single night, shallow trenches, 12 inches deep and 15 to 18 inches wide, which the men may straddle, will suffice.

In camps of longer duration, and when it is not possible to provide latrine boxes, as for permanent camps, deeper trenches should be dug. These may be used as straddle trenches or a seat and back rest improvised from poles or other available material. They should be screened by brush, condemned canvas, or other material. When open trenches are used, special care must be taken to insure that all excreta is covered with earth, lime, or ashes as soon as it is deposited.

In permanent or semi-permanent camps special sanitary facilities for the disposal or disinfection of excreta will ordinarily be provided. When trenches are used in such camps they should be at least 6 feet deep and 12 feet long and not more than 2 feet wide. Seats are walled to the ground and provided with lids to keep flies from reaching the deposits; urinal troughs discharging into the trenches are provided. Each day the latrine boxes are thoroughly cleaned, outside by scrubbing and inside by applying when necessary a coat of crude oil or whitewash. The pit is burned out daily with approximately 1 gallon of crude oil and 15 pounds straw. When filled to within 2 feet of the surface, such latrines are discarded, filled with earth, and their position marked.

In permanent camps urine tubs should be placed in the company streets at nightfall; they are emptied after reveille. Their location should be plainly marked thoroughly and frequently disinfected.

CARE OF TROOPS AND ANIMALS

Lack of sufficient rest renders troops unfit for hard work and diminishes their power of resisting disease. Therefore commanders should secure for the troops, whenever possible, their accustomed rest.

The rules of sanitation must be enforced.

Men should not be on damp ground. In temporary camps and in bivouac they raise their beds if suitable material such as straw, leaves, or boughs can be obtained, or use their ponchos or slickers. In cold weather and when fuel is plentiful the ground may be warmed by fires, the men making their beds after raking away the ashes.

When troops are to remain in camp for some time, all underbrush is cleared away and the camp made as comfortable as possible.

Watering troughs, shelter in cold weather and shade in hot are provided for the animals if practicable.

To prevent stampeding in camp it will in most cases be sufficient for the men to go quietly among the horses at the first sign of fright and speak to them. If horses are stampeded, men should mount the fastest animals within reach, place themselves in front of the herd, and conduct it back to camp. With old horses the sounding of *stable call* may prevent or stop a stampede.

One of the greatest difficulties of mounted organizations in campaign is to secure sufficient long forage. On this account the greatest attention should be given to grazing at every opportunity.

The horses are either held on the halter rope, picketed on the lariat, turned loose in inclosed pastures, or if there has been opportunity for sufficient training they may be herded.

Special effort should be made to give them an hour or two of grazing in the morning while the dew is on the grass (not clover), especially if the supply of hay at night has been short, and in such cases they should not be disturbed until the last moment, time lost being made up by more rapid marching.

Should the horses have to be protected from an enemy, they are taken out to graze under charge of an officer as soon as possible after camping. They are taken as far as is safe, so as to keep the nearer grass for night. It is occasionally practicable to arrange the camp so as to use the wagons and natural obstacles to inclose a space for night grazing.

Special attention should be paid to the grooming of animals and to the condition of their feet and backs.

Common and Wall Tents

Four men, numbered from 1 to 4, consecutively, pitch each tent.

Nos. 1 and 2 place the ridgepole perpendicular to the company street, with one end against the position pin; Nos. 3 and 4 drive a pin at the other end of the ridgepole. Nos. 1 and 2 mark the positions of the four corner guy-rope pins by placing the ridgepole parallel to the company street, to the right (facing the tent) of the position pin; Nos. 3 and 4 drive a large pin one pace in front of the outer end of the ridgepole. The other three corner guy pins are set in succession in the same manner, going first straight to the rear, then across the tent, and then to the front. All four then spread the tent on the ground it is to occupy; Nos. 1 at the front and 2 at the rear insert the uprights. The ridgepole and uprights are joined, the pole pins inserted in the eyelets of the tent and fly, and the tent raised to a vertical position with the poles at the pins. Nos. 1 and 2 hold the tent in position; No. 3 places the front guy ropes of tent and fly, No. 4, the rear, on their pins, and tighten the ropes so as to hold the poles vertical. The wall pins are then driven through the loops, walls hanging vertically. The other pins are then driven on line with the corner pins and in prolongation of the seams of the tent.

Conical Wall Tents

The conical wall tent is pitched by eight men. The ranking noncommissioned officer numbers the men from 1 to 7 and superintends the work. Upon the hood lines of the tent are placed three marks; the first about 8 feet 3 inches, the second about 11 feet 3 inches, the third about 14 feet 2 inches from the hood ring; the first marks the distance from the center to the wall pins, the second to the guy pins, and the distance between the second and third is the distance between guy pins. These distances vary slightly for different tents and should be verified by actual experiment before permanently marking the ropes. They should also be frequently verified on account of the stretching of the rope. To locate the position of guy pins after the first, the hood being held on the center pin, with the left hand hold the outer mark on the pin last set, with the right hand grasp the rope at the center mark and move the hand to the right so as to have both sections of the rope taut; the center mark is then over the position desired; the inner mark is over the position of the corresponding wall pin.

