THE

SIGNAL CORPS BULLETIN

▼

JULY TO SEPTEMBER 1937

WAR DEPARTMENT
OFFICE OF THE CHIEF SIGNAL OFFICER
WASHINGTON, D. C.

William F. Friedman
Washington
1937

THE SIGNAL CORPS BULLETIN

July-September 1937

Published Quarterly by The Chief Signal Officer of the Army

CONTENTS *

* This issue of the Bulletin is devoted primarily to the Seventh Corps Area.

RADIO STATIONS OF THE SEVENTH CORPS AREA

By Staff Sgt. ARTHUR F. CALKINS, *Signal Corps*

The transmitting equipment of radio station WVU is installed in a frame building at the extreme northwest corner of the Fort Omaha Reservation. The transmitters of the A. A. R. S. (Seventh Corps Area) net control station, WLU/W9BNT are also located in this building.

The set used for communicating with station WAR at Washington, D. C., is a Westinghouse, 1-kilowatt high-frequency transmitter operating on three authorized frequencies, 4305, 8610, and 13290 kilocycles. At the present time most of the traffic is handled on 13290 kilocycles, the other two frequencies being used when and as conditions warrant. A De Forest 2-kilowatt intermediate frequency, and a Signal Corps high-frequency transmitter type BC–185 are used for communicating with corps net stations. The intermediate frequency transmitter operates on 166 kilocycles and the BC–185 on either 4305 or 8610 kilocycles.

147970—37——1

In addition to the above there are three transmitters available for the exclusive use of the Army amateurs. Two of these have been built up locally and operate on the 80 and 160 meter bands, while the third is a commercial transmitter, manufactured by the Lew Brown Co., which operates on 6990 kilocycles.

The corps net includes stations: WVC, Fort Leavenworth, Kans.; WZZ, Fort Snelling, Minn.; WUI, Fort Riley, Kans.; WZT, Fort Des Moines, Iowa; WZM, Fort Meade, S. Dak.; and WURC, Fort Lincoln, N. Dak. Fort Snelling, Fort Meade, and Fort Lincoln are all equipped with high-frequency transmitters, while Fort Leavenworth, Fort Riley, and Fort Des Moines make use of intermediate frequency.

There are three attendants on duty at the transmitter station, one noncommissioned officer and two privates. The tricks of these men are so arranged as to give continuous service should it be necessary to keep on the air 24 hours daily. That these attendants are efficient is quite evident from the fact that during the past 4 years not one schedule has been missed due to the failure of a transmitter. There have, of course, been interruptions in the radio service but none of them have been due to equipment failures. Only recently a telephone cable which carries the transmitter control and remote receiving circuits failed and the station was off the air for the greater part of 1 day. Regular inspections, repairs, and adjustments are made each day after the transmitters are shut down.

The remote receiving station is located in a brick building at the extreme southeast corner of the Fort Omaha Reservation. The equipment used for receiving consists of three Hammerlund, Comet Pro, short-wave receivers. One of these receivers is kept tuned continuously on station WAR. A second receiver is used for communicating with corps net stations and the third is a "standby", ready for instant use in case either one of the other instruments should fail. The output of these receivers is carried over cable pairs for a distance of about 5 miles to the Federal Office Building where the messages are actually received.

The amateur system makes use of the "standby" receiver when necessary. The second Hammerlund is also available for amateur use when the corps net is clear.

Three men, a noncommissioned officer and two privates, are on duty at the remote receiving station. The noncommissioned officer takes the readings of the frequency monitor and the other two attendants split tricks tuning and monitoring the remote receivers.

The main receiving station is located near the corps area signal office on the tenth floor of the new Federal Office Building, Fifteenth and Dodge Streets, Omaha, Nebr. The equipment now being used consists of two Signal Corps radio receivers type BC–197, one

Hammerlund, Comet Pro, and one RCA model 136, short-wave receiver. The intermediate frequency receivers are used for communicating with the corps net stations which use intermediate frequency and the two short wave receivers are used whenever practicable to work with WAR or corps net short-wave stations. The location of the receivers, in the center of the city, makes short-wave reception during the daylight hours extremely difficult due to interference from nearby electrical apparatus. An effort was made to clear this interference and operate without the necessity of using remote receivers but the city authorities were unable to approve the necessary ordinances to control the interference.

The personnel on duty at the receiving station are: Chief operator, message center chief, message center clerk, and five radio operators. Tricks are so arranged as to have two radio operators on duty from 7 a. m. to 1 p. m., and three from 1 p. m. until clear. The Western Union and Postal Telegraph Co. both maintain teletype printers in the receiving station. All radio men on duty in the station are competent teletype operators.

RADIO FREQUENCY MONITORING STATION, FORT OMAHA, NEBR.

By Staff Sgt. Harold Taylor, *Signal Corps*

The following equipment is now in use at the frequency monitor located at Fort Omaha, Nebr.: A primary standard consisting of a timing unit, type 593; a 1 kilocycle multivibrator, type 592; a 10 kilocycle multivibrator, type 592; a temperature control unit, type 591; a heat control unit, type 594; an alternating current power supply unit, type 595; a secondary standard consisting of an interpolation oscillator, type 617–B; a heterodyne frequency meter, type GR–P–351; a heterodyne detector, type GR–P–303; a three-stage resistance coupled amplifier, type GR–X–173; and an alternating current power supply, type 595. (All equipment by General Radio.)

The temperator control unit, type 591, contains a 50-kilocycle quartz crystal and oscillator circuit, an enclosing asbestos-lined aluminum oven with heating pad and thermostat, a second aluminum oven similar to the first and enclosing it with a dead-air space between, and an all-enclosing balsa-wood case. This arrangement, with the coordination of the heat control unit, type 594, which contains relays and rheostats for regulating current through the heater pads, maintains the temperature of the crystal to within 0.01° C. at all times. A small variable condenser is shunted across the crystal to allow adjustments of a few parts per million in cases of aging of component parts, voltage changes, etc.

The output of the crystal oscillator is coupled into the 10-kilocycle multivibrator which is in itself an oscillator but of the type that can easily be controlled as to frequency by another but much weaker oscillator. The multivibrator also has the characteristic of producing very strong harmonics up to about 3500 kilocycles. These harmonics are made use of in the actual frequency measurements as will be explained later.

A daily check of the crystal frequency is made by use of two additional pieces of equipment, namely a 1-kilocycle multivibrator and the timing unit, type 593. The former is similar to the 10-kilocycle multivibrator but is set to a frequency of 1 kilocycle and is controlled by the 10-kilocycle unit. The latter unit consists of a 1000 cycle synchronous clock which is controlled by the output of the 1-kilocycle multivibrator.

If the crystal maintains constant oscillation at 50 kilocycles per second and the two multivibrators are consecutively controlled by it, and if the clock is being properly controlled by the 1-kilocycle multivibrator it can be seen that the clock will keep correct time. If any great frequency failure occurs, the clock will stop. If any frequency failure occurs which is not great enough to stop the clock the large second hand will show a gain or loss, or, if the frequency drift is too small to be noticed on the second hand, it can be computed to within one one-hundredth second by use of the microdial in conjunction with standard time signals. (NAA time signals transmitted on a frequency of 9250 kilocycles at 7:55 a. m. to 8 a. m. eastern standard time have been found to be the most reliable at this station.)

This microdial consists of a cam which revolves once each clock-second, and a large rotatable disk calibrated from 0 to 100 on the circumference and holding two contacts which are caused to be closed during approximately one-half of each revolution of the cam.

A switching system is established so that the contacts on the microdial short out the output of a receiver, which is used for receiving the time signals. To start the time check, the signals are tuned in on the receiver and microdial set so that all but the very first part of each second-signal is shorted out. Twenty-four hours later the same station is again tuned in, and, if the shorting out takes place at the same part of the second-signal, the clock has kept correct time, but if it is necessary to move the microdial forward or backward to attain the same shorting period it is evident that the clock has either been running too fast or too slow, and, consequently that the crysal has not been oscillating at exactly 50 kilocycles. The amount of deviation can be accurately computed by the amount of time gained or lost by the clock as shown on the microdial.

This method of checking gives the average deviation over a 24-hour period and does not tell the actual frequency of the crystal at the time of the check. To offset any error due to this fact, this station also makes use of the standard frequency transmissions of WWV. These transmissions are accurate to within 1 part in 5,000,000, therefore an accurate check can be made as to our crystal frequency.

If it is proven that the crystal is accurate at 50 kilocycles, then it is evident that all harmonics of the 10-kilocycle multivibrator will have the same percentage of accuracy. These harmonics are used according to the following method.

A signal is first tuned in to zero-beat on a superheterodyne receiver. The heterodyne frequency meter, type GR–P–351, is then adjusted until some harmonic of its fundamental frequency beats (at zero-beat) with the receiver. The fundamental of the frequency meter is then coupled into the heterodyne detector, type GR–P–303 which also has coupled to it the harmonics from the 10-kilocycle multivibrator. This heterodyne detector is then tuned to the frequency of the frequency meter. This action also tunes to the 10-kilocycle harmonic which is closest in frequency to that of the frequency meter. These two frequencies then beat together within the detector circuit and cause to be heard an audible tone which is equal in frequency to the difference between the two original frequencies. Since we are making use of 10-kilocycle harmonics up to 3500 kilocycles it can be seen that no frequency can be introduced within these limits which will be more than 5000 cycles from some particular harmonic (or two consecutive harmonics).

To measure this audible tone the interpolation oscillator, type 617–B, is used. This oscillator is, in effect, a very accurate and calibrated audio oscillator working between 0 and 5000 cycles, and an interconnected mixing circuit with an output meter to show when the calibrated oscillator is set at the same frequency as the unknown frequency.

After this audio tone is measured, we again return to the heterodyne frequency meter and move the dial in a direction which gives a decreasing tone as heard through the heterodyne detector. This means we are approaching the frequency of the harmonic against which we were beating. We continue this movement of the dial until we reach zero beat. This means that our frequency meter is now on the same frequency as that of the harmonic being used. A calibration chart then gives the frequency of this harmonic. If, in this movement toward zero beat, we went from a higher to a lower frequency, we know that our original frequency was greater than this harmonic by an amount equal to the audio tone measured with the audio oscillator, and we therefore add this amount to the harmonic.

We have, therefore, measured the frequency of the frequency meter. Now, by comparing this frequency with the approximate frequency of the incoming signal as evidenced by the dial setting of the receiver used, we can determine the harmonic which was used when beating the frequency meter with the receiver (or the incoming signal). By multiplying the measured frequency of the frequency meter by the value of this harmonic, we have the actual frequency of the incoming signal.

Most readings taken by this station are accurate within one part per million, which amounts to plus or minus 8 cycles at 8,000 kilocycles or 10 cycles at 10,000 kilocycles. If Army stations are found to deviate from their authorized frequency more than 0.03 percent, if authorized a frequency below 6,000 kilocycles, or 0.02 percent, if authorized a frequency above 6,000 kilocycles, a service message is immediately sent to that station, and a message is also sent to the Office of the Chief Signal Officer, both messages to the effect that such deviation has been noted. Thereafter that particular station is given special attention until the frequency has been corrected.

Most Army stations having a power of one-half kilowatt or more can be heard at this station at some part of the working day and an attempt is being made daily to measure all stations heard. However, this has often been impossible due to several reasons; namely, that operators fail to use their call letters on the call-up and sign-off, that the call letters are omitted from message headings, or that the actual periods of transmission are of too short a duration to allow getting an accurate zero beat on their frequency. Due to these causes about one-fourth of the effectiveness of the frequency monitor is lost.

SEVENTH CORPS AREA TELEPHONE CONSTRUCTION CREW

By Ray Blain, *Telephone Plant Engineer, S. S. L.*

Should you ever drive through the Seventh Corps Area and meet a big olive drab, all metal, streamlined truck and trailer, look closer and you will note cross-flags painted on the cab doors, and small white letters along the sides will advise you that this is the Signal Corps construction truck from headquarters, Seventh Corps Area, Omaha, Nebr. (See fig. 1.) Talk to any of the men from the Nineteenth Signal Service Company found with the truck and they will gladly inform you of the numerous advantages gained by its use. Work which formerly required 8 or 10 men is now handled, with the aid of the truck and power winch, by 3 or 4 men, quickly, safely, and economically. In fact we make use of the winch for about everything except cleaning our teeth and I have no doubt but in time some of the men will discover a means of doing this.

