2nd Lecture

on

FIELD SIGNAL COMMUNICATIONS

Infantry and Cavalry School

DEPARTMENT OF MILITARY ART

By

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Signal Corps

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FIELD SIGNAL COMMUNICATIONS.

To give an idea of the organization of a Signal Corps command necessary to keep satisfactory communication with a body of troops, for instance a division of an army,—while on the march, near the enemy in action, in retreat and in station,—it may be stated that electrical means have supplanted to a great extent all others and that visual means are only used as an adjunct, across impassable objects with detached parties, with a town undergoing a siege, or allied uses. A Signal Corps command, therefore should be organized primarily for the purpose of electrical communication and secondarily for visual communication.

The officers concerned with the use of the several means of communication should remember the working capacity of the various instruments and appliances: that is, whether the message they wish to send is to be transmitted by buzzer, telegraph or visual signals, and the time it will probably take to reach its destination.

Nothing is known which will instantly transfer the thought of one being to another; and, consequently, every signal takes time. At a distance less than two miles if a message of over 40 words be sent by telegraph, buzzer or telephone, a mounted orderly would propably be a more rapid means of delivering the message, provided he knew the position of the addressee. On the other hand if a message of 5 words were sent, it probably could be delivered before the orderly was fairly started. Also if a visual signalman is given a message of 200 words to send a

distance of five miles an orderly would undoubtedly deliver it first, but if one of a few words, the message would have been delivered before the orderly had been instructed as to the route he should take. In short, stations should not be established any closer than one mile from each other under ordinary circumstances and military messages should be as concise as possible during an action, and the system should not be blamed when it fails to do the impossible. That the visual signalist and telegraphist has justified his professional existence in every army in the world, has been the experience of each. The deterring factors in its full utilization by the persons for whose use it is intended, have been, incredulity, and a failure to accomplish the impossible taken as an argument for its unreliability. Many messages of 3 or 4 words sent on a battlefield have saved the day for the force transmitting them, and it is scarcely possible to overestimate the incalculable benefits which accrue from a reliable system of intercommunication for the parts of an army, under all conditions. With his hasty outline of the working capacity of the various devices when in the hands of trained men, (for trained they must be to a marked extent as nearly the whole efficiency of a Signal Corps command depends on the ability of the individual men composing it) we may go on to the organization of the command itself.

FIELD ORGANIZATION OF THE SIGNAL CORPS.

To illustrate the manner in which a Signal Corps command would operate with an army, we may take the division composed of three brigades, cavalry, artillery, and special troops, as an example.

We may suppose that this division has arrived at its concentration point and is to make an invasion of a hostile country. We may assume, (the distances

are taken to be maximum in every case), that this division is to march for one hundred and fifty miles into the enemy's country, then meet him, that the depth of the division on one road is fifteen miles, that it moves fifteen miles per day and that when it deploys for action its front will be equal to its depth. To keep the brigades, separate organizations and trains of this division in communication with its commander and with the base while en route, is therefore the first requisite and to do this it is necessary to put in fifteen miles of line per day. This line should be of such a character that little attention need be paid to its operation and maintainance after it has been built, unless cut or destroyed by the enemy. The lance line is the kind best suited for this contingency, worked with close circuit telegraph instruments. The lance line can be installed at the rate of fifteen miles per day by fifty men, and transportation, but it will take every minute of their time to do this and maintain one station; if several stations are necessary more men will be required for this work alone. Providing cavalry is sent out in advance or on the flanks communication systems of greater mobility than the lance line are required and mounted men reeling off light buzzer wire, and also equipped with visual signaling apparatus are necessary for this purpose. Possibly several detachments of this kind would be dispatched at one time as the enemy was approached more closely. When it becomes necessary to engage in battle and the division is deployed, something which can be depended upon more than buzzer wire is needed; the insulated field wire answers the requirements and should be used during deployments. Furthermore the Signal Corps should be able to deliver all its own messages, and not call upon the other branches of the service for orderlies, it should as far