To pitch the tent, No. 1 places the tent pole on the ground, socket end against the door pin, pole perpendicular to the company street. No. 2 drives the center pin at the other extremity of the pole. No. 3 drives a wall pin on each side of and 1 foot from the door pin. No. 4 places the open tripod flat on the ground with its center near the center pin. The whole party then places the tent, fully opened, on the ground it is to occupy, the center at the center pin, the door at the door pin.

The noncommissioned officer in charge holds the hood ring on the center pin, and superintends from that position. No. 1 stretches the hood rope over the right (facing the tent) wall pin and No. 2 drives the first guy pin at the middle mark. No. 1 marks the position of the guy pins in succession and No. 2 drives a pin lightly in each position as soon as marked. At the same time No. 5 inserts small pins in succession through the wall loops and places the pins in position against the inner mark on the hood rope, where they are partly driven by No. 6. No. 4 distributes large pins ahead of Nos. 1 and 2; No. 7, small pins ahead of Nos. 5 and 6; No. 3 follows Nos. 1, and 2 drives the guy pins home. No. 7, after distributing his pins, takes an axe and drives home the pins behind Nos. 5 and 6. No. 4, after distributing his pins, follows No. 3 and loops the guy ropes over the pins.

Nos. 1, 2 and 3, the pins being driven, slip under the tent and place the pin of the pole through the tent and hood rings while the noncommissioned officer in charge places the hood in position. Nos. 1, 2 and 3 then raise the pole to a vertical position and insert the end in the socket of the tripod. They then raise the tripod to its proper height, keeping the center of the tripod over the center pin. While they hold the pole vertical Nos. 4, 5, 6 and 7 adjust four guy ropes, one in each quadrant of the tent, to hold the pole in its vertical position, and then the remaining guy ropes. As soon as these are adjusted the men inside drive a pin at each foot of the tripod, if necessary, to hold it in place.

To Strike Common, Wall and Conical Wall Tents

1, Strike tents. 2, DOWN.

The men first remove all pins except those of the four corner guy ropes—four quadrant guy ropes in case of the conical wall tent. The pins are neatly piled or placed in their receptacle.

One man removes each guy from its pin, and all hold the tent in a vertical position until the command **down,** or the last note of the general, and then lower it to the indicated side.

The canvas is then folded, or rolled, and tied, the poles, or tripod and pole fastened together and the remaining pins collected.

To Fold Tents

Wall Tents.—Spread the tent flat on its side and place all guys but two over on the canvas; fold the triangular ends over so as to make the canvas rectangular; fold both ends so that they meet at the center, and then fold one end over on the other; fold the bottom and ridge over so that they meet at the center of the strip, and then fold one end over the other.

Fold the fly into four folds, parallel to its length, then in a similar manner across its length, making a rectangle with dimensions about the same as the folded tent.

Place the fly on the tent, cross the two free guys, and tie them so that they pass over the ends and across the sides.

The hospital and command tent are folded in the same manner as the wall tent.

Conical wall tents.—Spread the tent flat, with the door up; holding the ring vertical, fold the two edges in so they meet at the center, and again fold in the same manner; place the hood on one half and fold the other half over on it; turn wall over toward ring, fold coming at about middle of height of wall; two men working together then roll from the ring down, placing knees on each fold to make bundle compact and flat.

Tie the bundle with the two free guys, as in case of the wall tent.

General Remarks

As soon as the lines of company streets are established the positions of the tents should be marked, from the flank nearest the officers' tents, by pins. The front pole of the wall and common tent and the door pins of the conical wall tents occupy the points so marked. The distance between pins may be determined by pacing or by a light cord with the distances marked upon it. These distances are: For wall tents, 8 paces; common tents, 6 paces; conical wall tents, 10 paces. The pins marking the position of the tents are, when practicable, set on a straight line, and the company officers verify and correct the alignment of such pins in the quickest and most convenient manner.

Wall pins are so driven as to slope slightly away from the nt; guy pins so as to slope slightly toward the tent.

Each tent, its fly, hood, poles, and tripod, should have the me number.

The conical wall tent complete consists of 1 tent and hood, 5 pounds; 1 tent pole and tripod, 32 pounds; 48 pins, about 0 pounds; total weight, 128 pounds. Its dimensions are: Diameter, 16½ feet; height, 10 feet; height of wall, 3 feet; packed, contains 13 cubic feet.

The wall tent complete consists of 1 tent, 43 pounds; 1 fly, 15 pounds; 1 set poles, 25 pounds; 10 large and 18 small tent pins, about 15 pounds; total weight, 98 pounds. Its dimensions are: Length of ridge, 9 feet; width, 8 feet 11 inches; height, 8½ feet; height of wall, 3 feet 9 inches; packed, contains 6 cubic feet.