At Fort Riley, Kans., the military police automobile slipped off the highway into a deep ravine. The quartermaster had worked for hours with the usual equipment, trying to recover the car without success. The Signal Corps truck with the help of the pole derrick and winch required only 10 minutes to place the car back on the highway again. At Marshall Field an airplane, in landing on a wet field after dark, nosed over. The wind being high, it was feared that should the plane be left with the tail in the air all night it might be blown down and seriously damaged. After trying all surrounding towns for suitable equipment someone thought of the Signal Corps and the line construction truck which was doing some work on the field at the time. The pole derrick and winch again

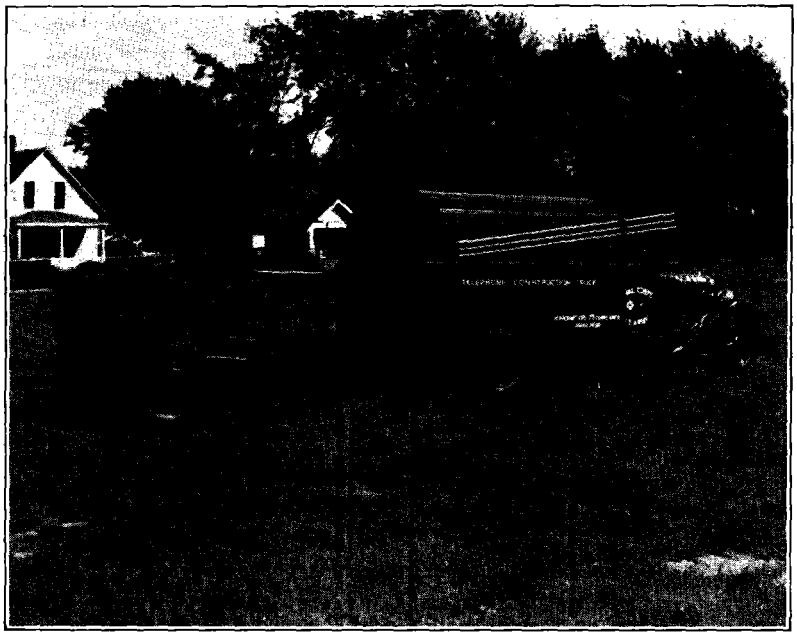


FIGURE 1.

came to the rescue and the plane was eased gently down, to the gratification of the Air Corps.

The 2-ton Federal line construction truck, cable reel trailer, and cable splicing trailer were received at Fort Omaha in January 1934. Tools were ordered, the truck outfitted, and the crew organized in February 1934. Since then it has been found necessary from time to time to add numerous tools, which are not easily obtained at posts, until the truck is now actually a portable machine shop. These special tools consisting of such items as gas cable testing outfits, electric drills, electric hammers, electric grinders, a small paint spray, electric planer and sander of the portable type, all of which are used

frequently and make possible a superior quality of work. These special tools are not ordinarily available at the average post and their infrequent use at any one post would not justify the Signal Corps maintaining several different sets, though the construction truck makes the one set available for use, when required, on all telephone systems in the Corps Area.

The majority of the small tools are carried in the regular tool compartments of the truck. Reels and some special tools are carried in the body of the truck and upon arrival at a post are kept in the storeroom when not in use. The cable reel trailer is hauled behind the truck and the cable splicing trailer loaded on the cable reel trailer. Special racks have been constructed on the top of the splicing trailer for hauling the gas tanks used for cable testing. The enlisted men, who comprise the crew, ride in the truck and carry their hand baggage and foot lockers with them. A hot-water heater is installed in the cab and a Delco steam heater in the rear of the truck in order that the men can ride in comfort regardless of the weather. This arrangement has been used for several thousand miles traveling over the Corps Area and the only improvement we could suggest would be one of the recently developed seven-man cabs.

This method of transportation in addition to being economical has numerous other advantages. When the truck arrives at a post the job may be started immediately as there is no waiting for the arrival of foot lockers containing fatigue clothes from the railroad station, or a delay of several days while special tools are being received by slow-moving freight. Neither is it necessary to spend several days gathering essential tools from various departments on the post or borrowing them from the local telephone or power companies. These local companies are usually very accommodating about loaning tools to the Signal Corps, or perhaps it is just that they are reluctant to refuse a loan. It does seem that if any concern, even the Government of these United States, is going to maintain a large telephone system, consisting of several exchanges, that it should also maintain the necessary tools. There has not been any borrowing of tools from local commercial companies in the Seventh Corps Area since receipt of the construction truck. Neither has any work been handled by contract except some cable splicing.

On several occasions we have had the opportunity of showing our construction equipment to representatives of local companies and they have in each case, indicated considerable surprise and interest. We believe that this modern equipment has done much to remove the long standing biased opinion of most connecting commercial companies, that Army telephone systems are, in the main, "junk" and a rather inferior grade of junk at that.

To visit all posts in the Seventh Corps Area requires travel of approximately 4,000 miles. The construction truck carries an average of four enlisted men and on the basis of one visit to each post annually, the saving in transportation of men alone will amount to approximately $800 each year. Saving in transportation of tools and material now moved by truck is estimated at $500 annually. The 2-ton Federal truck has given perfect service and has caused absolutely no trouble on any of the road trips. The speedometer now reads nearly 20,000 miles and the motor has probably been run an amount almost equal to half this distance while operating the winch. The regular and reserve gasoline tank provides capacity to cover short trips between posts in the area and seldom is it necessary to purchase any quantity of gasoline or oil while on the road. When it is necessary to purchase gasoline on the road, the regular quartermaster form is used and the oil company sends this voucher to corps headquarters for payment. When a trip is too long to be made in 1 day the men generally utilize tourists' cabins for the night as this permits them to keep within their allowance; the truck can be parked nearby, where it is safe, and storage charges are avoided.

In covering the corps area on routine work two separate trips are generally made annually. The first trip is Omaha to Fort Des Moines, Iowa; Fort Snelling, Minn.; Fort Lincoln, N. Dak.; Fort Meade, S. Dak.; Fort Robinson, Nebr., and back to Omaha. The second trip is Omaha to Fort Riley, Kans.; Fort Leavenworth, Kans.; Army and Navy General Hospital, Hot Springs, Ark.; St. Louis Medical Depot, Missouri, and back to Omaha. It seems a pity that Fort Francis E. Warren, Wyo., Fort Logan, Colo., and Fitzsimons General Hospital are not in the Seventh Corps Area as these posts would fit admirably in the first trip at Fort Robinson, Nebr., and the second trip at Fort Riley, Kans. The Army and Navy General Hospital, on the other hand, could be more conveniently reached from the Eighth Corps Area than from Omaha.

The first job handled by the construction crew, after its organization, was started in February 1934 at Fort Leavenworth, Kans., and consisted of pulling in approximately 80,000 feet of underground cable. Since that time work which it is estimated would have cost approximately $35,083.68, if handled by contract, has been completed by the construction crew at an estimated cost of $10,745.53, with an estimated net saving to the Signal Corps of $24,338.15. The following is a list of the principal jobs completed:

Fort Leavenworth, Kans.:

Pulling in 80,000 feet of underground cable.

Installation of six-position switchboard, 1,200 line main frame and power equipment.

Construction of underground cable system in training camp.

Fort Riley, Kans.:
- Installation of four-position switchboard, 800 line, moved main frame and power equipment.
- New underground conduit and cable system for entire post.

Fort Des Moines, Iowa:
- New underground conduit and cable for one-half of post.
- Installation of 200-line switchboard and main frame, also moving of power equipment.
- Installation of 100-line switchboard and 35 stations in C. C. C. headquarters.

Fort Snelling, Minn.:
- Pulling in 30,000 feet aerial and underground cable.
- Overhaul of central office.

Fort Lincoln, N. Dak.:
- Aerial cable construction.
- Construction of target range communication system.
- Overhaul of central office equipment.

Fort Meade, S. Dak.:
- Moved central office equipment to a nearby building.
- Moved radio station.

Fort Robinson, Nebr.:
- General repair of cable system.
- Overhaul of central office equipment.
- Stringing new wire to timber reserve.

Fort Omaha, Nebr.:
- Overhaul of central office equipment.
- Construction of rhombic antenna system.

Army & Navy General Hospital, Hot Springs, Ark.: Overhaul of central office equipment.

St. Louis Medical Depot: Construction of new underground cable system.

High poles for radio antenna systems have been erected at the following posts: Fort Des Moines, Iowa; Fort Snelling, Minn.; Fort Lincoln, N. Dak.; Fort Meade, S. Dak.; Fort Omaha, Nebr.

It must be admitted that such a large estimated saving has been made possible, first by hard work of the enlisted men who comprise the crew and the utilization of labor details from line organizations, the C. C. C., C. W. A., and W. P. A. The well equipped truck has also been an important factor in making this saving possible. Considerable labor saving has been realized by using special features, such as utilizing the winch line and a slip for backfilling conduit trench (See fig. 2), instead of the ordinary shovel method. The winch has also been used to advantage in the pushing of pipe under streets on lateral runs to avoid tearing up pavement. The winch does this job more efficiently and more quickly than the ordinary pipe pusher.

A few words regarding the method by which the estimated saving has been calculated might be in order. The average cost of constructing a standard 4-foot concrete manhole by contract, when the cover and other hardware is furnished by the Signal Corps, is about $45.80. The cost of constructing this size manhole in the Seventh

Corps Area has averaged $15 each and on one job where sand and gravel were furnished without cost the manholes were built for $4.80 each.

The cost of telephone maintenance supplies for the Seventh Corps Area averaged only 91 cents per telephone during the fiscal year 1935. This low cost has been made possible by the practice of preventative maintenance, that is, correcting conditions before they develop serious faults, causing expensive repairs. The maintenance force at the average post does not always have the time or means to practice this system of maintenance and it is believed that a visit of the construction

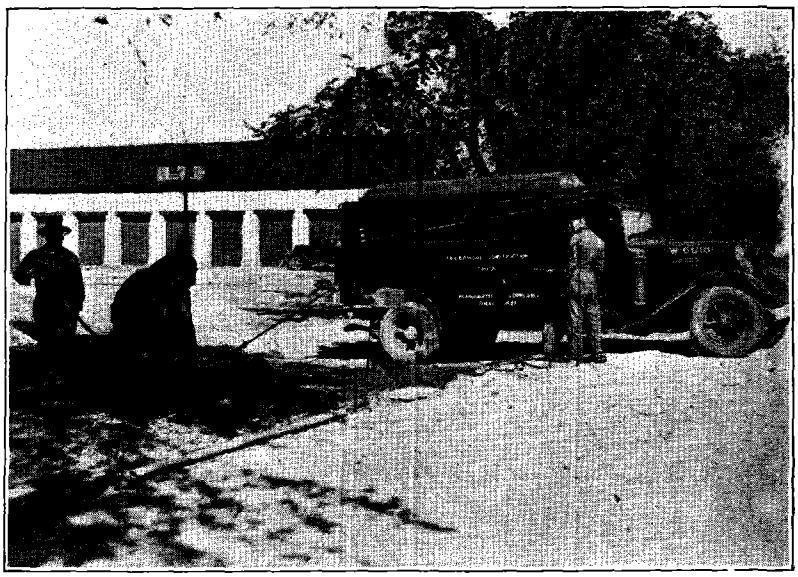


FIGURE 2.

crew to each post about once per year, to clear all unusual conditions before they cause serious trouble and interruption of service, will make possible considerable saving in maintenance costs and insure a much better quality of telephone service in general.

Many will probably raise objections to the general idea of a traveling corps area construction crew making regular visits to each post, believing that there will be a tendency for the regular maintenance force to postpone important work, saving it for the next visit of the construction crew. Experience during the past 3 years in the Seventh Corps Area has proved otherwise, as the regular maintenance men have made an honest effort to complete all work possible with the means available, believing that to leave work for the construction crew was a reflection on their own ability. We have found that work held for the construction crew has in all cases consisted of jobs which

could not have been satisfactorily handled by the local maintenance force with the facilities available. At one post it was necessary to slack-off messenger wire in order to remove "bows" from aerial cable which would in time have caused trouble. The local maintenance force did not have the necessary blocks and tackle, clamps, and other tools required to handle the job and had they attempted it the cable might have been ruined. This is just one of many cases where good judgment was exercised in waiting for the construction crew, who with the aid of the necessary tools, easily completed the work. The setting of large poles has in many cases been held over for the next

FIGURE 3.

visit of the construction crew so that they could be set with safety. (See figs. 3, 4, and 5). The local maintenance men are always willing to work with the construction crew and in many cases receive valuable instruction as to the correct methods of performing their routine work. Most maintenance men in the Signal Corps have not had sufficient experience to handle large construction jobs safely and economically. Carefully trained men on duty with the construction crew handle new or repair work with economy, safety, and dispatch. Safety is a factor which cannot be treated lightly, and proper tools are a real safety factor. I saw a Signal Corps soldier killed a few years ago because dangerous work was being attempted without proper facilities to insure safety. Such risks are not necessary with the properly equipped construction truck now being used in the Seventh Corps Area.

FIGURE 4.

FIGURE 5.

It is believed that the signal officer can gain much in a corps area by maintaining careful supervision from headquarters of all construction and maintenance of the telephone systems under his control. The commercial companies learned some years ago that this supervision from a central point was necessary and though the Signal Corps have had similar ideas they have been considerably handicapped through lack of transportation funds. It would be a fine thing if funds were available in order that the corps area signal officer, or his assistant, could visit each post in the corps area at least twice per year. Men on duty at a post, on detached service, who are doing good work are pleased to have their efforts noted and appreciated and if this is not done they soon lose interest and think, "What's the use." The corps area telephone construction crew, it is believed, proves of material assistance to the corps area signal officer in keeping a closer supervision of all telephone systems under his control. Post signal officers and post commanders all have welcomed these periodic visits of the construction crew which is evidenced by the numerous unsolicited letters of commendation that these men have received from various post authorities.