as possible furnish its own escorts and patrols, do its own reconnoitering for lines, be able to protect itself when small parties are attacked by the enemy, and lastly to put itself in the main fighting line, should all means of communication be out of the question. Taking these and other considerations into account, the following organization of the Signal Corps sufficient to give communication to a division is considered to be the best. No organization of units is prescribed by law for the Signal Corps of the United States. The following organization embodies the views of officers of the Signal Corps, and others who are thoroughly conversant with its needs, and follows to a certain extent the organization of the communication troops of some of the European armies. In the past the Signal Corps of the United States, has habitually been given the task of accomplishing the almost impossible, due to the limited number of men etc., given it for the work in hand. That the results have been favorable even under the circumstances surrounding each, has been almost the universal result. It is as absurd to send out fifty or sixty Signal Corps men to keep up and render efficient the signal communications of a division of troops, as it is to send a squadron of cavalry against a brigade of infantry well entrenched and supported by artillery. I, therefore, give the following number of men, organization, and transportation which although not authorized by law, would have to be adopted in a general way, if war were to be waged against a first class power. With this organization, under zealous officers, a division of troops would have as nearly perfect signal communication as would be commensurate with effectiveness and economy:

One Major — One Adjutant

One Quartermaster and Commissary

One Sergeant Major

One Quartermaster and Commisssry Sergeant

Two mounted companies. Three officers, 55 men, armed and equipped as cavalry machete in place of saber.

Transportation, 4 reel carts, 1 complete pack train, 64 mules and 12 packers. Each mounted company to be divided into two buzzer sections of 27 men each and each buzzer section into one field buzzer squad and one cavalry buzzer squad. Wire capacity 50 miles field wire, 110 buzzer wire each.

Two dismounted companies, 3 officers and 110 men each, with mounted platoons of 25 men each. Armed the same as mounted companies except for dismounted men no machetes. Four combination battery and wire wagons, 4 lance trucks, 4 escort wagons, each.

Each dismounted company to be organized with two sections of a field train of 50 men each. One hundred and twenty miles lance line, 100 miles buzzer line. Each company, squad, etc., to have complete V. S. apparatus for day and night signaling.

Total: Fifteen officers, 333 enlisted men.

Total line capacity of battalion:

240 miles lance line.
110 " field lines.
400 miles buzzer line.

Complete visual signaling apparatus. (By this is meant that every four men in the mounted companies and every 8 men in the dismounted companies, would have 2 flags, 1 night lamp, 1 heliograph.)

With this organization, as the division starts on the road, one dismounted company would be given the duty of building, operating and repairing the main line to the base. A station would be established at the base, and one officer, 8 dismounted and 2

mounted men left there for operation and administration. At the end of the first days' march or at a point convenient to guard and where supply trains camp, etc., the first station on the main line would be established, three dismounted men and one mounted man would be left at each way station for operation and repair. As the division camped each night one or both mounted companies would connect all brigades, separate posts, outposts, etc. This would take less time than it would for the troops to get their evening meal. For this purpose field wire would be laid on the ground from the reel carts, a telephone placed at each office and the various lines run into the small field central switch-board near division headquarters. Telephones or buzzers are the most convenient instruments to use for this purpose. Visual signals could be employed during the night for drawing in or pushing out the outposts or anything of this nature. When the march is taken up in the morning the camp telephone system would be as rapidly recovered as laid, and the main line continued as before along the line of march. If any permanent forces should be placed at a distance from the main road, the other dismounted company would connect them to the main line by lance line. If the division in question were part of an army corps and the other divisions were marching along parallel roads, lance lines would be built from one to the other every thirty or forty miles or as the terraine and activity of the enemy would dictate, in order to have interior lines of signal communication. This general plan of connecting various parts of the division and other divisions would continue until the near approach of the enemy made it necessary for more reconnoitering etc., in which case one or both mounted companies would be assigned to the duty of keeping up the signal commu-

nications of the reconnoitering parties, either electrically or visually.

