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FIELD TELEGRAPH LINES.

BEING AN ABSTRACT FROM A MASTER'S DEGREE THESIS ON

ELECTRICITY IN MODERN WARFARE.

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AMONG the untold number of inventions that have been brought forth in the last few years, great numbers have been theoretically applied to the uses of warfare. They comprise methods of accomplishing labor of all kinds with greater efficiency as to rapidity and volume of work handled, for the most part improving the results that were at one time reached by crude and unskillful means. In addition to this, there have been made possible many feats, which seem simple enough now, that were useless to attempt by the limited means of a few years back. As is the result of trial of all things yet untried, some have proven to be vastly overestimated; the difficulties involved in the use of others have outweighed the value of the good obtained, while the best that can be said of many is that they have exceeded all expectations and created a new sphere of usefulness. Two wars, the Boer-English, and the Spanish-American including the Philippine insurrection which grew out of it, have given

excellent opportunities for testing the real merits of many of these products of modern scientific invention, and it is the intention in this work to include in its scope the observations and deductions concerning the application of electricity to modern warfare that three years' campaign with the army in the Philippines has furnished.

Such uses of the electric current as the firing of large guns electrically, and the sighting of them by the use of electric motors, and the operation of search lights for signalling and illumination are worthy of mention, but by far the most general and most valuable applications of electricity are those of transmitting intelligence by means of the telegraph and telephone. At the beginning of the recent war with Spain, it was the common if not universal opinion that the signal flag, torch, and heliograph would play an important part in maintaining communication between the various parties making up an army in the field, and consequently the men of the Signal Corps were rigorously trained in the use of the Meyer code. Even the signal officers themselves, to whom this duty is intrusted, did not anticipate how completely these instruments would be superseded by the telephone and telegraph. This fact has not come about through any decrease in efficiency of the former, and it can only be said that their disuse is due to the infinitely more effective and practical applications of electrical transmission, which have been more phenomenal than their most enthusiastic promoter could have expected. I will venture to say that few people, even in the army itself, realize the extent of the business now being handled by the United States Military telegraph system. The figures for the month of October, 1900, were as follows:

Manila Central Office, sent and received, . . .	23,906
Luzon System, sent and received,	260,735

Even these figures do not tell you that many single messages would fill two of these printed pages. They range in importance from orders from the commanding general concerning the movements of troops to invitations to dinner.

Commissary, medical, quartermaster, and ordnance stores are ordered from the bases of supply by telegraph, and the principal function of the mail in handling official business is to carry certain printed forms and signatures required by the service, long after the real business has been transacted over the wire.



PLATE I. LANDING THE SIGNAL CORPS CABLE AT CORREGIDOR ISLAND.

Naturally, the first form of electrical communication to be used in warfare is the field line which connects the various bodies of troops with their headquarters and with each other. Other lines of this class are carried with moving columns which constitute expeditions against the enemy at a distance from the military base.

A typical system of field connections, perhaps, was the one used with the army operating against the city of Manila in August, 1898. On top of the tall shears on the dock at Cavité was placed a flag station, which communicated with all of the war vessels and army transports lying at anchor in the harbor. In an adjacent building a telegraph station was installed, from which ran a line around Manila Bay to Camp Dewey, a distance of about twenty miles. For this line, No. 14 galvanized iron wire was used, it being put up partly on