The common tent complete consists of 1 tent, 26 pounds; 1 set poles, 15 pounds; 24 small tent pins, weight about 9 pounds; total weight, 50 pounds. Its dimensions are: Length of ridge, 6 feet 11 inches; width, 8 feet 4 inches; height, 6 feet 10 inches; height of wall, 2 feet.

The shelter-tent equipment of each enlisted man consists of the following:

(a) One shelter half, weight 3 pounds.
(b) One pole in 3 joints, 47 inches long; weight, 10½ ounces.
(c) Five tent pins, 9 inches long; weight, 10 ounces.

The shelter tent is pitched by two men, whose combined equipment make a complete tent. The tent, when pitched, occupies a space 5 feet 4 inches deep and 6 feet 4 inches wide; the two triangular parts, when pinned to the ground, inclose an additional triangular space 20 inches deep.

In striking tents, common and wall tents are, unless otherwise directed, lowered to the right facing out from the tent door; conical wall tents away from the door.

BREAKING CAMP

Camp will be broken in the following order: Immediately after **reveille** the men will feed their horses and, if time permits, groom for 20 minutes.

Tents will be struck and rolls made, which is followed by breakfast, then **water call,** followed by **boots and saddles.** The picket lines are placed upon the transportation and the organizations formed as directed.

COMPANY GUARD MOUNTING

At the assembly the men warned for stable or other guard duty fall in on the company parade in two ranks, facing to the front; the senior non-commissioned officer on the right of the front rank, the other non-commissioned officers and the supernumerary in the file closers.

The first sergeant verifies the detail, dresses it to the right, and inspects the arms, equipment, and appearance of the men, and replaces by the supernumerary any man unfit to march on guard.

He then takes post 4 yards to the front of the detail facing it, and commands: **1. Guard to its post, 2. Right, 3. FACE; 4, Forward, 5. MARCH.**

At the fifth command the guard moves to its post; the senior non-commissioned officer marching near its left and rear, his place as guide being taken by a file closer. The supernumerary is then dismissed.

When an officer mounts the guard he will take post 6 yards in front of the detail; the first sergeant will salute and report to him the result of his verification of the detail and will then face to the left and take post 2 yards to the left of the front rank. The officer will inspect the detail and march the guard to its post as above described.

On arrival at the guardhouse or other designated place the commander of the old guard will give the commander of the new guard all the information and instructions relating to his guard and turn over to him all property or prisoners in his charge. The guard will then be divided into reliefs and the men designated for the different posts, less the commander of the guard, and the members of the first relief will relieve the corresponding members of the relief of the old guard on post. When all of the members of the old guard have been relieved the old guard will be dismissed by its commander.

THE SIGNAL CORPS AND GENERAL COAST DEFENSE

The United States, unlike other great nations of the world, has never established, and may never need to establish, permanent fortifications on the land frontiers, since the real frontiers are the seas. But even without the obligation of defense against neighbors to the north and south, the vast extent of the coast imposes upon the country a duty which can but grow greater as population and wealth advance and as the power and number of commercial ships and of navies increase. Types, speed, and size of ships are bringing alien shores yearly into more intimate relations and are making sea attack more easy, more swift, and more dangerous than ever before. The weight and range of floating batteries, the number and speed of merchant vessels and their great transporting power, the swarms of rapid and dependable auxiliaries, the submarine, the airplane, and the dirigible, leave all but strongly protected coasts without the chance of defense in war, except by airships and submarines and of course the mobile army, and fixed defenses in addition to a navy whose duty at the outset may call it into distant seas. The probability of the absence of the navy at the very moment when coast protection becomes most necessary is so strong as to amount to a certainty.

Regarding the defense of the seaboard of the United States, it appears clear in retrospect that the inertia which for years followed the close of the civil war and the later days of tranquility prevented the making by the nation of any serious effort to protect the coasts of the country from foreign attack until some thirty years ago when indifference began to give way to the demand for an efficient navy. The growth of the navy in turn emphasized the need of protected harbors and of permanent defenses; and as the fortifications required soldiers to man them attention was at last directed more and more strongly to the personnel of the defense. At last the coast artillery was given a working, if still a skeleton, organization; efficient armament and satisfactory equipment were added; systems of fire control and direction were devised and at least partial lines of information installed. Finally it began to be understood, though dimly at first, that defenses themselves must be defended; that the eyes and the hands of men must assist in coast protection and that two important factors of the defense, namely, the coast patrol and the mobile army, must form a front for any adequate system of protection.

For convenience in considering what follows, it is assumed that in war the coast defense, which combines the military and naval dispositions and operations necessary to resist attack on any part of the coast line, may be divided into six factors, each related to the other in operation and all dependent upon co-ordination of action to bring out their full value. These are, first, the fixed and floating defenses of the artillery, consisting of the armaments, submarine defenses and materials, coast and scout ships, and to some extent air craft, torpedo, submarine, patrol, and picket boats; the personnel, including all troops assigned to duty in connection with the fixed defenses. Second, the general defense troops of the regular or volunteer army, or of the organized militia, not including the supports of fixed positions. Third, the air service, including the necessary aero squadrons of various types, with their auxiliary tractors and the dirigible when used for coast patrol and defense. Fourth, the coast patrol, including the coast guard. Fifth, the service of the lines of information; that is, the Signal Corps of the army. Sixth, the navy.