This would be done by running field or buzzer lines with the parties themselves, or to a stated rendezvous where their messengers could report. Also if any hills or physical features present themselves in convenient places, they should be occupied by signal parties and a wire run from them to the main line, these stations being provided with visual signalling apparatus would then be picked up by the signalmen, with the reconnoitering parties, by visual means.

When the enemy is encountered and the deployment of the division is made, the companies would be detailed as circumstances required to various parts of the line. Field lines should in all cases possible be run from the division commander to the various brigades and artillery positions, buzzer lines not being reliable where troops are moving as the buzzer wire is too easily broken. These lines should be kept with the organizations which they are connecting as they move from place to place, the exact positions of the stations themselves depending on circumstances, that is whether with advance, support or reserve, but generally the support of each sub-divison, or the position taken by the commander thereof is the most convenient place as it is the most accessible to all. The positions where stations are to be placed should be known by all and if possible they should be marked by signal flags or in other ways providing it does not disclose their position to the enemy. As far as practicable, points of observation shouid be occupied and reports concerning the enemy and the exact positions of the troops should be reported by the signal troops to the division commander. This disposition would continue until the end of the action, the stations ad-

vancing or retreating as the case may be. Should it become necessary for the army to assume the defensive and entrench, each part of the line of defense would be connected by telephone or other means and all made mutually intercommunicating by the installation of a field switch-board. Should it be necessary to retreat, the lines would be rapidly recovered and to the dismounted companies would be assigned the duty of taking out the lances from under the line to the base. The stations would be kept until the last organization had come to them, then other stations would be established at short intervals each being abandoned as the rear guard approaches.

As the wire of the main line would be lying on the ground, the lances having been removed, it could be reeled up at a gallop by the wagons. The mounted companies during the retreat would occupy all prominent physical features on the flanks and signal visually to a prearranged point on the line of retreat or send couriers. We have now traced the division while on the march, near the enemy and in retreat.

In station, the signal installation would resemble to a great extent a town telephone system and telegraph offices connecting with outside lines in a friendly territory. The division commander would merely indicate the places with which communication was necessary, and lance lines, field telephones and field telephone switch-boards would be used for the camp telephone system. Regular main line relays and sounders would be attached to the permanent telegraph line running to the camp. In the field great use can be made of the communicating systems by spies or the military intelligence department. This may work either to the advantage or disadvantage of the force using them, and precautions should be taken accordingly.

In the actual establishment of lance lines the following general suggestions taken from an able publication on the subject should be observed.

"Lance lines should be as straight as possible.

"When following a road or highway the line should be placed beyond the ditch so as to be entirely out of the way of trains. When crossing country the same object should be kept in view, and the line run along the edge of timber or brink of ravines, avoiding ground likely to be selected for the parking of trains, or upon or across which artillery is likely to be moved." In short this means that everything should be done to safeguard the lines from moving troops. Often it is impossible to run lines in the time required except where troops will be moving, and it then becomes the duty of all officers to see that the wires or other appliances are not endangered by their commands. This point was well illustrated at the maneuvers of our army, where the militia organizations, not knowing the nature of these things, continually broke wires, lances, or anything of this nature in their path, while the regular troops were habitually careful. This could be calculated upon to such an extent that wherever militia trooops were operating three times the number of line patrols were necessary than was the case where the regular troops were moving. Consequently nearly three times more dependence could be placed on the line where the regular troops were, than where the militia were. The welfare of the wires and appliances should be looked to by every one in the military service during active operations, and if wires are seen to be broken they should be joined together if possible.

WIRELESS TELEGRAPHY.