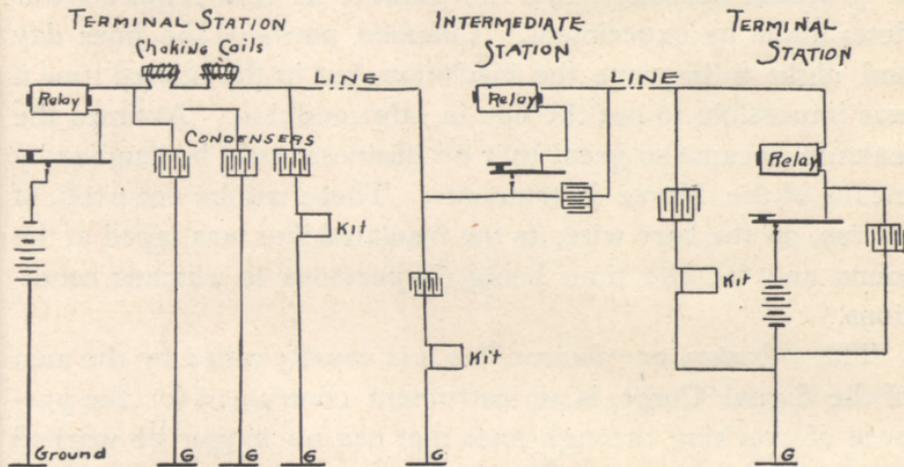
pine lances, partly on trees, and for some distance on the poles of the old Spanish line which was at that time being used by the insurgent forces. Pony insulators on ordinary light brackets insulated the line, and at the terminal stations, which were semi-permanent, Morse sets, consisting of relay, sounder and key were used. The battery was made up of gravity cells placed twelve in a box, and carefully packed to withstand rough handling in transportation.

The line of American trenches was about a mile nearer Manila than Camp Dewey, and to connect the various positions a separate line was built as follows: From either end of a single battery and set, at the Camp Dewey station, two insulated No. 14 copper wires were run toward and within half a mile of the trenches. Here they separated and ran to the extreme flanks of the trenches where offices were cut in. A similar wire was laid on the ground back of the trenches connecting these offices, and also including an office midway between the two. Leaving Camp Dewey the wires were raised on bamboo poles high enough to be out of the way of marching troops, but as they approached the trenches they ran along the ground, being less exposed to damage from shell fire. Thus it will be seen that all of these stations were connected by an endless metallic circuit, or without the use of a ground. However batteries were placed in the line at the two flank stations as well as the Camp Dewey station, so that in case both lines were shot away there would still be communication between all the stations along the line of intrenchments. This arrangement was carried into effect immediately after the first line, which was a single one, was carried away by a Spanish shell on the night of August 5th.

When the American troops advanced from the trenches on August 13th, the line to the left flank was detached from the triangular circuit, and continued on up the shore of the Bay into the city of Manila. A "ground" in place of the detached line left the remaining lines in working condition.

For the stations on this line, *box-relays* were used, which, although difficult to hear under heavy fire, were convenient on

account of being compact and easy to carry. This instrument is essentially similar to the ordinary Morse relay, but has coils covered by a square box fastened to the base-board. Holes are cut in the box opposite the ends of the cores of the relays, and opposite the front contact point of the armature lever. At the other end of the box are the screws for adjusting the magnet, and a Morse key is fastened to the right side of the base-board. The coils are usually wound to have a resistance of seventy-five ohms. The method of adjustment is exactly the



FIELD KIT SUPERIMPOSED

ON MORSE LINE

Signal Corps U.S.A.

FIGURE I.

same as that employed with the ordinary Morse relay. As the armature lever is made as heavy as possible, that, with the box acting as a resonator, increases the sound sufficiently to do away with the local battery and sounder, although these may be connected with the special binding posts provided for that purpose.

Under favorable conditions of weather, such a line as the one described has been found to work very satisfactorily, but during the time that this line was in operation the downpour of rain scarcely had an hour's intermission in days. The dense tropical foliage bent down under the weight of water, and in

many places carried with it the telegraph line, poles and all. The broad leaves of the banana and nipa palm enveloped the wire with their wet surfaces, and sapped from it the feeble current that was trying to carry the messages to direct the movements of thousands of troops, and the supply of their rations and ammunition. The theoretical resistance of the line per mile could be easily determined, but when the theoretical amount of battery to work the line properly was applied, it was found wanting, and all theory gave away to the demands of practical necessity, and the number of cells required was determined by experiment. Linemen patrolled the lines day and night to improve the insulation, but in the limited time it was impossible to put the line in safe condition. At times the leakage became so great that no business could be handled by means of the Morse instruments. These results occurred, of course, on the bare wire, as the insulated line was taped at the joints and for the time being, impervious to climatic conditions.