Although each of these factors supplements the others, it is evident that the one which binds them all into a working whole, and without which the other five will have rather less cohesion and connection than so many reeds shaken by the wind is the Signal Corps in control of the lines of information and the service of air craft.

To arrive at a proper understanding of the extent and character of the lines of information necessary to keep in brain touch the elements of the defense of a great seaboard like our own, it will be well to first outline the general scope of the defense and to indicate the part played by the other factors in war.

The first of the factors of defense to be considered is that of the fortified positions.

FORTIFIED POSITIONS

PERMANENT COAST OR HARBOR DEFENSES

In general terms, the permanent defense of a coast or harbor consists in the adequate protection of a number of distinct positions, which from their importance to the country or value to the enemy must be guarded against injury, occupation, or capture

Such positions are either actually or potentially guarded permanently by a number of fixed artillery emplacements, the fighting or tactical units of which constitute a chain of command. The artillery defense as a whole is made up of a series of tactical areas, each measurably complete and independent in itself, but separated usually by considerable distances of coast from the others, and the whole kept in touch by lines of information, usually commercial, which form a chain encircling the country.

On the coasts of the United States there are eighty-one separate forts where modern defenses are installed or are in process of installation; in the Philippines there are six; in Hawaii, four; in the Canal Zone, five; a total of ninety-six. It is evident, therefore, that the fixed defenses alone required a vast number of lines of information and, further, that for the purpose of control of its vast coast line these positions must be kept in communication not only with great centers of population and with the capital of the country but with each other, and that under certain probable conditions of war the chain of defense from Portland to Galveston, from San Diego to Puget Sound, or perhaps from Quoddy Head to the Straits of Fuca, must be kept in constant and immediate touch by telegraph, telephone, or radio. This, of course, is largely a problem for the existing commercial lines to solve.

THE MOBILE ARMY OF COAST DEFENSE

It is probably evident to all who have considered the matter that the most necessary factor of the land defense of the coast is the mobile army, together with its auxiliaries. Even to the unthinking it must be obvious that without such forces there can be no real and substantial protection for the coasts, except at those positions which have been selected beforehand for fortification, which of necessity will be few in number. Even if these fixed defenses could stand alone, which they can not do, they will of necessity form but a partial and interrupted protection to an extended seaboard and will leave open to attack many important towns, serviceable harbors, and landing places that may be used by an enemy as a base or as coaling and supply stations. The fortified positions are really harbor defenses only. It is clear also that a country with some 5,700 miles of coast line offered to attack, indented with innumerable minor harbors and anchorages and dotted with important towns that invite destruction, can not protect all its vulnerable points by costly and extensive armaments; as a consequence, minor positions must be otherwise defended or left to shift for themselves. While the defending navy remains within reasonable distance of the coast the minor positions will be free from danger, but a navy, if efficient, will not remain at home. In a serious war, therefore, protection for the less important positions must fall to the care of such of the floating defenses as may be withheld from distant seas; to the troops of the mobile army, aided by such land batteries as can be hastily constructed and armed; to the submarine and to the air craft. Such partial defenses may not prevent attack and local injury, but they can, at least, prevent destruction and an occupation that may provide the enemy with a naval base and perhaps threaten invasion of the country at large. Protection against this danger rests with the mobile army alone, once a foothold has been established on our coast.

The need of a mobile army in coast defense is not, however, confined to the protection of the lesser positions and harbors unprovided with effective fortifications and armament, for it is to be remembered that coast fortifications of today, unlike the permanent works of an earlier time, look only toward the sea, and of themselves are helpless against land attack; hence they must be protected at flank and rear from approach by hostile troops and landing parties.

In these days every serious sea attack, to be successful, must be accompanied by land operations, a fact well illustrated by the fall of Tsingtau and especially by the desperate sea fights of the Dardanelles and of the Gallipoli Peninsula and the subsequent land attacks. It is evident that though ships unsupported may cause great damage and even destroy cities or fortified positions, they can produce but little effect upon the ultimate result of a campaign unless combined with land operations, by means of which the defense is not only destroyed, but overwhelmed, the objective occupied, together with the surrounding regions.

It appears, then, that the country must be prepared to prevent throughout the vast extent of its seaboard the seizure and occupation of any one of many important points, both fortified and unfortified, and of all of its harbors and landing places useful to an enemy. This implies the existence of a mobile force so placed and so large and effective in organization as to insure, on the one hand, the safety of exposed positions by proper dispositions of troops immediately needed; and, on the other, by concentration of the major part of these mobile troops in reserve at strategic positions of the coast or possibly of the other frontiers as to permit the use of an overwhelming number of defense troops at any threatened point.