Wireless telegraphy has had no practical test with an army in the field during active operations,

the navy having used it more than the land forces. A wireless telegraph line was operated by the Russians from Port Arthur to Chefoo during a part of the siege of the former place; this is the only instance where it has been used successfully by an army during active operations. It may be said at this point, that the Signal Corps of the United States Army has as good a system as any, now in operation between St. Michael and Nome, Alaska, a distance of 117 miles across Norton Sound. This system has been largely the outcome of investigations carried on by officers of the Signal Corps, especially Capt. Wildman, who obtained patents on several devices, which he turned over to the United States. At present, as far as I know, Germany is the only power which has adopted a standard wireless field equipment. Each station requires a portable dynamo driven by an engine, a system of accumulators or storage batteries, a telescopic pole for elevating the antennae, and a recording instrument or coherer.

The whole outfit is extremely ponderous and of little mobility except along perfect roads. This apparatus is capable of exchanging messages at a distance of 30 miles, and might be utilized for maintaining the principal line of signal communication from an army in the field to its base. For rapidly moving columns the apparatus at present is too heavy, unless used on railroad trains. With most apparatus the messages can be taken and the transmission interfered with by the enemy, or by other instruments that may happen to be near enough; this, however, is being eliminated to a great extent by synchronizing or tuning the instruments to each other, thereby making an instrument receive only the waves which will directly affect it. Major Squier of the Signal Corps has recently conducted some interesting exper-

iments with plant life in connection with wireless telegraphy. These tend to show that trees may be used as receiving and transmitting apparatus, acting to some extent like the transmitting wires and receiving coherer. This may be of great service in the future application of wireless telegraphy in the field. At present the science of wireless telegraphy in its practicable application under all conditions is in the development stage, although rapid strides are being made to its perfection.

AUTOMOBILES.

Although the perfection which has come in recent years has made the automobile a comparatively well known vehicle the fact must not be lost sight of that this, like many other mechanical devices has come through a long period of experiment, which has culminated in the practical machines which we have today. The first automobile recorded, was designed and built by Captain Gugnot of the French army in 1769. This might be called the first military automobile. Its motive power was steam, but due to the many faulty devices used in its construction it was not a success. From 1769 until 1830 experiments continued. At length the machine took the form of what we now call the traction engine. This sort of automobile is now used for heavy transportation by the armies of many nations. The light road vehicle as we know it today did not come into practical utility much before 1885. Their perfection is due in a great measure to a German named Gottlieb Daimler who about that time, made his gasoline motors a practical reality. At present we have, generally speaking, three distinct propelling forces for automobiles; the gasoline, steam, and electric motors. Each has its advantages and disadvantages. The experiments carried on by the Signal Corps of the

United States Army for the past six years, show that the gasoline car is the best suited for a light military vehicle, steam propulsion for traction, and electric for general trucking around a town, or where it is convenient to electric charging plants. The vehicle which has given the most satisfactory results in the Signal Corps, is a gasoline car, of 20 horsepower. A machine of this kind should be able to propel itself over ordinary country roads at the rate of 20 miles per hour, while carrying 2000 pounds. It should be able to climb a 25 per cent grade, and use not to exceed one gallon of gasoline per ten miles of distance covered over level roads whether running fast or slow. It should have at least fourteen inches distance from any point of its axles or body from the ground—this to give sufficient clearance for ordinary roads. Its construction should be as simple as possible. The motors of the automobile should be so arranged that they can be used for transmitting power while the machine stays in one place. Such power could be applied to running a wireless telegraph plant, charging storage cells, running a field search-light or to pull the machine itself out of difficult places by blocks and tackle. The 20 horsepower gasoline car embodying these requisites will weigh about 2000 pounds. The use to which automobiles are put in the Signal Corps, consists of transporting parties to points on a line which has been broken or cut, running field lines from the machine itself, occupying a point well in advance for signalling or reconnaissance purposes, before the enemy could possibly arrive with his cavalry, and in short to cover great distances in a minimum time, while carrying several men and sufficient material to repair ordinary breaks in lines, operate visual signal stations, or run new lines. The utility of the automo-