Some may claim that when a corps area construction crew exists an effort will be made to keep them busy by creating unnecessary jobs. This is far from the fact in the Seventh Corps Area, for work on any telephone exchange is never completed, be it a large or small system; it is even more true of an Army telephone system for just about the time that we think we have everything set, something happens making changes or extensions necessary. Years of experience by commercial companies has proved that small annual replacements are to be preferred over the method of permitting things to ride for a number of years without attention until inferior service makes major replacements necessary. The 10 telephone systems in the Seventh Corps Area keep the small construction crew gainfully employed at all times. While it has been stated that annual trips are made to each post in the corps area, this does not mean that these trips are made at regular periods each year; large construction jobs at certain posts have often kept the crew on duty there for much longer periods than at other posts where a smaller volume of work is required.

The training of enlisted men is believed to be another useful function of the Signal Corps construction crew. Observation of this crew in the Seventh Corps Area has indicated that men actually learn more on this construction work in 1 year than they ordinarily do on maintenance work in 5 years. It has been noted that graduates of the Signal Corps school seem to have a tendency to become proficient in this work faster than does the average soldier who has not had the benefit of this schooling. A peculiar fact is that men

are anxious for assignment on the crew and when assigned always object to being relieved, although the work with the crew is hard, the hours are sometimes longer than those observed by other organizations, and Wednesday half holidays are seldom observed. On every post where the crew is on duty, numerous men from other organizations inquire as to the possibility of their transfer to the Signal Corps for duty with our rambling construction crew.

It is believed also that the construction crew and truck creates much favorable publicity for the Signal Corps. An effort is made to keep the truck well painted, clean, and polished at all times. We frequently hear the remark: "That Signal Corps truck from Omaha is the best looking piece of equipment on the post." The crew and truck were recently taken on a recruiting expedition and stole the show. Every effort is made to comply with State highway regulations as to speed and loading limits, and suitable flares and warning signals are always carried. The governor on the motor is still in operation and no highway accident of any kind has ever been experienced.

Due to the shortage of noncommissioned officer ratings in the Nineteenth Signal Service Company, it has been possible to assign only one duty sergeant to the construction crew. This noncommissioned officer supervises the details of the work and is held responsible for the tools and truck, and carries them on a memorandum receipt. During the total time the crew has been in existence, not a single one of over 400 different items of tools has been lost. An effort is always made to repair or replace defective tools on the completion of each big job and everything is given an overhaul on each return to Omaha.

That is the story of the Signal Corps construction crew in the Seventh Corps Area. Like the Canadian Royal Mounted and our own "G" men, they always finish everything they start, and we are quite proud of them and their achievements. A total of 15 different men have worked on the crew at one time or another and only one member of the original crew remains. These men have all worked hard at all times and their combined efforts have established a record most difficult to equal, and, we truly believe, impossible to excel.

SIGNAL CORPS ACTIVITIES AT FORT LEAVENWORTH

By Capt. C. W. CLARKE, *Signal Corps*

When one thinks of Fort Leavenworth one instantly thinks of the Command and General Staff School often referred to as the keystone of our national defense structure. For it is to serve this school that all other activities at Fort Leavenworth exist.

And especially is this true of the Signal Corps which is perhaps more closely and more intimately linked with the school than almost any other auxiliary service at Fort Leavenworth. But a glance at the other activities will indicate that the Command and General Staff School is not alone in its demands upon the Signal Corps.

The troops stationed at Fort Leavenworth comprise the Command and General Staff School staff and faculty, student officers, Command and General Staff School band, Tenth Cavalry (less Machine Gun Troop and Second Squadron), Headquarters Third Battalion and Companies I and K, Seventeenth Infantry, Detachment Nineteenth Signal Service Company, Companys A and E, Seventh Quartermaster Regiment, and detachments, Air Corps, medical department, ordnance department and Quartermaster Corps.

The total population of Fort Leavenworth, exclusive of C. C. C. enrollees of the Missouri-Kansas district and the Federal Prison Annex, controlled and supplied by Fort Leavenworth is 3,437. This population is divided as follows:

Officers	414
Warrant officers	4
Nurses	16
Enlisted men	1,288
Civilian employees:	
Civil Service	174
Domestic	347
Wives, children, and other dependents of officers and enlisted men	1,194

In addition to the foregoing, there are over 12,000 C. C. C. enrollees in the Missouri-Kansas district who are administered, paid, fed, clothed, and supplied by the administrative agencies of the Army located at district headquarters, Fort Leavenworth.

There are 342 public buildings on the reservation that range in size from a single set of noncommissioned officers' quarters to the famous "Bee Hive", housing 50 families of student officers.

The post itself occupies an area of 15,079.07 acres, or 23.6 square miles, has over 20 miles of roads, 10 miles of Government-owned railroad track, and over 20 miles of bridle paths.

From all these statistical data it will be seen that Fort Leavenworth is no small institution, but it does not paint a true picture of the station hospital, large post exchange, commissary, Y. M. C. A., or the College Building which alone has almost 200 telephones in constant use.

The first contact that a new arrival at Fort Leavenworth has with the Signal Corps is through the telephone system, and the post signal officer spares no efforts to insure that the service is superior to that found elsewhere in the Army and that it is equal in all

respects to that found in the most highly developed civilian communities.

The officers at Fort Leavenworth who are students or who are on the staff and faculty are admittedly outstanding members of their profession. They are officers who a few years hence will be guiding the destinies of the Army, and the impressions that they gain of the Signal Corps in their contacts with the operating services here may well influence them in future decisions affecting this branch. Hence, it is only good policy to put our best foot forward.

The student officers here and their families (and no less the members of the faculty and their families) are under a constant strain and every effort is made to free them from all administrative worries and irritating details. The post signal officer, therefore, has always available a telephone trouble shooter who can be at the scene of trouble within 5 minutes after a complaint is received. This always has an impressive effect on the new arrivals who have not always been accustomed to such prompt service, and tends to present the Signal Corps in a favorable light at the beginning of their tour here. Seldom, if ever, is there a complaint from this individual during the remainder of his tour.

Telephone service to the garrison is furnished by an entirely new plant, central office and outside. The switchboard is a 1,200-line full feature American Electric, which incorporates all modern features. This, together with its associated equipment, is housed in a new Signal Corps communication building at the approximate geographic and wire center of the post. The board is operated entirely by civilian operators (female) who are paid partly by the Signal Corps and partly by local subscribers. The average traffic load at Fort Leavenworth is 12,000 calls per day, of which over 5,000 are trunk connections with the Leavenworth city exchange. There are 19 trunk lines connecting the post with the city exchange.

The outside plant construction is entirely underground. Three 600-pair cables enter the cable vault at the central office. These cables serve the entire post from the cantonment at the southern end of the post to the Hog Ranch at the extreme northern end of the reservation, a distance of more than 5 miles. In addition a 75-pair 19-gage toll cable runs a distance of 2 miles to the edge of the reservation, making connection with the telephone company cables in the city of Leavenworth.

A 50-pair cable reserved for special telephones used by the Command and General Staff School in its map maneuvers and command post exercises, terminates in the map problem rooms and lecture halls of the college building. During these exercises special operators are

147970—37——2

hired by the school to supplement the regular force. Since these exercises sometimes last 48 hours or more without a break they place an extra heavy traffic load on the telephone exchange.

The Signal Corps detachment also assists the school in its map exercises, map maneuvers, and other instruction by furnishing public address service. This service is very popular with the members of the faculty and used almost daily during the school term. The post signal officer has three of these sets and at times all are in use. There are numerous methods of employing these sets but the one most commonly used is to provide microphones for each control director and a microphone in each map problem room or lecture hall. With this

Communication Building, Fort Leavenworth.

arrangement all students are within hearing of all statements made by any instructor and in addition may hear the answers to any question asked a student in any of the several rooms. At present there is a plan under consideration to wire the college building throughout with outlets for microphones and horns, and to permanently install a new and modern public address system to obtain uniformity in all instruction.

Not only are these public address systems used in the college building, but one portable set is always used when the classes go out on tactical rides or terrain exercises.

Another instrumentality of close contact between the Signal Corps and the personnel at Fort Leavenworth is the post radio broadcast system. This section furnishes, for a nominal sum, radio programs to subscribers, in their quarters anywhere on the post. This is a self-sustaining institution and furnishes a valuable service, especially to those who, for personal reasons, do not care to own a private radio set. This system is operated on the same principle as that used in hotel radio service with speakers in each room. A total of 6-wire circuits, each fed from its own amplifier, are adequate to serve the entire post.

The post radio broadcast system is used extensively for making official announcements to the post, on occasions when time does not permit the issuance of written bulletins.

The post telegraph office, located on the main floor of the college building, maintains, in connection with the Western Union and Postal Telegraph Co., direct wire service with Leavenworth and Kansas City, Mo. The radio receiver with its remote control equipment is located in the same room with the telegraph office, and since a large number of the radiograms received here are for other Government agencies and require relaying by wire, the commercial teletype printers are also located in this office. At present there are two transmitters at Fort Leavenworth which can operate in the War Department net, the corps area net, and the Air Corps net.

The Signal Corps also supervises the operation of a C. C. C. radio net for the Missouri-Kansas district C. C. C. The control station for this net is located on the post and is operated by C. C. C. enrollees. The field sets of this net are located at C. C. C. camps in the more isolated sections of Missouri and Kansas where telephone service cannot be easily made available.

One of the most important Signal Corps activities at Fort Leavenworth is the meteorological section. There are, during the school term, about 50 airplane pilots stationed here. Naturally this makes for a great deal of air activity with the corresponding demands for meteorological data. The personnel of this station are successful forecasters and their forecasts have come to be accepted without question, not only on the post but by the people of Leavenworth, whose newspaper prints the forecasts of the Signal Corps station daily.

The post signal supply problems of Fort Leavenworth are those of any other post at which tactical units are stationed. Here, however, is the additional problem of signal supply for the Missouri-Kansas district C. C. C. with its 73 camps. The summer camps, both R. O. T. C. and C. M. T. C., which are held here annually also make demands on the post signal officer for supplies.

One of the most difficult tasks which confronts the post signal officer at Fort Leavenworth is the construction of communication facilities for the camps of the command post exercise and general terrain exercises which are held in the field in the closing weeks of the school term.

These camps are usually held about 15 or 20 miles from Fort Leavenworth and require a rather extensive installation. A specially constructed portable common battery switchboard, equipped for 100 lines and 5 trunks, is maintained here for use at these camps. This board satisfactorily meets the needs of the directors, umpires, and player groups.

One or more of the public address systems are installed in the camp so that announcements may be made, either from the switchboard or by the camp commander or director. For this latter use, a microphone is placed on the director's table for his convenience. A trunk line connects the camp with either the post or the nearest commercial exchange and in addition a radio station is set up in camp for direct contact with the post of Fort Leavenworth.

EVOLUTION OF THE POST TELEPHONE SYSTEM AT FORT LEAVENWORTH, KANS.

By Charles F. Robinson, *Electrical Assistant*, S. S. L.

The available records indicate that telephone communication at Fort Leavenworth prior to 1895 was furnished over a small magneto switchboard, owned by a Leavenworth, Kans., concern. This equipment was installed in a frame building located in the rear of what is now the general service school. This arrangement did not prove a financial success and the switchboard was finally removed and service furnished by direct lines from the Leavenworth exchange.

At the conclusion of the Spanish-American War, the service schools were reorganized and Fort Leavenworth began a period of expansion. Numerous additional buildings were constructed and with the increase in personnel a demand was created for a more flexible and better grade of telephone service. Early in 1900 the Missouri & Kansas Telephone Co., a subsidiary of the American Telephone & Telegraph Co., installed a switchboard in the administration building of the Federal prison which was then located in the post proper. Later this prison was turned over to the military authorities, who operated it for years as a disciplinary barracks. This switchboard, which was equipped with 40 lines and 5 trunks, was filled to capacity within a few months. The outside plant consisted of open wire construction with only a short span of cable between the office pole and the main frame. No circuits were metallic and ground

return was used. Civilian female operators were used during the day and prisoners operated the switchboard at night.

Soon after the Bell System was installed, the Peoples Home Telephone Co., a competitor, installed a 100-line magneto switchboard in the post headquarters building. This building now houses the Army bank and the post finance department. Competition of the two telephone companies was keen and the post personnel took advantage of the situation by demanding frequent reductions in rates until in some instances telephone service was furnished for as little as 25 cents per month with 3 months free service as a starter. This low rate caused a large increase in telephones and it was necessary to enlarge the Bell System three times in less than 3 years. The original 40-line switchboard was replaced with a 100-line board, which in turn was supplanted by a 2-positon, 200-line common battery switchboard. The change from magneto to common battery required complete rehabilitation of the outside plant, the grounded return was eliminated and replaced with full metallic circuits. Aerial cables were extended and, with the introduction of the new type common battery with no crank to turn, the Bell Co. enjoyed a large increase in subscribers. Due to this increase, in 1905 it was necessary to replace the 200-line switchboard with a 3-position, 300-line installation.