In the defense by a mobile army the plan adopted may well be somewhat as follows: The Atlantic, the Gulf, and the Pacific seaboards will be divided into defensive areas, the extent and boundaries of which will depend upon strategic, geographical, and economic conditions. These areas will not, as a rule, be coextensive with military departments, since they depend upon different conditions and lie mainly along the sea. They will be controlled by their own general officers, acting presumably under one chief. In each area there will exist in war a mobile force adequate not only for its defense proper—that is, for land defense of fixed positions, unprotected harbors, and other vulnerable points within the area itself—but for service with other troops mobilized and held as a general reserve. Within defensive areas there will be placed a sufficient number of men of the regular army, of the trained citizenry, and of the organized militia of the state or neighboring states to form a nucleus of the force required. In addition to the aero squadrons, which form part of a division of the mobile army, there should, of course, be gathered together all of the flying men who can be brought into service with the militia or the volunteers, and to them should be allotted the duty of watching the coasts, so far as practicable.

It should be evident that of this force the men most needed in the preliminary work of the defense are not coast artillerymen alone, but engineers, and signal troops, especially of the aviation section, since the first step in mobilization is the establishment of lines of information, of which soldiers alone should be in control, and the training of airmen.

The mobile troops of the coast defense obviously require ample strength in engineer and signal troops, field and horse artillery, and a due proportion of cavalry to erect and defend the field works on the land fronts of fixed positions, to establish and maintain lines of information, to check sudden attempts at coast landing, and to perform the duties of mounted troops in the field and for air service.

It is certain that if so trained the small quotas of state troops, are of the utmost value to the defense at a time when the lines of information—the telegraph, the telephone, radio and air service—are urgently needed in the organization, disposition, and control of newly organized levies. Together with the signalmen of the regular army, they may well undertake the organization of additional signal troops from the citizenry called to the colors.

If it becomes necessary to put forth the strength of the country by calling to the colors the larger part of the mighty reserve available for national defense, it is certain that the total number of men of the ultimate levy will be so enormous that occasion for mobilizaton of the whole can hardly arise. But though the *leve en masse* may never be resorted to in this country, a force called to the national defense in a great war is no small thing, and the work of turning it into an efficient army and of supplying it with an adequate force of technical troops properly equipped for the field requires the best efforts of every trained man of the service.

General levies are certain at first to be weak in these very arms, since they are of necessity almost nonexistent with the organized militia of many of the states in ordinary times. Lack of the assistance of technical troops hampers the defense, gives to the troops little mobility, and compels them to remain tied to their base or semi-permanent camps. This condition will doubtless be corrected as time goes on, but its existence at first multiplies the lines of information and the duties of signal troops. It is certain therefore that the communications by which the first line and the reserves will be linked together and to the permanent works should from the early efforts at concentration be ample and effective, and so continue, for without them the whole army of the defense becomes a mere aggregation of inert units.

SUPPORTS

A third class of troops organized are, if not large in number, at least of vital importance in coast defense; they are the supports of artillery positions proper. These men, placed at stations suitable to the defense of fixed positions against land attack, act in concert with the coast artillery and are under the immediate command of artillery officers, presumably of posts or districts, since it is evident that they must be kept as directly in touch with the officers fighting the positions as are the marines aboard ship. The supports may well be drawn from the mobile troops proper and be composed of the first and best men called to the general defense; that is, of such troops of the regular army as can be assigned to the duty and of the flower of the organized militia. Made up almost entirely of infantry and field artillery, with as many machine-gun batteries as may be available, there should be added a far larger proportion of signalmen than is usually considered necessary for an army in the field, since upon these men falls the service of information not merely with other elements of artillery defense, but with the fixed positions, the mobile troops, coast guard, and with the navy.

The lines of information of these supporting troops are those of the field army. They will be mainly dependent upon the buzzer, airplane—or perhaps the dirigible—the radio, field telegraph or telephone, and visual signaling.

In considering defense against invasion, it should appear that the mobile troops indicated will stretch over many miles of country and operate under widely varying conditions. Even more than for a well-organized army in campaign, therefore, the lines of information for the, at first, somewhat unorganized forces of the general defense must be ample and widely extended.

Indeed, except in emergencies, these lines are more necessary in the early days of the defense than later when the machine moves smoothly, but at all times the mobile troops, without an adequate service of information, have rather less direction and mobility than a collection of tortoises. Properly laid, the lines of information not only form a network throughout the defense area but tie each theater of operations to the others and provide the entire army with the lines heretofore shown to be essential in the field.

With headquarters of the defense and those of mobile troops fixed at the places best suited tactically for the purpose—and it is reasonably certain that these positions lie at centers of commercial activity—they will be distant from the camps of divisions and brigades and still farther separated from the smaller commands and detachments, from the artillery headquarters and from observation stations and outposts of coast defense. Yet with all these commanding officers of the mobile forces must be kept in constant and immediate touch, as well as with the military commanders of departments, should the latter not be in command of the general defense—and with Washington. In turn, army, division, and brigade headquarters must be kept in communication with dependent and outlying commands; these with the observation stations and coast patrol; and the latter given the power to communicate readily with the floating defenses, with artillery districts, and with ships.