bile can be readily appreciated when it is stated that a machine such as the one spoken of above, can start with four men and supplies to the weight of 800 pounds, go out for one hundred miles and return within fifteen hours if on fairly good level roads. Mud is the great enemy of the automobile, over nearly any road where wheel transportation can go propelled by their own transportation animals, an automobile can follow, except where the mud exceeds one foot in depth. An automobile should be able to cross streams the depth of water in which does not exceed thirty inches. A gasoline car is difficult to operate (as is the case with other types) at temperatures much below freezing, as the cold air admitted into the carburretor renders the mixture of the air and gasoline difficult, a proper mixture of the air and gasoline being necessary for the operation of the motors.

SEARCH-LIGHTS IN THE FIELD.

The same considerations which render a wireless telegraph equipment cumbersome in the field, also apply to the field search-light plant. The single light is run by a steam engine driving a dynamo, both of which are mounted on one wagon. From the dynamo the power is transmitted to the light by a cable some hundreds of yards in length, mounted on a drum and generally placed on the wagon with the light. The light itself is mounted on a wheel base with a bullet proof steel shield surrounding it. An appliance is also placed in the vicinity of the carbons of the search-light so that the light can be flashed for signalling. The power of these lights is such under favorable conditions that they can illuminate objects at distances varying from seven to ten miles. For practical purposes objects can be brought out clearly for minute observation at at about the same distances that they are by daylight,

namely, from two to five miles. At a distance of two miles, with most of the search-lights as now made, the diameter of the illuminated space is about two hundred yards. In observations with the search-light considerable experience is necessary, as objects which by day are illuminated from above present a different appearance when illuminated by rays parallel to the earth from a search-light. The principal difference between daylight and the beams of a search-light is the character of the shadows cast by the objects illuminated, in search-light work the shadows are very large and black. If an object is illuminated from the rear it is nearly as difficult to distinguish what it is, as one lying between the sun and an observer. In the case of artillery and infantry firing upon a search-light when it is in operation, it has been established that at their mid or long ranges, the search-light has little to fear as it is extremely difficult to get the range. Should an enemy have a search-light it would therefore be necessary to approximate its probable position during the day, and estimate the ranges accordingly if it became necessary to fire on it at night.

In order to obtain the best result from search-lights in the field, they should be capable of covering the whole front of the organization employing them with a continuous circle of light.

This would hardly be practicable as too many lights would be required, and the costs probably would not be commensurate with the results. One or two field search-lights will probably be found necessary with each division of troops, and will be used for observations beyond the outposts, keeping watch of roads, lines of communication, signaling, and of the positions of the enemy or his disposition preparatory to a night or morning attack. What is of con-

siderable advantage in search-light work is the fact that troops at night move scarcely half as fast as they do in the day time, thereby making it possible to observe them twice as long while marching a given distance at night as would be the case in the day time. Another mode of applying the beams of the search-light is to place two at some distance from each other and cross their beams near the earth some distance to the front. The triangle formed by the line between the lights and the point of intersection of their rays is practically invisible to a person in front of it, even if the beams of another search-light be directed against it. By this means entrenchments may be constructed within the perimeter of this triangle, during the night which the enemy will be unable to see. This method has been applied successfully by the Japanese in their present campaign. Photography can also be used in conjunction with the light, and when not in use with a search-light the dynamo could be employed to furnish light for various works or for charging wireless storage cells. The personel of a field search-light plant should consist of two officers used to observing with it and who should do all the observing, three non-commissioned officers and nine privates three of whom should be mounted for delivering messages. The enlisted men would act as electricians, machinists, light operators, firemen, and tend to the signal telephone or other signal communications placed with the light. There should also be two teamsters.

BALLOONS.