The *vibrator*, or "*buzzer*," as it is usually called by the men of the Signal Corps, is an instrument constructed for the purpose of working through lines that can no longer be worked by the Morse system. The first form of this instrument was invented by Major Cardew of the English army in 1881, and the various types now in use in the United States service depart but slightly from the original pattern. Some convenient arrangements have been added by way of improvement, and the accompanying illustrations show Type "C," which has proven to be the most efficient instrument of this kind. The *field kit* as it is also called, consists of a stout wooden box, about a nine inch cube, which opens into two nearly equal parts.

One side contains the battery of eight dry cells. The other side contains an electromagnet with an armature mounted upon a spring, and a back-contact stop; the coils, armature, and stop forming with the key a local circuit for the battery. When the circuit is completed by the key the armature is attracted, breaking the battery circuit, thus allowing the armature to fly

back and reestablish the circuit. The armature, which is a steel spring, is short and very rigid, and the vibrations produced are so rapid that a musical note is made, and the ordinary current from the battery is transformed into a pulsating one, which is originated by the charge and discharge of the coils. The adjustment is very delicate, and as shown in Figure I, the instrument is provided with an adjustment screw attached to the spring armature, and to further facilitate and maintain the adjustment, the contact point is mounted upon a spiral

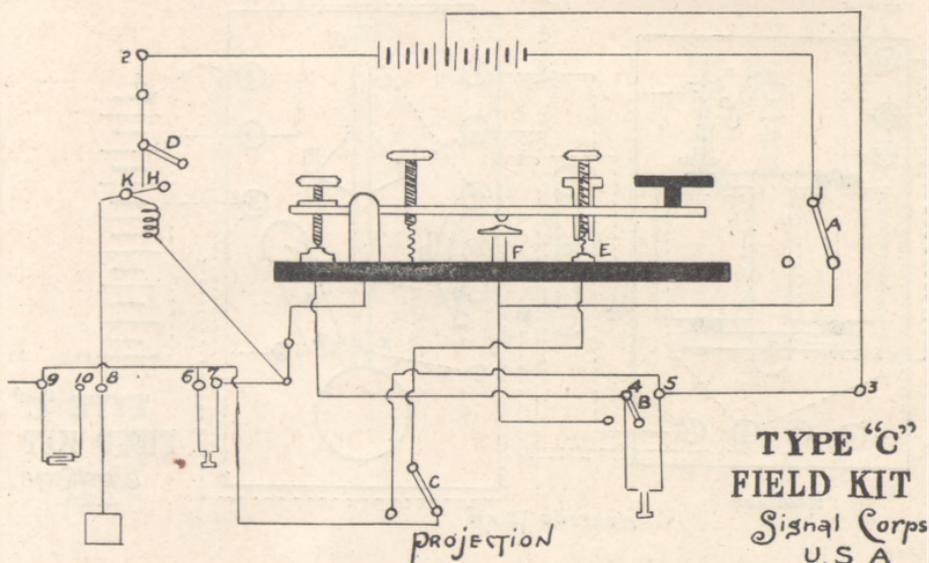


FIGURE II.

spring, and this in turn upon an adjustment screw. The telephone receiver is placed in the line, because by means of it the operator can tell that the signals are going out of the line and that the adjustment is correct. The buzz of the unaided armature itself is not loud enough to be heard while sending. The accompanying illustration, Fig. II, showing a projection of the connections, will indicate, perhaps more clearly, the method of the connections, and the relations of the switches, A, B, C, and D, to the parts they affect. It will be seen that the battery is divided so that the transmitter uses but four cells. When the full battery is used, the grating or rasping sound produced

impairs the efficiency of the instrument. The switch D short-circuits the coils, thereby producing instead of a musical note the regular Morse click, which works well enough over short distances, but the succession of rapid pulsations will actuate the instrument at a considerable distance, more clearly. A condenser is placed below the base of the instrument, and is inserted in the line by using the binder post for that purpose