To keep pace with competition the Home Telephone Co. installed a two-position switch board in the college building. It was then that competition really started and the Home Co. placed a telephone on all instructor's desks in the college building at the low rate of $3 per annum. The Bell Co. then retaliated by installing a double-throw switch, at a cost of 50 cents per month, so the instructors could obtain either Bell or Home service from the one telephone instrument. The combination of the two systems in this peculiar manner provided fairly good service to the residents of the post until the complete consolidation of the two companies in 1914.

To satisfactorily handle the consolidated system a five-position multiple switchboard was installed in the college building in 1915. Rates were then gradually increased until Fort Leavenworth subscribers were paying a rate equal to Leavenworth, Kans., subscribers.

Soon after the close of the World War in 1919, the War Department purchased the entire telephone exchange from the Bell Co. This included all telephone company property on the reservation, both inside and outside plant. The outside plant at that time consisted of a combination of both the Bell and Home Co. and on almost every street and alley there were duplicate lines of poles and wire in service. This condition was eliminated in 1920 with the completion of the first telephone project under the direct supervision

of the Signal Corps. A new six-position switchboard was also installed at this time to replace the old five-position Bell board. Service at that time in Leavenworth, Kans., cost $2.25 and $2.50 for residence and $6 per month for business telephones. Unlimited personal trunk-line service was furnished the residents of the post over the Signal Corps system for a flat rate of $1 per month. It has never been necessary to increase this rate.

The first Signal Corps switchboard installed in 1919 gave good service until replaced in December 1934. This new full-feature switchboard now in service is considered perfection in manual equipment and was installed entirely by Signal Corps personnel. It is equipped with automatic ringing and listening features, which in themselves speed up service considerably. With this feature it is not necessary for the operator to open her listening key to obtain the number from the calling party. Her headset is connected to the line when she inserts her answering cord plug into the line jack. Then when she has ascertained the number desired, by merely inserting the calling cord plug into the line jack of the called party, her headset is disconnected and automatic, interrupted ringing is started. This ringing continues until the called party answers or the calling party hangs up the receiver. An audible ring-back tone also notifies the calling party that his number is being rung. An instantaneous recall feature is provided whereby a second call can be made by flashing the line lamp again while the first cord is still in the line jack of another position. Multiple line lamps enable an operator on any position to answer a call. Trunk equipment is also automatic in its action. Busy lamp signals are associated with the trunk jacks, which eliminates the usual trouble with false busy tests on trunk lines. The 1,200-line capacity of the new switchboard is sufficient to care for present needs and also for reasonable future expansion.

The terminal room of the exchange contains the latest development in power equipment and ringing apparatus. A modern main frame, relay rack and wire chief's test cabinet are also located in this room. Conveniently placed wallboards keep necessary tools and test receivers available for instant use when trouble occurs. Adequate protection is provided for the 1,800 pairs of cable which terminate on the main frame.

The three 600-pair cables enter the exchange building through multiple clay conduit. The clay conduits terminate in a modern cable vault in the basement. Spare ducts are provided in all conduit runs. The outside cable plant consists of a complete underground system which has been engineered to provide ample facilities for a reasonable future expansion. Main feeder cables are incased in multiple clay conduit with subsidiary runs in creosoted wood conduit. Man-

holes are constructed of reinforced concrete with the usual covers. Most of the underground runs avoid streets and are located in the space between the curbs and sidewalks.

All main cable terminals are located so as to be accessible to repairmen at all times. Lateral cables of from two to seven pair feed out from many of the main terminals. All small cables terminate on connecting blocks and are cross-connected to the main cables. Distribution within the post proper is entirely underground, which eliminates practically all drop wire and costly, troublesome substation protection.

The 19-gage trunk cable, which connects the city of Leavenworth, is of underground construction to the city limits. At this point it is cross-connected through a suitable terminal to the telephone company's cable.

So far, in looking backward over the span of years, we have noted only the equipment change and its steady improvement at Fort Leavenworth. In our reminiscence we must not forget the faithful telephone operators, for without them even the best manual equipment cannot give good service.

The present chief operator, Miss W. McDonald, operated one of the first switchboards installed at Fort Leavenworth and has given constant and faithful service for more than 30 years. The Army telephone operator, in addition to her usual duties must also supply general post information. She must also handle fire, police, ambulance, in fact any emergency calls given her for quick action. She is expected to know the whereabouts of all new arrivals on the post and locate lost children when called upon to do so. On one cold and stormy night many years ago the post lighting system failed suddenly. It so happened that a "blessed event" was taking place in the post hospital. The surgeon snatched the receiver from the hook and shouted, "Get me some light quick." All other post utilities being closed, the operator called the fire department, who rushed lanterns to the hospital where a future major general (?) was already being ushered into the world.

Due to the peculiar conditions existing in almost every Army post the telephone traffic load may be considered heavy practically every day of the year. The daily traffic load per hundred telephones at Fort Leavenworth is considered almost twice that of a similar commercial exchange.

The Signal Corps personnel at Fort Leavenworth, in addition to providing telephone service, also maintains radio, telegraph, meteorology, electric time service, public address systems, and radio broadcast systems. They strive at all times to play an important part in the scheme of things of the United States Army Signal Corps and to serve well, in time of peace as in war—*Pro Patria Vigilans.*

DUTIES OF THE SIGNAL CORPS DETACHMENT AT AN INFANTRY POST

By Staff Sgt. LEONARD A. JENSEN, *Signal Corps*

The duties of the Signal Corps men at an Infantry post are numerous and varied. These duties run the gamut from technical to clerical, with a "dash" of plain and fancy "pick and shovel" work thrown in for good measure and to vary the daily routine. In order to present a clear word picture of these duties it is necessary to make known what troops are garrisoned at the post. Fort Snelling, Minn., at the present time is the home of the following troops:

Headquarters Fort Snelling.
Headquarters Company, Fourteenth Brigade.
Third Infantry, Regiment.
Seventh Tank Company.
Battery F, Fourteenth Field Artillery.
Staff troops.

The Minnesota district headquarters C. C. C. is also located at Fort Snelling, which has 3 subdistricts and 64 camps. During the summer this number is increased to over 100 camps.

The present Signal Corps detachment consists of 13 men, who maintain and operate the post telephone system, the corps area net radio station, and the target range communication system. It is necessary to requisition supplies and equipment for these activities as well as for organizations whose table of basic allowances entitle them to draw Signal Corps equipment. The furnishing of signal supplies to organizations entails considerable work, as all requisitions must be consolidated before forwarding to the depot, and then, when the supplies are received, they must be separated and shipped to the various organizations.

Much of the detail work in connection with the above duties falls directly to the signal sergeant. The post signal officer detailed from the line usually has various and sundry duties in connection with his special jobs and cannot ordinarily devote much time to detailed supervision of Signal Corps activities. An effort is always made to have all reports and routine correspondence ready for the post signal officer's signature when he makes his rounds each morning. He then advises how any special correspondence will be handled and this will be ready for him when he makes his next stop at the signal office. The whereabouts of the signal officer is generally known by the switchboard operators and much of his work is transacted over the telephone.

The signal sergeant is also designated as the acting first sergeant and as the size of the detachment does not warrant a company clerk he must perform these duties as well. Actually he must assume

practically the same duties as that of the entire noncommissioned staff of a rifle company, though of course on a much smaller scale.

The maintaining of accurate records in a post of this size is in itself no small task. The signal property on hand must be checked at regular intervals and inventory and inspection reports submitted. Supplies must be properly stored and care taken that the storeroom presents a neat appearance at all times. Reports of survey and reports of surplus property on hand must be made when required. Historical records on both the telephone and radio systems must be kept up to date. Telephone rental and toll statements must be checked and vouchers forwarded to the finance officer for payment. Rates must be checked on all official telegrams and the necessary vouchers passed for payment. A collection list and individual statements must be prepared, covering the monthly pro-rata charge for personal use of trunk line service, personal telegrams, and telephone calls. A correct post telephone directory must be maintained for the use of the switchboard operators and in order that new directories may be published, at regular intervals, for the use of the residents of the post. A telephone operator's working schedule must be maintained with proper hours and relief designated.

The entire outside plant of the telephone exchange was rebuilt about 3 years ago. All cable, with the exception of the cantonment area, is now underground and outside trouble is held to a minimum. The present three-position switchboard has been in service about 6 years and is giving good service. Trunk lines connect the post switchboard with the commercial telephone exchange in St. Paul, and Minneapolis service is available at no extra cost. All telephones on the post are equipped with dials and city numbers may be dialed direct after the connection is made by the post operator. Regular telephone moves and changes cause the usual amount of work.

An effort is always made to give the best possible service. No reasonable request on the Signal Corps is ever refused. These requests are at times rather numerous and cause considerable work, so the life of the Signal Corps men on duty at Fort Snelling contains no dull days.

SEVENTH CORPS AREA ARMY AMATEUR RADIO SYSTEM

By Staff Sgt. JAMES W. HUDGINS, *Nineteenth Service Company, Signal Corps*

All nets of the Seventh Corps Area A. A. R. S. operate in accordance with a master net schedule which coordinates traffic channels on Monday drill nights to provide every city of the corps area represented by an Army amateur station an opportunity to send a radiogram and receive a reply the same drill night to any other city of

the corps area also served by the system, as well as Washington, D. C. Routine traffic for other corps areas sometimes requires more time due to necessity for additional relays. On nights other than Monday, excepting Sunday, skeleton nets are operated. The several stations of a city having more than one Army amateur station generally arrange for one station representing the city to report into the district net each of these nights.

Urgent and priority messages (real or simulated) are given the same expeditious handling as in Regular Army tactical procedure. In case of emergency, where there is a tendency for people to become excited and nervous, and for conditions to be chaotic, Army amateur operators are trained that the duty to be performed is a mechanical routine. The same general methods of operation provide maximum service during any emergency operation.

Each year Army amateur operators take part in numerous emergency communication activities. For the most part, this work is not vital to the safety of life and property, because this danger does not exist in most cases. But these operators are prepared and willing to furnish reliable communication channels from communities otherwise without any means of requesting aid, if needed. In January 1933, the hourly weather reports of the Omaha Airport were sent via amateur radio to the Grand Island (Nebr.) airport for 2 days due to heavy snow and ice disrupting the teletype circuit between Grand Island and its airport, a distance of only a few miles.

Seventh Corps Area Army amateur stations formed the only means of communication to many sections of the Nebraska flood of June 1 to 6, 1935. Station WLU/W9BNT of the office of the corps area signal officer was in operation when McCook reported rapidly rising water of the Republican River threatening valley residents and the local power plant. This station and many others were mobilized immediately for continuous operation for the following 4 days. An emergency report and request for assistance was radioed to the headquarters, midwestern zone, American Red Cross, St. Louis, Mo., by the Red Willow County chapter. Chairman A. A. Wolfe was immediately authorized to incur such expenditures as necessary to meet immediate emergency needs. A representative was dispatched to the McCook area. Army amateurs handled these messages and many others at a time when amateur radio was the only means of communication.

The Omaha office of the Chicago, Burlington & Quincy Railroad was extremely anxious to learn the whereabouts of its crack passenger train, "The Aristocrat", long overdue in Denver on the morning of the 2nd and known to be stranded in the flooded area without communication. A general broadcast was transmitted by control

station W9BNT. In less than an hour, Army amateur W9POB of Wauneta, Nebr., reported into the net with a hastily constructed emergency transmitter advising the train was at Benkelman, Nebr., and safe on a high spot. W9POB drove the 12 inundated miles to the train several times to handle radio reports.

Through the facilities of W9MGV, the Omaha office of the Nebraska Power & Light Co. sent a service crew by plane to the Angora section. WLUX/W9FZX and W9EKK and crew of five went by truck with emergency radio equipment from Lincoln as far as Oxford, advanced 3 miles into the flooded area by boat, established a base radio station and reported to W9BNT. Operators not on duty at the station aided with rescue work. This station served the main link of communication between the flooded section and Omaha, also relaying with W9BAE of McCook and with other auxiliary powered stations.

Newspaper and civic leaders were quick to praise these amateur radio operators who were credited with greatly minimizing the loss of life and destruction of property in this emergency.

The part Army amateur operators played in the recent floods of the Ohio and Mississippi Rivers between January 24 and February 5 of this year would read like fiction if all could be told in one volume. All Seventh Corps Area stations knew that net control station W9BNT would transmit special instruction on the corps area net frequency of 3725 kilocycles if any nets or individual stations were to be mobilized. A general broadcast by W9BNT at 9:05 p. m. advised all nets of Arkansas and Missouri to mobilize, for all State control stations to report in the corps area net, and for other stations to listen for emergency calls and to refrain from any unnecessary transmission. Within 25 minutes each State in the corps area had reported.