No mention has been made of balloons nor their direct application during an engagement in my remarks above. Their application to warfare has been of long standing, but, due to the former weight of the appliances necessary for their operation and

maintenance, they have not been used in the past to the extent that they will be in the future. The spherical and German, or "sausage" type as it is sometimes called, have been thoroughly tested, and their usefulness and limitations have been definitely established. So far, no organization for balloon work has been authorized by law in the United States army. I shall therefore give some notes on the organization of the German balloon company, their manner of operation and the results which may be obtained by a judicious use of this valuable adjunct to the service of security and information. The German balloon company is organized about as follows:

5 officers.
20 non-commissioned officers.
130 men.

They are divided into seven groups.

The balloon group,	2 non-com. officers	38 men.		
" gas "	1 non-com. officer	12 "		
" car "	1 " "	4 "		
" cable "	1 " "	4 "		
" telephone group	1 " "	4 "		
" advance guard group	8 non-com. officers	30 "		
" reserve group	4 " "	16 "		
" drivers "	2 " "	22 "		

20 wagons, 9 for material, generating and compressing apparatus, 12 for gas, 1 windlass.

The balloon group unfolds, inflates, and gets the balloon ready for the ascension. The gas group attends to the application of the gas. The other groups are employed as their designation indicates. The advance guard prepares the ground where the balloon is to be inflated and then deploys as skirmishers to to the front, to keep away small parties of the enemy, marauders, etc.

The men in the reserve group are detailed as sentinels, orderlies, and patrols. In addition to the wagons mentioned above other wagons known as the re-

serve train are also attached. While acting with a large body of troops, the balloon company should be marched near the head of the column and be ready to begin filling at a moments notice. The discovery of the enemy in force would under ordinary circumstances be the proper moment for beginning to fill. It must be remembered that the balloon upon rising will indicate to the enemy the approach of the advance guard, but as it takes about thirty minutes to fill the balloon the organization with which it has been marching, will have gained about one miles distance to the front, and presumably will continue advancing. The principle things to be learned by the observer are the roads over which the enemy is advancing the strength of his troops, the length of his columns, the length of his lines, the positions he occupies, and details of a like nature. These things should be immediately reported clearly and briefly. On the basis of these reports, instructions will be given by the commander for further observation. A balloon may be used as a means of reconnoissance during an entire engagement when other means are impossible. Regarding the effect of hostile artillery fire against a balloon, it may be stated that if the distance is less than three miles the safety of the balloon is at stake, if at greater distances and one thousand feet in the air, it is practicably immune from the effects of hostile field artillery. Frequent changes of position render it more difficult to hit. The ordinary maximum distance at which reconnoitering can be carried on is about five miles, although it has been stated that with a thirty power telescope the different branches of the service have been distinguished at a distance of nine miles. Under ordinary conditions of atmosphere however, the maximum distance is about five miles. It may be noted here, that a bal-

loon sent up in the center of a division in line would be able to cover its whole front in its field of observation. Theorectically a balloon company should be attached to each division. As can be seen by the foregoing the principal uses of the balloon are in the attack but it may also be used with effectiveness on the defensive providing the enemy's artillery can be kept at a distance of something more than three miles. In retreat the balloon would also be useful if towed along the line of retreat with sufficient speed to keep it away from the enemy. This maneuver would probably result in the loss of the balloon, but might be compensated for by the results obtained.

Photography plays an important part in the balloon reconnoisance. The exposure must be instantaneous as there is always more or less vibration to a balloon. As it is difficult to see the image of the object to be photographed in the finder of the camera at the distances usually met with a good many devices have been tried. Probably the most successful is an arrangement resembling the stock and sights of a rifle. The camera is attached to one side of this, with its focal axis parallel with the line of sight, the trigger is so arranged that by pulling it an instantaneous photograph will be made. This apparatus is then set, the object aimed at and the trigger pulled. These photographs serve as good maps of the locality taken. An approximate scale can be made if the photographs are taken vertically downward, which can be assured by the spirit levels on the camera. Then taking the balloons altitude if captive, by the cable, if free by barometer, for the base of the right angle triangle, the angle formed by the hypotenuse with the base would be one half the angle of the camera's lens, the perpendicular would be the distance from the centre of the picture to its edge. It is said that with a teleophoto lens, the outline of a fortress, number of guns and their positions can be taken at a