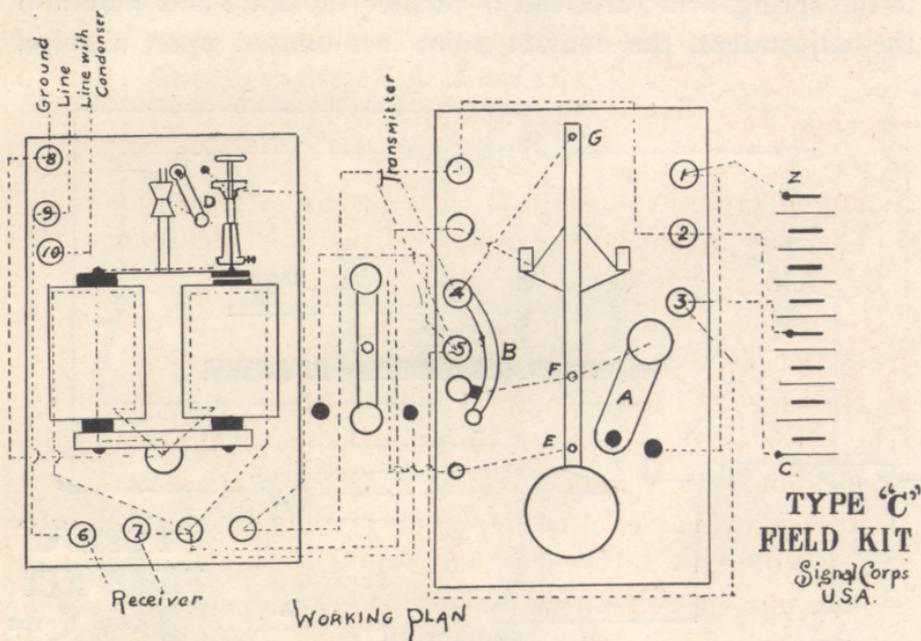


FIGURE III.

as shown in the illustration, Figure III. It has the effect to increase the intensity of the charge or discharge of the coils, and proportionately extending the range of usefulness of the instrument.

The receiver is usually of the head type, and is worn by the operator during the entire time that he is on duty. It has been found that the addition of a second receiver allowing the operator to have one to each ear, is a great help when the signals come faintly.

The intermittent current produced by this instrument penetrates seemingly impossible conditions of line, working through a barb wire actually down in the mud, and on several

occasions has been known to work satisfactorily over breaks where the separate ends were lying on the ground as much as two feet from each other. Thus in the case of the field heretofore described, as in a great many instances since, messages were gotten through on a line that was incapable of being worked with Morse instruments. No estimate can be made of the value of successful communication by this means. The use of the "buzzer" always becomes necessary just at a time when the messages are of the most vital importance. The general in the field in these later days, has come to depend greatly upon the telegraph to control the movement of troops at a distance, and its failure would render concerted action uncertain, and the rapid handling of troops impossible.

The most remarkable example of the efficiency of the type "C," field-kit that comes to mind, is as follows:

Early in December, 1899, a cavalry expedition was made from Bocaue, a station on the Manila and Dagupan Railroad, to Norzagory, a town some 15 miles distant; a signal officer was given orders to keep the column in telegraphic communication with Manila. Just at that time there was no insulated wire available, in fact, the only wire to be had was some heavy No. 9 galvanized iron wire, and the idea of following a rapidly moving column with such material seemed impossible. It was undertaken, however, and the line party laid a No. 9 bare iron wire, weighing about 330 pounds to the mile, along the trail behind the troops and kept up with the same. No attempt was made towards insulation, except to see that the wire was placed along the edge of the trail where the ground was bare of grass, and to hang it on the fences where it ran through villages. Field-kits were installed at the terminals, and for more than ten days during which the line was used, not a single message was delayed. This remarkable success was due to the fact that December is in the dry season, for in the early morning when the entire line was wet with a heavy dew, the signals could be read very faintly indeed, and during the one shower that fell they were drowned out entirely, but were restored soon after by the sun rapidly drying the ground.