Since the headquarters of the midwestern zone, American Red Cross, are located at St. Louis, Mo., station WLUW/W9EFC operated in the Army net, of which WLH, Columbus, Ohio, was acting NCS by authority of the Chief Signal Officer. WLU/W9BNT maintained a continuous watch for 374 hours—over 11 days. WLUA/W5BMI, of Little Rock, handled the Arkansas organization, which included W5FB, of Helena, Ark., whose station was the town's only means of communication for nearly 3 days. W9OUO, operated by C. C. C. enrollee Francis Holland, of Company 3733, Berryman, Mo., used portable battery-equipment at Army headquarters of the Missouri district at New Madrid and later at Sikeston.

Personal messages of inquiry to relatives and friends in the flooded area were not handled during the period of mobilization. A total of 371 messages were handled, subdivided as follows: Red

Cross, 71; Army, 47; C. C. C., 38; commercial, 42; National Guard, 27; police, 5; and important personal messages, 131.

Twenty-three percent of all member stations are equipped to operate both transmitting and receiving equipment from auxiliary power on a moment's notice. An additional 11 percent have emergency equipment complete except for batteries, for which arrangements have been made, in most cases, for supply without charge by local merchants. Other stations are working on emergency equipment and it is expected that fully 75 percent of the 148 stations of the corps area soon will be equipped for operation from auxiliary power.

Each of the eight States of the corps area is divided into from three to five district nets, each of which is assigned a specific frequency in both the 80- and 160-meter amateur bands. The latter is used only when "skip" prevents short-distance operation on the higher frequency. The corps area and State nets operate on frequencies in the 80-meter amateur band. Each station is required to be able to transmit on the net frequency within the 8 weeks of probationary appointment. This necessitates the purchase of a quartz crystal for frequency control on the part of each new member.

In August 1934, the corps area net and each district and State net were authorized individual net calls. The net call provides the NCS a means of calling all secondary stations collectively and gives the latter an opportunity to report into the net when the station call of the NCS or acting NCS is not known. Regular Army tactical net procedure is used in all nets. The Seventh Corps Area was the first to request the assignment of net calls. At this time every A. A. R. S. net in the Nation and possessions has been assigned an individual net call by the Chief Signal Officer.

Army calls, WLUA to WLUZ, inclusive, have been assigned the State net control stations and alternates, three alternate corps area net control stations, and two special monitor stations for operation on the Army frequencies of 3497.5 and 6990 kilocycles.

Weekly reports by radiogram, eliminating a similar report by mail, by each station was inaugurated in November 1935. This move resulted in an increased interest, allowed the district and State NCS an opportunity to keep a weekly record of each station's activity by using the relayed radiogram, and effected a considerable saving to the Government in that WD SC form 53 cards are not now used except when a station is unable to report into his net.

In order that the 20 Government-owned short-wave stations installed in July 1934 might operate in Army amateur nets at night when not required for official frequency operation, the corps area signal officer purchased crystals in March 1935 to allow all C. C. C. stations in a State to operate in a separate net. The 15 additional

stations installed in January of the following year were equipped with crystals for operation on the proper A. A. R. S. frequencies. The largest C. C. C. district net of the corps area is that of Minnesota with 12 stations.

Equipment at headquarters station WLU/W9BNT consists of a custom-built 100-watt, four-stage, crystal-controlled, transmitter capable of operation between 1700 and 7300 kilocycles and is used normally on 6990 kilocycles, a 200-watt self-excited set on 1748 kilocycles, and a four-stage crystal-controlled 300-watt transmitter on 3725 kilocycles. The latter two units are home-built. All three may be keyed simultaneously, if desired. Separate antenna systems of the single-wire Hertz type are used for each transmitter and are approximately 80 feet above ground. The operation of WLU/W9BNT is performed by Signal Corps personnel after regular working hours, except in case of emergency.

Eleven operators have been enrolled in the Army Extension Subcourse 10–16, "Elementary Military Cryptography" since the authorization by the Adjutant General January 2, 1934, of the enrollment of three Army amateur operators in each corps area at any one time. However, only three operators have completed the course.

Prior to February 1936, Seventh Corps Area stations were unsuccessful in solving any of the unknown key cipher messages broadcast by station WLM, Washington, D. C., with the single exception of W9DYA who solved 4 of the 20 transmissions. Lately, a series of articles on solving unknown key messages of the substitution type, distributed to all members, has furnished a basic knowledge of solving this type of unknown key message.

For the seven national A. A. R. S. contests held during the fiscal year 1934, the Seventh Corps Area had two first, three second, a fourth, and a sixth position among corps areas. In 1935, results in the four contests were one each second, third, fourth, and eighth standings; while in 1936 the four contests resulted in a first and three second-place positions.

Upon the assignment of Capt. Robert B. Woolverton, Signal Corps, as liaison officer in charge A. A. R. S., activities in September 1935, steps were taken to increase the percentage of member stations reporting in weekly drills and to enroll only stations fully capable of meeting membership requirements. Both of these aims have been realized with 148 stations handling 15,432 messages per month for the 9-month period beginning September 1, 1935; while for the same period of the previous year, 115 stations averaged 4,210 messages per month.

A bulletin, Army Amateur Time, containing special information and instructions regarding A. A. R. S. activities is published and distributed each month to all members of the corps area. The bulletin is in its seventh year of publication.

A SIGNAL CORPS OFFICER'S EXPERIENCES IN THE C. C. C.

By First Lt. KIRK BUCHAK, *Signal Reserve*

So many officers have written about the technical phases of the Civilian Conservation Corps, its objectives and accomplishments, that an insight into the human side of this great program may prove interesting. It seems that this is a highly important part of the C. C. C. that is generally overlooked in the public's consideration of the program's tangible accomplishments such as reforestation, soil conservation, and other work projects.

A Signal Corps officer is practically an orphan in the C. C. C. His training has no particular connection with the C. C. C. work except in general company administration. However, he has an opportunity to apply his general training and knowledge.

The effect of the C. C. C. in rehabilitating the youth of the Nation in time of its greatest crisis, reestablishing their morale by giving them something self-respecting to do, cannot be measured in dollars and cents. The effect, too, of teaching America's young men the valuable lessons of discipline is another factor of boundless benefit to the Nation.

An officer on C. C. C. duty has great opportunities to learn much about human nature. He finds that most boys enrolled are clean-minded, honest, law-respecting, and God-fearing. If occasionally one does stray from the narrow path he is, as a rule, generally repentant and willing to take his punishment. The great majority of those who do, have learned a lesson to be remembered.

On one occasion the enrollees were confined to the camp area for the day. Two boys could not resist the temptation to attend a local "hop." Their absence was discovered and the boys were called on the carpet for going AWOL. When asked what their punishment should be, they both grinned and said, "About a week in 'hock', Lieutenant, and extra K. P. duty should fix it up." This demonstration proves that the boys know what the penalty is when they violate a regulation, and are willing to accept the consequences cheerfully.

Inquiries are frequently made concerning discipline. Camp discipline is usually no great problem. The administration of a reprimand, confinement to camp for several days, or extra fatigue, is sufficient to maintain discipline. Major violations of regulations are not tolerated, and a discharge is the consequence.

The welfare of the enrollees is of utmost importance. They have the advantages of well-balanced meals, directed educational activities, supervised athletics and recreation, and excellent medical attention.

One amusing incident that may be recalled concerns a rookie named Petersen who afterward was known throughout the Nebraska district as "Three Shot Petersen." During routine inoculation against typhoid the physician turned from the table containing his vaccine phial, and punched the nearest arm. That boy left and the next one in line stepped up. It was Petersen's turn. The physician turned around in one motion, jabbed his arm, wheeled around to the table, replenished his needle, and punched another arm. Still again he went through this procedure. He stopped short as he saw three punctures in the arm.

"Haven't I inoculated you before," he asked. "Sure", came the wan youth's reply. "Every boy is supposed to have THREE SHOTS, isn't he?"

Happily, there were no serious consequences from the overdose.

The enrollees in the camps range in age from 18 to 25. They are a happy-go-lucky lot. One of the strangest things about them is their ability to step into the social life of any town to which they are assigned, and the readiness of the townspeople to accept them. Camp life seems to rub off many of their rough spots. Many of them become homesick, but after they recover these boys are usually the most reluctant to leave camp. They like the life and want to remain and that is the finest testimonial for the C. C. C.

SEVENTH CORPS AREA C. C. C. COMMUNICATION

By Capt. R. B. Woolverton, *Signal Corps*

In November 1935, corps areas were directed to reduce C. C. C. costs. This did not mean that operation of the corps up to that time had not been efficiently administered, but it did mean that large savings were required to provide funds for more enrollees.

The Seventh Corps Area was particularly fortunate in its economy task in having had assigned to it at this time a corps area commander well known in the service for his ability to execute any assigned mission at minimum cost. Previous to his assumption of command, C. C. C. activity at corps area headquarters had simply constituted an added duty in each staff section. Now it was practically divorced from Regular Army activities by detailing one or more officers from each staff section concerned to a newly created separate C. C. C. staff, all functioning under a C. C. C. deputy chief of staff, and all of this staff located on one floor of the corps area headquarters building.

The C. C. C. signal officer, being the only assistant to the corps area signal officer, had, of necessity, to function in both offices, but his C. C. C. duties, clerks, and files were completely divorced from

the corps area signal office. Cost data was obtained on every telephone at every district and subdistrict headquarters and work camp, both as to fixed charges and long-distance tolls. Traffic data was secured on all C. C. C. radio stations to learn whether each station was serving a maximum number of camps in its vicinity, in order to minimize telephone and telegraph tolls. Finally, a study was made of telegraph costs, particularly between corps area and district headquarters. All of these data had to be secured and cost reduction measures initiated just as the corps area was hit by one of the severest winters in the history of the Middle West. The districts were burdened with a critical fuel shortage and with difficulties in effecting delivery to camps of necessities of all kinds. The real burden of economy measures fell upon the staffs of the district headquarters, not yet recovered from the extensive movement of companies to California for the winter, consolidation of companies, the abandonment of camps, and the delivery of winter supplies.

Under the above conditions, the necessity for extensive use of all channels of communication was great, and too much credit can hardly be given to district commanders and their signal officers for their cooperation in the reduction in communication costs.

Every directive issued by corps area headquarters concerning reduction of costs in all C. C. C. activities, temporarily added to communication costs, because they had to be retransmitted to 280 camp commanders. By the middle of December 1934, however, expenditures for current obligations began to fall rapidly.

The average communication cost per month for the 12-month period ending August 31, 1935, was $3,138.38 for telephone and $705.45 for telegraph. By March 1, 1936, the total telephone and telegraph costs for the month of February had dropped to $1,563.80 and $420.45, respectively. A few examples of how these reductions in communication costs were accomplished may be of interest. Camp commanders were made accountable for every telephone toll call. Many long, leased telephone lines from camps to commercial exchanges were discontinued and service established over existing Forestry Service lines. Camp radio stations were relocated, so that by means of Forestry or short commercial telephone lines to nearby camps as many as seven camps were served by one radio station. A radio station, owned by an enrollee operator, was installed at the Arkansas district headquarters with a resultant saving of hundreds of dollars per month in telegraph toll to corps area headquarters. Camp radio stations not showing sufficient savings were moved to ambulance station camps with resultant savings in telephone tolls.

The 47 C. C. C. radio stations of the corps area are components of a net connecting the five district headquarters with corps area head-

quarters, and a secondary net in each district. The five districts embrace the following States: (1) Arkansas, (2) Iowa, (3) Minnesota and North Dakota, (4) Missouri and Kansas, (5) Nebraska and South Dakota.

THE SEVENTH CORPS AREA PHOTOGRAPHIC LABORATORY

By Pvt. (1st cl.) C. G. WELCHER, *Signal Corps*

The production of photographs is only one of the numerous duties required of the photographer in charge of the Seventh Corps Area photographic laboratory at Fort Omaha, Nebr. Training films must be cared for and repaired, photostat copies produced and projection equipment kept in order and available for instant use at all times.

Several hundred reels of positive motion-picture film is indexed and stored in a specially constructed fireproof vault located in the basement of the photographic laboratory. This film consists of historic and training in both the 16 and 35 mm sizes, some with sound and others of the silent type. These films are shipped on request to various Regular Army, National Guard, and Reserve Officer activities in the Seventh Corps Area. When films are returned they are immediately rewound, inspected for faulty splices or other defects, and repaired if necessary. Both a 16 and a 35 mm projector are available when it is necessary to exhibit films in or near Omaha. A portable stereopticon is also available for lantern-slide work.

Numerous are the requests for photostat copies of maps, drawings, letters, reports, and court-martial evidence, such as canceled checks, birth certificates, or other documents. When photostat copies of extremely large charts or maps are desired a reduced photographic copy is made and then a photostat made from it.

A large volume of copy work is required and the Cooper-Hewitt mercury-vapor lights furnished with the photostat machine are used for this work to advantage. An 8 by 10 view camera with a 5 by 7 back makes an ideal copying arrangement. Straight process film is used in most cases and it has been found that by manipulation, or by variation of exposure and development, a satisfactory degree of control is possible with this emulsion. It serves equally well for both half tones and line drawings.