distance of six miles. To one unaccustomed to the perspective from a balloon, some cifficulty is experienced, as the image resembles a bowl when looking down at it. In other words the edges of the picture appear as if they were raised, and the part around the center looks as if it were sunk down. This also applies to the image produced on the eye by looking down from a balloon. Balloons are used to signal from by flags, lights and along a cable by telephone; and recently for raising the antenna of a wireless telegraph equipment. With this hasty summary of the uses of captive balloons we may now consider the free balloon. Nearly everything said concerning the observations which are made from the captive balloon can also be said about the free balloon, the great drawback being the fact that generally no communication can be had until the landing of the free balloon, unless carrier pigeons are used. The principal use of a free balloon is in sending it out of a beleagured city to convey information to its own country beyond the lines of the attackers, or by the attackers in sending balloons over a besieged city for observation or to drop explosives.

As the directlon of flight of free balloons depends on the direction and strength of the wind they can only be used with good results at favorable times.

DIRIGIBLE BALLOONS.

This branch of ballooning has not been practically applied up to the present by any army during active operations, and I make brief mention of it here merely to convey an idea of what has been done in this field, and what will undoubtedly prove to be a fact in the future. At present there are two distinct schools of aerostation; one holds that the navigation of the air should be made in the same way that birds sail, namely the aeroplane principle. of which school Professor Langley of the Smithsonian Institute in

Washington is one of the foremost exponents. The other school holds that an airship should be made on the same principles as one on water: namely, that it should have an instrument for holding it up, and an impelling force to drive it on, analogously to the hull and propellor of a steamer. Of this school, Santos Dumont, a Brazilian, is the foremost exponent, and as he has accomplished more in a practical way than any other person, I shall give some notes of the performances of his airships.

With his "No. 6" ship Santos Dumont has traveled twenty seven miles per hour over a measured course in still atmosphere. His "Number 7," known as the racing airship, is built to go more than twice this speed, and can probably be relied on to go fifty miles per hour although I have no data showing that it has been done. This means that an airship can rise, maneuver and alight in any atmospheric condition short of a hurricane. As to its application in war, all that has been said of the captive balloon would apply to the dirigible balloon except that communication with the earth would be more difficult. It could course at will over a battlefield, carry messages out of a besieged fortress, or sail above a beleagured place, immune from the actions of men on the earth's surface. By towing another balloon loaded with explosive, several hundreds of pounds of gun cotton could be dropped from the balloon which it is towing in the midst of an enemy's fortifications. It may be said at this point, that dropping a weight exceeding a pound or two would probably disrupt any balloon envelope as made today, due to the tremendous speed with which the balloon would instantly rise. Ballast has to be handled carefully, generally not more than a pinch of sand or a teaspoonful of water ballast is to let go at one time. As no con-

crete organization has been adopted for dirigible ballooning it is not mentioned. The French military authorities are especially busy on this subject, and so far are probably the leaders, One interesting fact connected with dirigible balloons is, that when cruising over a body of water at a height of some one hundred or two hundred feet, objects in the water can be perceived at a great depth; some day therefore we may see dirigible airships acting as scouts for the navy to detect the presence of submarine vessels. Conflicts no doubt will be carried on in the future in the air, on the surface of the earth and water, and under the earth and water.

In conclusion it may be stated that the Signal Corps troops serving with an army should be composed of an extremely well educated body of officers and men, both individually and collectively, proficient in the subjects of electricity, reconnaissance, signalling electrically and visually, the use of codes and ciphers, disciplined and drilled in the use of their arms, and having a good knowledge of organization and tactics, in order to better serve the various branches of the army, to all of which they act as a common carrier of information. It is recognized that these subjects are a separate and distinct science in themselves requiring an organization which can give up its whole time and energy to their perfection; this is the duty of the Signal Corps.