For the mobile coast army the systems of information needed are even more extensive and varied than is considered necessary for a field army in campaign; and it follows that the proportion of signal troops to line soldiers in coast defense should be increased.

It is hopeless to suppose that the Signal Corps of the regular establishment can ever supply more than a leaven for the mass of men needed, especially for the air service, or even that the militia possessing signal troops of approved efficiency can provide more than the framework of the organizations required. The signal troops mobilized for war must be filled in by men drawn direct from civil life. But excellent and abundant as the material for these troops undoubtedly is among the men engaged in the electrical and mechanical pursuits of the country, and from the few who have been trained in airplane work, such men before they can be of any real value must be made into soldiers. The Signal Corps of the army will never have the numbers or the opportunity to take upon itself alone this training and the assistance of the organized militia and of suitable and willing men in civil life must be asked and given. The training must be quick and effective, and therefore be performed by men who have themselves been drilled in peace in the methods of the Signal Corps of the army. Unfortunately, trained militiamen and airmen are at present few and are confined to a small number of states, and even where signal organizations exist, they are not always given, be it said without disparagement of the troops themselves, the strength in numbers, the equipment, nor, up to now, the training to make them immediately valuable in coast defense.

SERVICE OF AIRCRAFT IN COAST DEFENSE

A third and very important factor in coast defense is the service of air craft, and it is becoming increasingly evident that in addition to lines of information laid or worked on land, there must now be recognized and carefully considered the part played in coast defense and observation by aerial fleets. It is not intended here to speak of the airplane merely, but to suggest also the potential value of the lighter-than-air craft, whose special use is now thought to be in scouting or reconnaissance work, which means, of course, its use as a coast patrol.

Divided into areas or districts patrolled by dirigibles or airplanes, all communicating back to central stations and maneuvering far out to sea, such scouts should make impossible a hidden approach or surprise attack by an enemy. The captive balloon also finds a useful place in service of this kind. But the time has not yet arrived to indicate definitely what form the defense air service will take. It has been suggested that the coasts of the country be divided into sections or areas, each of which should contain an aerodrome or center from which scouting land and sea planes could operate at sea and send reports by radio, if satisfactorily installed, to the central stations regarding the movements of enemies' or friendly ships.

Whether this air patrol shall eventually be installed and conducted by the army, the navy, or the coast guard is undecided, and in the present condition of affairs is not a matter requiring consideration here. There is involved, however, a vast and important field of Signal Corps work, not alone in this aviation service, but in the transmission by wire, radio or otherwise, news received from aircraft at central stations, often located at isolated points, to the proper headquarters.

The fourth factor of the coast defense, and that one which depends for its value, if possible, even more closely upon the lines of information than others, is the coast patrol, or coast guard, as it is now called.

THE SIGNAL CORPS AND THE COAST GUARD

To a student of the present condition of our defense it will perhaps appear that the important subject of coast observations, or coast patrol, has not received from the army the attention it deserves. Radio and signal stations have been erected within artillery districts, and by the navy; but great stretches of coast, often containing good harbors, landing beaches and magnificent lookout stations remain without the means of rapidly communicating their news to the telegraph and telephone lines of the country. At many of the lookout stations valuable information of friend or enemy at sea may be gathered, yet they remain in general unprepared for service in war. The need of the co-operation of the trained men and efficient equipment prepared by the Signal Corps for just this kind of work is important.

Without the full co-operation of the Signal Corps of the army and the participation of troops trained in the service of lines of information and in the use of the airplane; the establishment of signal stations, and telegraph, telephone, and buzzer lines; cables; the captive balloon and the dirigible, it is hard to see not merely how the best methods of gathering intelligence in war can be employed by a coast guard, but how, when so gatherea, the information obtained can be transmitted to the centers of control, to artillery fixed positions and their auxiliaries, and to the mobile army from distant observation stations, coast islands, and lighthouses, or from the floating auxiliaries and passing ships, with the speed and certainty which alone make such information valuable.

COAST DEFENSE INFORMATION IN WAR

In general it appears evident that the service of security and information in coast defense, as in the field, implies, first, the collection of military information or intelligence; second, its transmission; and, third, its correlation and use. In regard to the first of these elements it may be said that the *collection of information,* is primarily the duty of the coast patrol, but in war becomes the duty of the mobile army, the fixed defenses, and of every man of the government service, both civil and military, and, indeed, of all people of the country. But although important information may thus come from many sources and, no matter what the source, should be transmitted to proper authority, yet incidental information, like incidental soldiering, is merely auxiliary to the organized service of information. The continued value of this service depends upon a properly organized corps of men who will transmit the reports of trained observers from the aircraft, signal, and observation stations, from lighthouses and other government establishments, from the floating auxiliaries and ships as well as from chance sources of information, and from the thousand watchers of the coast, upon all of whom reliance must be placed in war to collect that information upon which will depend the attitude of the defense.