A large variety of photographs are made, consisting principally of interior and exterior views for the quartermaster's historical record or construction reports, views of old or new equipment to illustrate defects, portraits for official files or publication, and an occasional passport photo. A large variety of Army activities are recorded by the camera for historical files and publicity. This may be the re-

147970—37——3

tirement of a soldier after 30 years' service, sports, parades, drills, and recruiting activities. An officer may desire lantern slides to illustrate a lecture, which usually involves making copies from books or other material he has collected. A 4 by 5 speed graphic camera with lantern slide plates is used for making negatives. The slides are then conveniently made by contact printing.

Frequent requests are made for the Signal Corps photographer to accompany troops on special missions. One such trip was with a detachment from the Seventeenth Infantry, Troop E of the Fourth Cavalry, and the United States Army equestrian team when they journeyed to the little town of McCook, Nebr., to participate in the 3-day reconstruction jubilee to celebrate their remarkable recovery from the disastrous floods suffered when the Republican River overflowed its banks a few months previous.

One very interesting photographic assignment was that of covering the United States National Geographic stratosphere flight at Rapid City, S. Dak. Besides the Air Corps soldiers, the Cavalry from Fort Meade, S. Dak., maintained a large detachment at the strato camp. This situation presented a wonderful opportunity of recording photographically the prominent part played by the Army in the extensive preparations necessary before the actual flight took place.

The Signal Corps photographer played an important part in the preparation of General Hagood's "Soldiers Handbook." The extensive use of photomontage made the work extremely interesting. Hundreds of photographs were required. Before the complete lay-out, with manuscript and illustrations, was submitted to the printer, three sample books were made up by the photographer in order that General Hagood could present a tangible idea of the proposed book to the authorities in Washington. To accomplish this, photographic copies were made of all typewritten text and page lay-outs, made by copying the combined text and illustrations. Half tones and line drawings were collected from various sources, some of which were enlarged, others reduced in size. Retouching and elimination of parts of certain illustrations and varying contrasts required considerable careful work and study. The challenge given the photographer's ability caused the work to be extremely interesting from start to finish.

The photographic laboratory is not exactly all that is to be desired though considerable improvement has been made in it during the past few years. The dark room is about 8 by 13 feet. All films are processed, contact prints and enlargements are made, and all washing is done in this room. All films, including 8 by 10, are developed in fine grain developer. Not only does this developer pro-

duce finer negatives but it is also economical, as a 4-gallon tank lasts about 6 months. Continuous improvement is being made in the photographic laboratory as funds and equipment become available.

AN IMAGINARY LETTER FROM A SIGNAL CORPS SERGEANT TO HIS COMPANY COMMANDER

By Ray Blain, *Telephone Plant Engineer, S. S. L.*

The facts here presented have been gathered from the experiences of several different persons on various Signal Corps construction projects, in years gone by. It would not be impossible for the conditions mentioned here to happen in almost any corps area. Some of them happened in the Seventh.

Dear Captain: Just thought that I would drop you a personal note to advise you that we are coming along fine with the construction work despite the usual, far from perfect, conditions.

The barracks are all overcrowded here so we are messing with the QM and sleeping in one corner of a squad room in the Infantry Barracks. This is a bit unhandy as we must get up rather early in order to hike across the post to the QM barracks in time for early "chow." The QM mess is good, though terribly crowded, due to the fact that they are feeding a large number of C. C. C. men and we must eat either very early or very late. We understand that the new C. C. C. barracks and mess hall will be completed in the near future, which will relieve the overcrowded condition of the mess and then we will have to find something new to growl about, for it has been said that when a soldier does not grumble about something he is not happy, and we intend to remain contented.

We have surely been having some lucky breaks on this job. Just yesterday while we had a conduit ditch open on a side hill it was decided to cut out and build a terrace for a parking lot, and we had to deepen our ditch to 7 feet in order to maintain our grade and have conduit buried to proper depth on the upper end of the lot. We were surely lucky that we were able to make this change before the clay conduit was in place. Also while we were digging the conduit ditch in front of the new C. C. C. camp it was decided to run a railroad spur alongside the new warehouses and across our cable and conduit run. By increasing the depth of our ditch to 7 feet we were able to provide proper clearance between our conduit and the ties of the new roadbed. Then again they are building a new truck scale for weighing hay and coal right on the line where we were supposed to place the new conduit. By swinging the line slightly we were able to clear the scale pit, but had we been there first this change would have presented considerable extra work and expense. This makes three times that we have been exceptionally lucky in 1 week, so I figure we must be living right.

We found that we could obtain sand and gravel for manhole construction, without cost, from a pit located within a few miles of the post proper. We had a detail of garrison prisoners to load the trucks, but the provo marshal would not permit the prisoners to ride in the trucks with the sentries and, as the distance from the post was too great for walking, the Signal Corps men were required to load the trucks. We hauled three loads and then the truck

was needed to haul some supplies from the rifle range, but we have the promise of it again, either tomorrow or next day. We were lucky, though, for we had enough sand and gravel to build two manholes.

We borrowed a small concrete mixer for a half day but lost an hour getting it started. One of the troubles was located in a defective spark plug and, as none of this size was in stock on the post, we acquired one from a model T Ford parked nearby. We were caught in the act but were lucky, for after we explained the facts to the owner, who was then not quite so mad, he permitted us to use the plug until he started home at quitting time, as he was a laborer working on a paving job nearby. This was sufficient time to permit us to complete pouring the two manholes, though we didn't have any time for resting.

We were unable to draw any garden hose from stock but were fortunately able to borrow sufficient footage from three sets of quarters on the noncoms row, used on lawn sprinklers. This really taxed our diplomacy for we had just recently dug a ditch across these same lawns and even though we replaced the sod neatly, the ladies still feel that we should have dug up some one else's lawn. One declared the Signal Corps is just like a gopher, always digging.

We also had a little difficulty over on the officers' row when one of the men dug up what he thought was weeds only to learn later that they were valuable flower bulbs. Peace was finally restored when all bulbs were located and stored safely for the winter. One lady objected to the manhole cover in her lawn and considered that she was being imposed upon as we didn't place similar covers in the lawns of the adjacent quarters. We explained that manholes were placed only at cable junction points, then the lady wanted to know why we could not place this cable junction in some other lawn instead of hers. We finally settled out of court by agreeing that next spring we will paint the cover green to harmonize with the grass. If it is as dry next year as it was last it will probably be more appropriate to paint the cover brown.

Nearly every one advised us that they would not object to us digging up their lawns if we would install hand-set telephones for them. If we only had an unlimited supply of these instruments we could surely make a lot of friends for the Signal Corps. It would be fine if we could only tell people when we start digging up their lawn that we were placing new cables so that we could install hand set telephones for them.

The men are all disappointed that laced boots are no longer an issue for the Signal Corps. These boots were always preferred by linemen wearing climbers. Boots of this type are also mighty fine when one is climbing in and out of ditches all day on an underground conduit job, as they do not fill with dirt and small stones as do ordinary shoes, which never does ones feet any good. It does seem that the Signal Corps, especially the service companies, should be authorized some special issue of clothing, such as laced boots, a good grade of unionalls, and mackinaws. Did you ever see a lineman climbing a pole wearing a long tailed overcoat? The new gauntlet work glove issued by the Signal Corps is certainly fine and the men are all pleased with them. We are indeed fortunate in getting such good fitting gloves, as a man can do practically everything except roll a cigarette without removing them.

Our men are all short on work clothes this week as the laundry is swamped with work on account of three C. C. C. companies leaving for permanent station and needing their clean linen before leaving. We will have to wait about 10 days for our laundry, but I understand that everything will be back

to normal in about 2 weeks and we shouldn't get so very dirty in that length of time.

I almost forgot to tell you it was necessary for us to cross under a new concrete street 45 feet wide with a conduit run and I fear if we had busted this concrete it would have been more serious than when we dug up the flowers. Well, we just dug down at each side of the concrete slab and tunneled right under the street without difficulty or damage. We had a tunnelling scoop made from an old tile spade, with sectional pipe handle, made-up locally, which surely does the trick. We were lucky, for we tunneled from each side and met exactly in the center. The fire chief was kind enough to come down with a section of fire hose after the clay conduit was laid, and flush the dirt back into the tunnel with swift moving water.

We are working both Wednesday and Saturday afternoons, for we desire to finish the job on schedule. Also the post authorities are anxious for additional phones in the C. C. C. headquarters, which will not be possible until after the new cable is cut into service. Besides some of the men have wives and sweethearts back at headquarters, whom they desire to see before Christmas. Then, as you know, this is a dry State, parties are slow and dry, so we just go to the post movies, read, and string wire verbally, for recreation.

Sincerely yours,

SGT. D. LUCKY.

CIPHER BUSTING IN THE SEVENTH CORPS AREA A. A. R. S.

By Col. STANLEY L. JAMES, *Signal Corps, Signal Officer*

To the more mature members of the Army amateur radio system, the most interesting feature of their training by the Signal Corps is the decipherment of cryptograms, the key word and length of key word for which is unknown except to the originator of the cryptogram.

Prior to the A. A. R. S. operating season of 1936–37, all of these unknown key cryptograms originated in the office of the Chief Signal Officer, and the custom has been to transmit one of these cipher messages on the first Monday of each month. Members were instructed to reply to these messages in the same key with which the original was enciphered. Credit for solution is given by the Chief Signal Officer in his monthly publication P. D. C., by listing therein the amateur station calls, by corps areas, of all who solved each message.

The general impression among members of the Seventh Corps Area system seemed to be that the solution of these cryptograms was too difficult, and therefore, up to September 1936 too little activity was shown. In order to correct this situation, the signal officer, Seventh Corps Area, published monthly in Army Amateur Time, an article on cryptanalysis, confining these articles, for the most part, to the solution of cryptograms enciphered by means of the old Signal Corps Cipher Disk, now known as the Army Amateur Cipher, and designated ARMAC.

In addition to these monthly articles, a Cipher Buster's Certificate was designed, and awarded to each member who solved five unknown key cryptograms during the year 1936–37. The stimulating effect of these certificates, although most gratifying, was anticipated, because if there is anything coveted by a radio amateur, it is a certificate of some kind which he can frame and hang on the wall of his "shack."

In addition to our own efforts, we have been greatly assisted by the office of the Chief Signal Officer during the current season, by the introduction to Army amateurs of single transposition cryptograms, thus breaking the monotony of the old ARMAC substitution cipher.[1] At first the change to transposition was received with considerable consternation, because the Army amateurs had had no instruction in anything but substitution; but as first one member and then another succeeded in solving a transposition cipher, and the solution method was discussed and explained among the members, interest and activity in the whole subject of cryptanalysis became greater than ever before. In order to facilitate the reward for this increased interest, we have increased the available number of unknown key cryptograms by augmenting those transmitted by the Chief Signal Officer monthly by originating one or two each month at corps area headquarters, thus increasing each member's opportunity to earn a Cipher Buster's Certificate during the operating season. We are now doing a thriving business in certificates, which is another way of saying that the Seventh Corps Area has an ever increasingly large number of cipher busters.

ANALYSIS VERSUS THE PROBABLE WORD

By Howell C. Brown, WLVS/W6BPU, Pasadena, Calif., *Cryptographer Ninth Corps Area, Army Amateur Radio System*

Some cryptanalysists swear by the "probable" word method and others by the analytical one. In all probability the middle ground is the quickest and safest in the long run. Some cipher busters seem to have the faculty of "guessing" a word that will be found in the text. If they guess right it is the shortest way to find both the period and the key word but, if they are mistaken, they have lost a lot of valuable time and must go back and try others or fall back on analysis. Some of the members have found this out in my Camra in the December Corps Area Bulletin and, after having spent days with probable words, have had to go to analysis and then broken it in a short time.

---

[1] Monoalphabetic substitution with reversed alphabet generally known as the Beaufort system.

In a very short message about the only possible way is to try for the probable word because we do not have enough letters to make a frequency count of much value. When we have a message of about 50 letters it becomes quite burdensome to try sliding the suspected word along, step by step, and the purpose of this article is to explain an easy and fairly rapid method of doing the same thing. It was originated by a famous French cryptographer, Commandant Bazeries, but has been modified and put in its present form by a member of the American Cryptogram Association who writes under the nom de plume of "Efsee."

We have the following message:

YGFAT NZAQS CAAAX QSGGO EZAGP RYAXX

It shows no decided period and is so short that a frequency count even if we could find a possible period, would give us little or no information. Our only recourse is to try for a probable word. Both the message and its solution are based on the cipher known as the Beaufort system which makes use of reversed alphabets, and which was once used by the United States Army. However, by making use of a St. Cyr slide or tableau, it may be used the same way on any cipher of the Vigenère type.