Uniformity in instruction and coordination in work by the individuals, being an indispensable adjunct to a satisfactory signaling system, to attain excellence in coordination and the work mentioned above it is necessary to have a definite organization of units in which systematic work and instruction can be given. No organization of units is prescribed as yet in our service. In the armies of the leading mili-

tary nations, the Signal Corps is organized in definite units and in most cases is regarded as a special adjunct of the general staff, in its roll of gaining, transmitting and receiving military information.

LIST OF QUESTIONS ON SECOND LECTURE; FIELD SIGNAL COMMUNICATIONS.

1. What should be the first consideration when it is desired to hand in a message for transmission?

2. Why is a lance line the most reliable means of communication in the field?

3. How many men are necessary for the installation of fifteen miles of lance line in one day?

4. What kind of wire should be used in deployments and how rapidly can it be installed?

5. What kind of wire is best adapted for connecting with rapidly moving troops off the main line of advance?

6. Give in a brief manner the system of signal communications of a division of troops; while on the march, near the enemy, and in retreat.

7. What three appliances in general make up the field signaling equipment?

8. How many Signal Corps men are necessary for the operation of a route telegraph station?

9. How and with what instruments may a camp signal communication system be installed?

10. How should signal stations be marked, and what should be known to the army in general as to their location?

11. Can the enemy use the lines of signal communication of the force against which it is operating, for its own good?

12. About what should all officers be careful in reference to lines or communicating systems in the field?

WIRELESS TELEGRAPHY.

1. What is the longest distance that is signaled over by wireless telegraphy in the United States Signal Corps at present?

2. What is the ordinary range of the field wireless telegraph equipment?

3. Why is a wireless telegraph equipment immobile in the field and where can it be used to advantage?

4. How can the transmission of wireless telegraph messages be interfered with by the enemy.

FIELD SEARCH-LIGHT.

1. What are the essential parts of a field search-light equipment?

2. At what distance can the field search-light illuminate objects and at what distance can objects be brought out for minute inspection?

3. What is the difference in the aspect of an object if illuminated by daylight or by rays from a search-light and how do the shadows differ?

4. What effect does hostile artillery fire have on a search-light at four thousand yards, and what would it be necessary to do in order to destroy an enemy's search-light by artillery fire?

5. What are search-lights used for in the field, and what consideration plays an important part in observing troops at night?

6. How can intrenchments be pushed forward by the aid of search-lights?

7. What training should officers have who are to observe with the search-light?

BALLOONS.

1. In general what are the two types of military balloons as used at present, and what are the attributes of each?

2. Where should the balloon party be marched in the column and what ordinarily would be the proper time for sending up the balloon?

3. What can be learned by balloon reconnoissance and in what sort of a country is it most efficient?

4. What ordinarily is the maximum distance at which reconnaissance can be carried on from a balloon?

5. What part does photography play in balloon recon-

naissance, and at what distance can the outline of a fortress, number of guns, etc., be taken?

6. What do photographs taken downward from a balloon serve as, and how does the perspective appear from a balloon?

7. What is the free balloon used for, and on what conditions does its flight depend?

8. How can communication be had with the ground from a free balloon?

DIRIGIBLE BALLOONS.

1. What are the two schools of aerostation, and what are their principal differences?

2. What advantages have dirigible balloons over others?

3. How would dropping a considerable weight from a balloon affect its envelope?

4. What notable effect is produced when a dirigible balloon is cruising over water?

AUTOMOBILES.

1. What three kinds of propelling force are now used in automobile construction, and what is each best suited to?

2. What is the best kind of light military vehicle? Give horse-power, carrying ability, consumption of gasoline, speed, climbing ability and height of body from the ground.

3. What are automobiles used for in the Signal Corps, United States Army?

4. What is the worst condition of road with which an automobile has to contend?

What in general are the duties of the Signal Corps of the United States Army in the field?