But both judgment and experience in regard to the weight to be given this information will be needed by officers and men in charge of this service, and of its transmission, if a constant condition of unrest and excitement is to be avoided at inshore terminals. Who can doubt, for example, that information received at the centers of control will determine the attitude of the army of the defense in threatened areas, and perhaps its ability to prevent surprise or repel attack; that the news or no news, often equally important, from the coast will govern the preparedness and vigilance of the mobile troops and supports and keep the artillerymen at the guns or give them release; that, in short, a well-organized service provided with trained men skilled in the use and maintenance of lines of information will relieve the defense of the greater part of its strain in the absence of the enemy, multiply many times its efficiency in his presence, and permit the smaller force to do the work of the larger. While, on the other hand, an insufficient service of information, handicaped by slow, inaccurate, or faulty transmission, will plague and worry the defense with useless anxieties and alarms, if it does not even lead on to disaster.

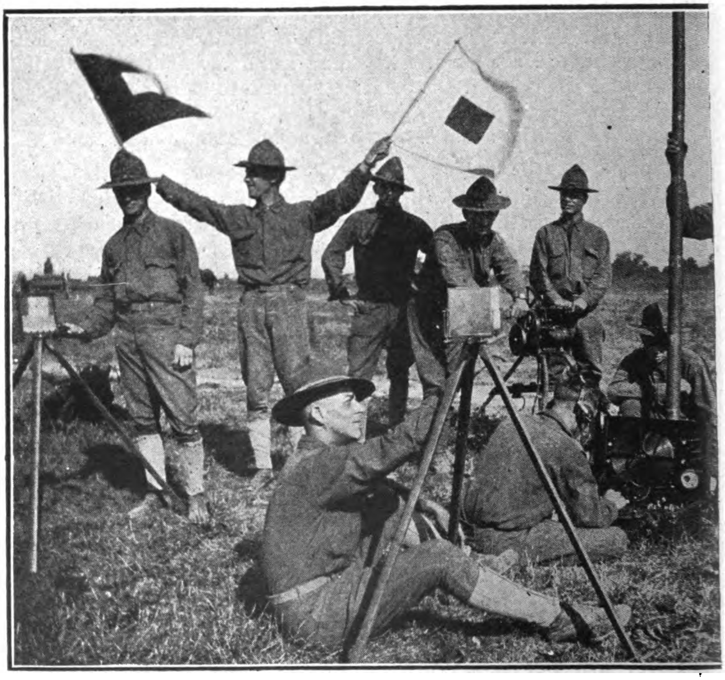
The *transmission of information,* which is the second element of the service of security, is a duty of vital importance, which should be intrusted only to trained men under military control, supplied with the best known appliances for this service, and should never be left to the chance efforts of any irresponsible person who can use a telegraph key or a radio instrument. In other words, that the section of the coast guard to which *the duty of transmission of information is intrusted should be composed of men trained in naval and military signaling and familiar with the methods of the Signal Corps of the army.*

With the use that will be made of the information when received, which is the third element of the service of security, the patrol has no concern, since this will depend upon commanding generals, and the reception and correlation of reports upon staff officers at headquarters, presumably signal officers, whose duty it should be to formulate and weigh the information transmitted.

It appears that the coast patrol will become in the future one of the strongest arms of that service of security and information upon which so much dependence is necessarily placed in modern war. It follows, and it cannot be doubted, that this patrol or guard when organized should be thoroughly efficient in numbers, personnel, organization, and equipment, and that its men, who are frequently placed at lonely stations and required to act upon their own initiative, should be not only steady, well-disciplined soldiers, but in addition must be carefully selected, intelligent, and keen men, skilled as observers and trained in the use of the telegraph and of mechanical appliances. Besides all this they should possess that judgment which seldom blunders in its work. Fortunately for the country, men of this character are many in civil life and will be found in abundance when called, but these men must be trained as soldiers.

The work of installing the fire control was formerly performed by the Signal Corps of the army, and many of the types of instruments used have been designed or adapted by the corps. But in addition to the fire-control systems there must exist both within and without artillery districts the fifth factor of the coast defense, that is lines of information, whether electrical or visual, by means of which artillery headquarters are kept in touch with the interior of the country and with centers of control; the factors and elements of the defense are brought into co-ordination; fixed positions connected; and the district bound into a whole under control of its commander, as an army in the field is linked together and maneuvered by its general.

These units are, as a rule, separated from each other by considerable distances. Each headquarters, however, is kept in touch with the others electrically, mainly through the commercial systems of the country; but the commercial systems are, of necessity, frequently supplemented by military lines, which extend them to



ILLUSTRATING TWO VISUAL AND ONE ELECTRICAL MEANS OF SIGNALING; HELIOGRAPH AND WIGWAG AT LEFT, WIRELESS ON RIGHT

artillery headquarters. Within artillery areas the various posts may, or may not, be reached by commercial systems; even district headquarters, when placed on coast islands or at other isolated and scantily peopled localities, from which the money returns would be small and the expense of installation and maintenance of land lines and cables would be great, are dependent at all times upon military lines of information for communication with the outer world as well as with the fixed positons themselves.