Let's suppose we hope to find the word "bearer." Write the message horizontally and, at the left, the suspected word:

	YGFAT	NZAQS	CAAAX	QSGGO	EZAGP	RYAXX
B						
E						
A						
R						
E						
R						

Our next step is to take B, the first letter of the suspected word and using it as the first letter of the plain text, find what each letter of the cipher text will give as key letter. Next, starting with the second letter of our message, we do the same thing with E. Start with the third letter of the message and do the same thing with A. Continue this until you have used all the letters of the probable word and you will have a work sheet that looks like this:

	YGFAT	NZAQS	CAAAX	QSGGO	EZAGP	RYAXX
B	ZHGBV	OABRT	DBBBY	RTHHP	FABHQ	SZBYY
E	KJEX	RDEUW	GEEEB	UWKKS	IDEKT	VCEAA
A	FAT	NZAQS	CAAAX	QSGGO	EZAGP	RYAXX
R	RK	EQRHJ	TRRRS	HJXXF	VQRXG	IPROO
E	X	RDEUW	GEEEB	UWKKS	IDEKT	VCEAA
R		EQRHJ	TRRRS	HJXXF	VQRXG	IPROO

It looks as if it took quite a while and does not appear very promising but let's see. We only had to make the decryptment of four lines, BEAR, because the other letters in the trial word were repeated and it was only necessary to copy from the lines already completed.

It is natural that under each A we will find the trial word because with A as message letter the trial word letters remain unchanged. However, in this method, we are not interested in the vertical or horizontal lines but the diagonals. Start with Z in the first or B line and follow the diagonal. It makes no sense. Keep on with the others in order and, starting with the second B in our line the diagonal reads BUSTER. This must be our key word or a part of it anyway. Our next step will be to try it as a key-word and see if we can decipher the cryptogram. Counting from the first letter of the message to the place where the key word starts, we find seven letters, which shows that the period is probably seven and we still lack one letter. We will write our cipher text in seven columns; placing what we have of the key-word over them:

B U S T E R —
Y G F A T N Z

A Q S C A A A

X Q S G G O E

Z A G P R Y A

The fact that the letters Q, S, and A repeat in columns 1, 2, and 7 would make it appear that we have selected the correct period. Next take the cipher disk or sheet and decipher. This gives us:

B U S T E R —
Y G F A T N Z
d o n t l e
A Q S C A A A
b e a r e r
X Q S G G O E
e e a n y d
Z A G P R Y A
c u m e n t

It is easy to see that the first line should read: "Don't let", which furnishes another plain letter and, with Z as cipher letter and T as the plain letter, reference to your disk or sheet shows the missing key letter to be "S." The message reads: DONT LET BEARER SEE ANY DOCUMENTS.

If the trial word had been a short one such as THE, we would only find fragments of the key (If that word had been in the message). Unless BEARER had been in the message you would have had a hard time guessing any other probable word and might have continued for a long time before you tried DONT, LET, ANY, DOCUMENTS. I call your attention to this fact to show just how hard it is to guess the probable word. During war a cryptanalyst may be almost certain that the message will have such words as, CORPS, GENERAL, REGIMENT, ATTACK, etc., but a message in civil life, when we know nothing of its origin or about the sender, may resist breaking down for a long time especially if it is very short. If we have several messages enciphered with the same key, it is rather easy to break them down no matter how short they may be but do not be disappointed if a short message resists your efforts entirely. That has happened to the most famous cryptanalysts.

Now let's go back to our message again and repeat a few things. Be sure and do not use the letters of the probable word as key. They are suspected plain-text letters and, instead of sliding the word along through the whole text step by step, we just take each letter and slide it under the message. It will always be the key that shows up when working with the Beaufort cipher.

When looking over these diagonals it is extremely easy to miss a key fragment so keep a close lookout and, if the key does not appear, try any fragments that look as if they might be parts of English words. It might happen that your probable word was not in the message but some of the letters in that word might be there. To illustrate, if we had tried THERE on the above cryptogram, the RE of BEARER would have produced TE of the key. Even with such a small fragment as TE, it might be possible, using it as key and then working on the plain text fragments that appear, to reconstruct the entire key word.

EDGAR ALLEN POE, CRYPTOGRAPHER*

By Lt. Col. WILLIAM F. FRIEDMAN, *Signal Reserve*

It is a curious fact that popular interest in this country in the subject of cryptography received its first stimulus from Edgar Allan Poe. Should a psychologic association test be made, the word "cipher" would doubtless bring from most laymen the immediate response, "Poe" or "The Gold Bug." The fame of Poe rests not a

*EDITOR'S NOTE.—Reprinted, by special permission, from American Literature, vol. VIII, no. 3, November 1936. In the next issue the author will present additional data in amplification of some of the statements contained in the original article, together with the actual cryptograms discussed herein.

little on his activities with cipher, and much of the esteem in which this American genius is held today rests in part on the legend of "Poe the cryptographer."

Several years ago, in an extremely interesting and penetrating analysis, Joseph Wood Krutch discussed Poe's activities in cryptography, saying:

> Doubtless nothing contributed to a greater extent than did Poe's connection with cryptography to the growth of the legend which pictured him as a man at once below and above ordinary human nature; but the whole subject is still unfortunately wrapped in some obscurity, and it is impossible to be sure of the facts as distinguished from his own report of them.[1]

The popular conception of, and the reaction toward, the subject of cryptography in Poe's time—and to a certain extent today—are the remnants of a medieval point of view, which regarded it in somewhat the following light: A cryptogram is a piece of writing to which a meaning exists but is not immediately perceptible; its intelligibility is concealed, hence mysterious or occult, and thus supernatural. Therefore anyone practicing the art is of necessity the associate of forces governing supernatural phenomena. The mental portrait the average layman has even today of the professional cryptographer is that of a long-haired, thick-bespectacled recluse; a cross between a venerable savant and a necromancer who must perforce commune daily with dark spirits in order to accomplish his feats of mental jiu-jitsu.

This impression was doubtless prevalent in Poe's time because authentic information concerning cryptography was extremely limited and is even today quite meager. One of the interesting anomalies in the whole field of cryptology is the paucity of sound literature on the subject. In the most extensive bibliography in print,[2] the number of treatises of real technical merit does not exceed a dozen. Such a pitiful showing for an art that has been practiced from time immemorial cannot be ascribed to a lack of interest in the subject on the part of the general public, or to a lack of usefulness as a branch of knowledge. On the contrary, cryptography is employed to a great degree every day in all countries, in diplomatic, military, naval, busi-

---

[1] Edgar Allan Poe: A Study in Genius (New York, 1926), p. 103. More recently, Prof. Killis Campbell (in The Mind of Poe and Other Studies Cambridge, Mass., 1933) says: "What, finally, of the fiber of Poe's mind, of his natural endowments, and of his intellectual integrity? No one, so far as I know, has ever denied to Poe the possession of a peculiarly acute and active mind. * * * That he had extraordinary powers of analysis comes out everywhere—in his critical reviews, in his studies in sensation, in his ratiocinative and pseudo-scientific stories, in his solving of ciphers and cryptographs" (pp. 28–29). "Question has likewise been raised in some quarters as to Poe's honesty and his intellectual integrity. * * * But an even more serious indictment has been brought against him, to the effect that he at times made a display of learning or affected an erudition to which he had no claim" (pp. 30–31).

[2] André Lange and E.-A. Soudart, Traité de Cryptographie (Paris: Librairie Félix Alcan, 1925). The number of items in this list is approximately 100.

ness, and social affairs; and as a pastime, it presents many of the elements that constitute the *raison d'être* of the best types of puzzles. Even those who have never delved into it agree that the subject intrigues and tantalizes them. Yet information concerning methods of preparing cryptograms of sound merit is very meager, and that concerning methods of solving them is abysmally lacking to all except a very small circle of professional cryptographers who remain in office only so long as they violate no governmental secrets connected with their work.

It is not strange, then, that in a field wherein popular interest is great but popular knowledge extremely limited many spurious ideas should be current. This state of affairs existed in Poe's day, and consciously or subconsciously Poe saw an opportunity to exploit it for his own purposes. To exhibit deep understanding and thorough knowledge where the stock of knowledge on the part of others is practically nil, would seem to be a pardonable source of gratification to a perfectly normal person; what could be more soothing and reassuring to the victime—according to Krutch's view—of a rather well-developed inferiority complex?

Poe's known cryptographical writings include the article "A Few Words on Secret Writing" which appeared in the July 1841 issue of Graham's Magazine; three supplementary articles appearing in the August, October, and December issues of the same magazine; his tale The Gold Bug; and, if it may be included under the heading of cryptographical writings, a recently discovered letter written to a Mr. Richard Bolton, of Pontotoc, Miss. In none of them can the serious student of the subject find any evidence that Poe was more than a tyro either in the art of cryptography or in its handmaid, the science of cryptographic analysis. Long before his day, men who had made a study of these matters were far more proficient, and their names are all but forgotten.

One of the references that Poe made to cryptography occurs in connection with a review of a book entitled Sketches of Conspicuous Living Characters of France, which appeared in the April 1841 issue of Graham's Magazine. It is as follows:

> In the notice of Berryer it is said that, a letter being addressed to the Duchess of Berry to the legitimists of Paris, to inform them of her arrival, it was accompanied by a long note in cipher, the key of which she had forgotten to give. "The penetrating mind of Berryer", says our biographer, "soon discovered it. It was this phrase substitute for the 24 letter of the alphabet—*Le gouvernement provisoire!*"
>
> All this is very well as an anecdote; but we cannot understand the extraordinary penetration required in the matter. The phrase *Le gouvernement provisoire* is French, and the note in cipher was addressed to Frenchmen. The difficulty of deciphering may well be supposed much greater had the key

been in a foreign tongue; yet any one who will take the trouble may address us a note, in the same manner as here proposed, and the key-phrase may be in either French, Italian, Spanish, German, Latin, or Greek (or in any of the dialects of these languages), and we pledge ourselves for the solution of the riddle. The experiment may afford our readers some amusement—let them try it.[3]

The way in which Poe puts the matter reminds one very much of the manner in which a conjurer, performing a mystifying trick, extremely simple in itself, surrounds its execution with a great deal of unnecessary stage business to make it appear more complicated and difficult than it really is. A casual inspection of the type of alphabet said to have been employed by the lady of forgetful memory will quickly convince even a novice that the arrangement of letters in the cipher alphabet has absolutely nothing to do with the case. The solution is entirely independent of the arrangement of letters and, of course, Poe knew it. He admits this, in fact, in his essay which he published 3 months later. We might be very much inclined to overlook this particular bit of hokum were it not for the fact that this incident led directly to his writing the essay which appeared in the July number of Graham's.

In the course of this essay Poe repeats, almost verbatum, the remarks made in the April number in connection with the Berryer cryptogram and adds that "this challenge has elicited but a single response, which is embraced in the following letter." He then gives the letter, which encloses two cryptograms composed by means of cipher alphabets of the nature indicated above. Poe solves them, gives the solutions, and says:

In the solution of the first of these ciphers we had little more than ordinary trouble. The second proved to be exceedingly difficult, and it was only by calling every faculty into play that we could read it at all.[4]

Anyone who will take the trouble to go into the matter carefully will, I am sure, be entirely at a loss to account for the difficulty Poe experienced with regard to the second example. The reader will have to take my word for it, of course, but I say that any person who, having devoted but 2 weeks' study to elementary cryptograms, cannot solve that particular cryptogram in 2 hours at the most, had better turn his attention to other pursuits wherein success will crown his efforts with less expenditure of energy. As a matter of fact the experiment was recently tried upon four persons who had just completed exactly 10 days' study of cryptography. They worked independently, and each accomplished the solution in approximately 35 minutes.

---

[3] J. A. Harrison (ed.), The Complete Works of Edgar Allan Poe (Virginia Edition) [New York, 1902], X, 135–136. Hereafter cited as "Works."

[4] Ibid., XIV, 126.

Over half of "A Few Words on Secret Writing" is devoted to the Berryer form of cryptogram, a type which, despite its utter simplicity, is so impractical that it is employed only by novices, and then only seldom. The actual Berryer cryptogram must, indeed, be considered the concoction of amateurs or of persons whose knowledge of cryptography was extremely limited, for, so far as history records, no such impractical system was ever regularly employed for serious purposes. It is true that Poe comments upon its impracticability, but as to the complexity of the type it is apparent that he thought highly of it.

In this same essay Poe refers to other writings on the subject of cryptography, which, he says, appeared "in one of the weekly papers of this city [Philadelphia]." This paper has been identified as Alexander's Weekly Messenger.[5]

> In the discussion of an analogous subject, in one of the weekly papers of this city, about 18 months ago, the writer of this article had occasion to speak of the application of a rigorous method in all forms of thought—of its advantages—of the extension of its use even to what is considered the operation of pure fancy—and thus, subsequently, of the solution of cipher. He even ventured to assert that no cipher, of the character above specified, could be sent to the address of the paper, which he would not be able to resolve. This challenge excited, most unexpectedly, a very lively interest among the numerous readers of the journal. Letters were poured in upon the editor from all parts of the country; and many of the writers of these epistles were so convinced of the impenetrability of their mysteries, as to be at great pains to draw him into wagers on the subject. At the same time, they were not always scrupulous about sticking to the point. The cryptographs were, in numerous instances, altogether beyond the limits defined in the beginning. Foreign languages were employed. Words and sentences were run together without interval. Several alphabets were used in the same cipher. One gentleman, but moderately endowed with conscientiousness, inditing us a puzzle composed of pot-hooks and hangers to which the wildest typography of the office could afford nothing similar, went even so far as to jumble together no less than seven distinct alphabets, without intervals between the letters, or between the lines. Many of the crytographs were dated in Philadelphia, and several of those which urged the subject of a bet were written by gentlemen of this city. Out of perhaps 100 ciphers altogether received, there was only one which we did not immediately succeed in resolving. This one we demonstrated to be an imposition—that is to say, we fully proved it a jargon of random characters, having no meaning whatever. In respect to the epistle of the seven alphabets, we had the pleasure of completely nonplusing its inditer by a prompt and satisfactory translation.