Since that time moving columns have sometimes been followed by a No. 20 bare copper wire, put up on insulators when time permitted, but for the most part hung on the bushes which line the sides of the roads and trails. This method has been used where the distance was too great, and the transportation too limited, to permit carrying the heavy insulated wire. The copper wire was wound on reels in one mile lengths and weighed but three pounds per one thousand feet, but had the disadvantage of being easily broken. Its



PLATE II. TESTING SUBMARINE CABLE, SHOWING CABLE BOX ARRANGEMENTS.

small size made it difficult to see, and consequently our own troops did not have a fair chance of observing and avoiding the line. Spans have been driven into by escort wagons and broken without the driver knowing it, where if a wire of greater breaking strain were used, the obstacle would have made its presence known and the line preserved. Although the value of the two classes of line just described should not be underestimated, they serve to show, mainly, what may be accomplished when the most desirable materials are not obtainable and how extremely valuable a makeshift may become. In one instance when wire was not to be had in any other way, the copper wire making up the armor on two

miles of river cable was unwound, thereby giving about forty miles of light copper wire.

TRANSPORTATION. It has been the great improvement in materials, rather than in the methods of carrying materials, and constructing lines, that has made it possible to keep rapidly moving columns of troops in telegraphic communication. In the practical work of the Signal Corps, there has been a notable absence of any departure from the old time methods of stringing wires. Usually, the original coils of



PLATE III. FIELD TELEGRAPH STATION IN NIPA SHACK.

insulated wire for field use have been loaded on transport wagons, bull-carts, or on the backs of coolies, and from these supplied to an ordinary Western Union reel. The reel has been mounted across the top of a wagon box when the course lay through country that could be traversed by wagon. In other cases the reel has been carried on the backs of four natives or Chinese coolies. In one instance a cart was built, very similar to a two-wheeled hose cart, with a reel that contained about four miles of insulated wire. The wheels were but three feet apart, which permitted the cart to be taken along narrow trails, and its compact solid construction enabled it to be taken wherever a mule could go, or wherever men

could climb. A friction brake on the reel prevented its running away while paying out, and handles, which extended radially from the end plates at either end of the reel, furnished the means of taking up the wire. The use of more such carts at a time when they would have been of the greatest service was impossible because there were no materials at hand for their construction. Had they been already in use, it is believed that the problem of carrying insulated wire into the mountains where the ordinary wheeled transportation is abandoned, would have been solved. On accompanying General Hall's expedition to Antipolo in June, 1899, 15 miles of insulated wire weighing about two tons, was carried by 45 Chinese coolies over a trail that was inaccessible except to men in single file. A short bamboo pole was passed through two coils of a half mile each, and was raised to the shoulders of two coolies and carried thus, but at the end of the first half day, two coolies could carry but one coil, and nearly half of the wire had to be relayed to the front, requiring that all carriers traverse the ground three times.

During the forenoon of the second day so many of the coolies became disabled from swollen and lacerated shoulders, that some three miles of wire had to be abandoned on the trail, it being beyond the limit of human endurance to carry it further in the manner described.

It will be seen that four such carts as the one above described, would have carried the amount of wire required for this expedition, and could have been drawn with less power, besides having the wire in shape to be reeled out without additional labor for that purpose.

Pack-mules and pack-ponies have given good service when the amount of this class of transportation was in abundance, but the amount of wire which one animal can carry is so small that their use becomes very extravagant when they are urgently needed for carrying commissary stores and ammunition.

One American mule can carry two half-mile coils of insulated wire for an entire day, and if necessary can carry three

coils for a few hours over a good trail. Native Philippine ponies are hardy and require little feed, but as they weigh scarcely more than six hundred pounds, the load must be reduced, not to exceed two hundred pounds.

The caribao, or water-buffalo, usually draws his load upon a heavy two wheeled cart, but makes a valuable pack animal during the rainy season when the roads are deep with mud. He travels with ease where a horse would be unable to get out alive, and thus compensates for his slow speed of from two to three miles an hour.

In summarizing the account of field telegraph lines, it may be said that with one or two exceptions, where communications were not requested, no military expeditions have been undertaken in the Philippines without being accompanied by the field telegraph line, and the captured territory occupied simultaneously by the troops, and the establishment of a telegraph office ready to report the success of the expedition, its casualties, and to requisition for needed supplies.

The men who have undertaken this work, have had to traverse, in working back and forth, two or three times the distance covered by the troops of the line of the army, at the same time working as hard as men can under a tropical sun, to keep up with the advancing column. When night came, and the troops went into camp for a well earned rest, the men who had labored through the day, would each take his turn at the instrument, clearing the business of the previous day.