In general, artillery lines of fire control and of information (except the field lines necessary in maneuvers) are, in peace, permanent in type; but in war to permanent lines are added a network of temporary systems as flexible and extensive as need be, and in character resembling those of an army in campaign. These may be more limited in extent, perhaps, but based on more stable conditions they are consequently easier to install and maintain against interruption by an enemy, except in the case of the radio. If interrupted, repairs are easier made, since the material should always be at hand at the fixed positions, But as with lines of information in the field, those of the coast defense, both permanent and temporary, must be certain and speedy. They will be more complicated and varied than is possible with the former, since they imply, in addition to land lines, systems of information extending both under and over the sea, and include in their scope every known method of transmitting intelligence from the wink of the ardois, the flash of the searchlight, the tick of the telegraph key, or call of the buzzer to the message of the long-distance radio and of the airplane or dirigible.

With the permanently laid lines of the coast defense transmission should, of course, be as efficient and satisfactory as in civil life if the systems are properly installed and skillfully operated in practice; but in order to secure these results it is evident that the ponderous permanent systems of the fixed defenses, both fire control and information, cannot be thrown out in an hour like the wires of a marching army, but must be carefully planned and constructed in advance as the defenses themselves are planned, must progress to completion with them, and when in place must be proof against reasonable probability of interruption.

Temporary lines will, of course, be installed only when demanded by the exercises and maneuvers or by the exigencies of war. Neverthel ss, the means of providing them should be at hand within each artillery district, so that when needed field telegraph and buzzer lines may be laid easily, quickly, and without confusion from district headquarters to the supports, mobile troops, to headquarters and observation stations of the coast patrol. The telegraph and telephone, radio sets and visual appliances should be in readiness for use in the exchange of signals between the fixed positions and coast-defense ships, patrols, picket boats, and scout ships, as well as torpedo planters and the cable ship when necessary, and with the navy. The field telephone should be ready to tell its story from observation stations and the airplane and dirigible should be at hand to send by radio or visual signals their messages from land or sea. Thus the temporary lines of artillery districts will include many aerial systems, and even the permanent comunications will not be electrical alone. Both will depend largely upon the auxiliary, but still very important, class of visual and oral signals, which before the introduction of the radio telegraph were the only means known of exchanging ideas without material connection. Visual signaling is probably more important in coast defense than with the army in the field and is vital when communication is needed between ships and shore and the radio is silent. Whether all the signal apparatus outlined will be used by the defense is another matter; still the possibility exists, and the fact remains that opportunity should be given those who have control to employ every method of transmitting information that may prove reasonably valuable. To do this it is necessary that signal appliances of all useful kinds be stored in depots within artillery areas, in addition to the material required for the emergency repair of permanent systems.

In war the headquarters of each artillery position, even more than coast patrol stations, becomes a nucleus of intelligence regarding events at sea, and therefore the service of information in and from these districts should be as perfect as it can be made.

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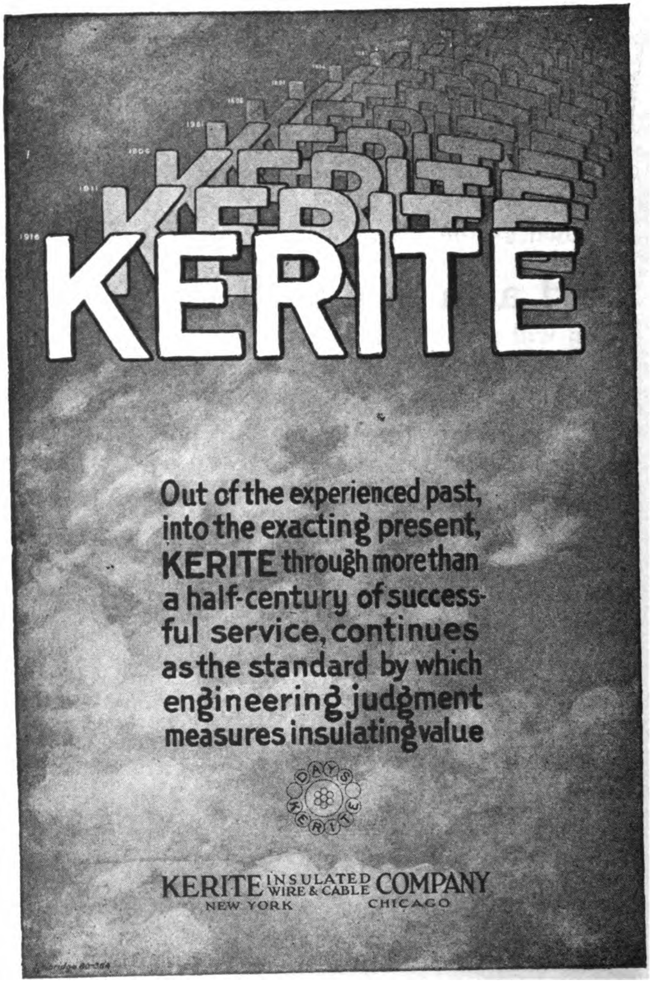
Equipment Section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