Unfortunately the records that remain of Alexander's Weekly Messenger are exceedingly fragmentary. Despite painstaking research by numerous Poe experts, not a single issue containing any cipher solutions that Poe may have published as a result of his asserted challenge has ever been found, and there seems to be no

[5] Krutch, op cit., p. 104.

way at the present moment of corroborating Poe's statements.[6] However, we may consider, from Poe's own words, that the cryptogram employing "no less than seven distinct alphabets" represented the most difficult of all those submitted to Poe, and therefore warrants special scrutiny.

Ciphers involving a plurality of different alphabets have been known in the art for a long time. The principle is very clearly described in the oldest tract on cryptography that the world now possesses, that written by Alberti.[7] Multiple alphabet ciphers vary in complexity to a much greater extent than do single alphabet cryptograms, and it is possible to employ in one dispatch a practically unlimited number of distinctly different alphabets. In general it may be said that the greater the number involved, the more difficult becomes the analysis, but the particular manner in which the separate alphabets are employed is an equally important factor in solution. It is very unfortunate that Poe's statements with respect to the seven-alphabet example he solved tell us nothing about the latter factor. Internal evidence contained in his article, especially in his supplementary remarks with reference to a system known as the *chiffre quarré*, indicates that the seven alphabets were employed in one of the simplest possible ways, probably in rotation according to sentence lengths. If such were indeed the case the problem merely resolved itself into the solution of seven separate examples, each of the single alphabet type. But granting that the seven alphabets were used in one of the more intricate ways—let us assume that they were employed in a cyclic manner, changing with successive

[6] The following is quoted from Krutch, op. cit.: "Now the first of these articles [in Alexander's Weekly Messenger] was never found by any of the editors of Poe's works and has never been reprinted; but though no complete file of the periodical in question is known to exist some numbers are extant and in one of them is an article on enigmas which does challenge the reader to submit an example of secret writing in which an arbitrary symbol is substituted for each letter of the alphabet. It is not, however, possible to check up on Poe's later statement that in response to this challenge 'Letters were poured in upon the editor from all parts of the country' and were in every case successfully read in spite of the fact that many violated the conditions imposed and one employed seven distinct alphabets in the course of a single communication. Indeed, the fact that Alexander's Weekly Messenger, the paper in question, was exceedingly obscure and very short-lived, coupled with the fact that the second and similar challenge in the very prominent Graham's Magazine certainly brought much less response, makes legitimate a suspicion that Poe's statement embodies a considerable exaggeration" (pp. 103–104). "Just how much of this mysterious power was real and how much pretense it is impossible, as we have said, to determine, and it is extremely unfortunate that the results, if any, of the article in Alexander's Weekly Messenger cannot be traced. It is unfortunate also that the only explanation of his method which he gives, that contained in The Gold Bug, applies only to the simplest sort of cryptogram, and that he nowhere discusses the method employed in solving the more complicated ones" (p. 106).

[7] Leo Baptista Alberti, Trattati in cifra. Vat. Arch., Series Varia Politica, vol. LXXX, folios 173–181. (In the bibliography referred to in footnote 2, this treatise is dated 1480, but I can find no warrant for this. The acknowledged historical authority, Dr. Aloys Meister, in Die Geheimschrift im Dienste der Päpstlichen Kurie (Paderborn, 1906), who prints the Latin treatise in question, assigns no date to the manuscript, stating merely that Alberti died in 1472.)

letters of the text—the solution of such a problem still represents a relatively simple case. To give Poe the greatest credit possible, however, it might be considered an achievement for an individual who simply plays with cryptography as a hobby.

In the August number of Graham's, Poe published a cryptogram composed by a Dr. Frailey, of Washington, and sent to him by his well-known friend, F. W. Thomas. Poe says that the solution was forwarded to its author by return mail, and offers "*a year's subscription to the magazine, and also a year's subscription to the Saturday Evening Post, to any person, or rather to the first person, who shall read us this riddle.*"[8] He goes on to say:

> We have no expectation that it will be read; and, therefore, should the month pass without an answer forthcoming, we will furnish the key to the cipher, and again offer a year's subscription to the magazine, to any person who shall solve it *with the key.*

The September number of the magazine is entirely silent on the subject. In the October number, Poe says:

> The cipher submitted through Mr. F. W. Thomas, by Dr. Frailey, of Washington, and deciphered by us, also in return of mail, as stated in our August number, has not yet been read by any of our innumerable readers. We now append its solution * * *.

Poe did not abide by the terms of his August agreement, in which he stated that he would furnish the key and again offer a year's subscription to any person who would solve it with the key. Perhaps his exuberance over his achievement had somewhat died down after the August issue. But an examination of the Frailey cipher should show what there is about it that so excited Poe.

It is unnecessary to illustrate the cryptogram here; one need only indicate that it followed very closely the Berryer type, with the sole modification that a few words and the terminations SION and TION were represented not by letters, but by single symbols. For example, £ stood for IN, and the figure 7 for ON; there were 19 such symbols, all instances of this sort. That they were not the representatives of individual letters was obvious from a mere ocular examination. Compared with the use made of the ordinary letters of the alphabet, the symbols were relatively insignificant. In fact, the solution can practically be accomplished without an analysis of these symbols, the meanings of which can then be merely inserted from the context. What then made the cryptogram seem so intricate to Poe? Let us take a look at the "clear text", and the matter may become apparent:

> In one of those peripapetic circumrotations I obviated a rustic whom I subjected to catechetical interrogation respecting the nosocomial characteristic of the edifice to which I was approximate. With a volubility uncongealed by

[8] Works, XIV, 134. The italics are Poe's.

the frigorific powers of villatic bashfulness, he ejaculated a voluminous replication from the universal tenor of whose contents I deduce the subsequent amalgamation of heterogeneous facts. Without dubiety incipient pretension is apt to terminate in final vulgarity, as parturient mountains have been fabulated to produce muscupular abortions. The institution the subject of my remarks, has not been without cause the theme of the ephemeral columns of quotidian journalism, and enthusiastic encomiations in conversational intercourse.[9]

Despite a long experience with the absurd texts that cryptographic "inventors" are prone to employ, this, I confess, is quite a gem. It is a curious thing that persons who offer samples of cryptographic puzzles of their own "invention" almost invariably contrive to produce a monstrosity of diction like the foregoing. Perhaps it tickles their sense of humor—the unreasonableness of their language seems never to occur to them.

If Frailey's cipher was difficult, therefore, it became so not because of any inherent complexity in the method employed, but solely because the diction was so outrageous. But after the preliminary stages in solution—that is, after a few of the most important values had been obtained, which certainly should not consume more than 1 or 2 hours at the utmost—the completion of the puzzle was merely a matter of patience and the use of an unabridged dictionary. Certainly very little use of the analytical faculties so lauded by Poe was requisite. The Frailey cipher (naturally, without any information) was presented as a simple test to the same four students referred to before. In 3 hours all had recovered or reconstructed the phrase upon which the cipher alphabet was based, which was "But find this out and I give it up."

The terms in which Poe issued his challenge in regard to the Frailey cipher are startling enough in themselves, but the esteem in which he really held the cryptogram is shown and, in addition, an interesting sidelight on his character is revealed by some correspondence which appeared in the November 15, 1925, issue of the Memphis Commercial Appeal. A Mr. Richard Bolton, of Pontotoc, Miss., on November 14, 1841, addressed a letter to Poe, taking him to task in the following terms:

The November number of your valuable magazine has just arrived. To my great surprise no notice is taken of my solution of the cryptograph proposed to your readers in the August number. This I can attribute only to accident or oversight. As you had thrown the gauntlet which I took up, I must call upon you as a true man and no craven to render me according to the terms of the defiance the honors of a field worthily contested and fairly won.

A friend lent me for perusal your magazine for that month. On the 9th of September, within a month after the arrival of the magazine, my solution was mailed postage paid, addressed to the editor. Accompanying it were certificates of two subscribers, Messrs. Glokenau and L. C. Draper (the latter assistant

[9] Ibid., XIV, 138–139.

postmaster) that I had effected the solution unaided by the key and that the September number in which the key was exposed had not arrived.

My solution fully agrees with your published solution except in two words about which I will soon take occasion to remark. I therefore claim to have fully complied with the terms of the challenge and to be entitled to all the rights, privileges, and honors therein expressed.

Poe's prompt reply, couched in the most friendly terms, offered a very clear and unquestionable explanation of what appeared to Bolton as an unwillingness to a division of the honors of victory and a participation in the spoils. The explanation, of course, lay in the fact that the forms of any periodical of fair size must go to press long in advance of issue. Poe then continued as follows:

Upon this hint you will easily see the possibility of your letter not having come to hand in season for acknowledgment in the November number. Otherwise I should have had high gratification in sharing with you then the reputation of a bottle conjurer—for thus the matter seems to stand. In our December number (which has been ready for 10 days) you will find an unqualified acknowledgment of your claims—without even allusion to the slight discrepancies for which I believe the printer is chargeable. I mean to say that you have (I believe) solved the cipher as printed. My solution follows the MS.—both are correct.

Allow me, Dear Sir, now to say that I was never more astonished in my life than at your solution. Will you honestly tell me?—did you not owe it to the accident of the repetition of the word "itagi"? for "those"? This repetition does not appear in the MS.—at least, I am pretty sure that it was interpolated by one of our compositors—a "genius" who takes much interest in these matters—and many unauthorized liberties.

In Dr. Frailey's MS. were many errors—the chief of which I corrected for press—but mere blunders do not much affect the difficulty of cypher solution—as you, no doubt, perceive. I had also to encounter the embarrassment of a miserably cramped and confused penmanship. Here you had the advantage of me—a very important advantage.

Be all this as it may—your solution astonished me. You will accuse me of vanity in so saying—but truth is truth. I make no question that it even astonished yourself—and well it might—for from at least 100,000 readers—a great number of whom, to my certain knowledge, busied themselves in the investigation—you and I are the only ones who have succeeded.

It is with some regret that I must place beside this frank acknowledgment an extract from a letter written by Poe to F. W. Thomas, dated November 26, 1841 (for which I am indebted to Dr. T. O. Mabbott). Bolton's letter, Poe declared,

* * * was dated at a period long after the reception of our Magazine in Pontotoc. * * * He pretends not having seen my solution—but his own contains internal evidence of the fact. Three blunders in mine are copied in his own and two or three corrections of Dr. Frailey's original, by myself, are also faithfully repeated. I had the alternative of denying his claim and thus appearing invidious or of sharing with him an honor which in the eyes of the mob at least, is not much above that of a bottle-conjuror. So I chose the last and have put a finale to this business.

147970—37——4

If Poe honestly entertained the suspicion which he directed against Bolton, the course which he followed and the complimentary letter he sent to Bolton, redound to his great credit. But I am sorry to say that after a minute investigation of the whole matter, in which no detail was too insignificant to be overlooked, I must declare that Poe had utterly no foundation for his suspicion. Internal evidence in Bolton's solution, which also appears in the newspaper mentioned, as well as all the attendant circumstances, serve to indicate conclusively that his work was accomplished without the key. Nowhere can one find "three blunders in mine which are copied in his own"; and so far as regards the "two or three corrections of Dr. Frailey's original, by myself", are concerned, who can doubt that Bolton did what every cryptographer does constantly—correct errors from the context? And there were errors—many of them in the cipher text as published by Poe, of which the latter was possibly not aware, though he was aware of the errors in the original. Furthermore, it will be noted that Poe did not, in his letter to Bolton, deny having received the latter's solution mailed on September 9. Now if Bolton mailed his solution on the date indicated, even allowing a whole month for its transit, Poe must have received it by October 9. The key to the cryptogram did not appear in the September number, as Bolton inadvertently stated (a slip of the pen which adds weight to his claim), but appeared in the October number, which could not possibly have arrived before September 9. In fact, as the matter stands, one could, in truth, impute to Poe an unwillingness to share the honors with Bolton, but we may accept in good faith the explanation he offered the latter.

Several inaccurate statements by Poe also occur in connection with his very brief description of a well-known cryptographic method often referred to as the *chiffre quarré.* In the December article in Graham's, speaking of the difficulty of composing impenetrable cryptograms, Poe said:

> We may say, in addition, that the nearest approach to perfection in this matter, is the *chiffre quarré* of the French Academy. This consists of a table somewhat in the form of our ordinary multiplication tables, from which the secret to be conveyed is so written that no letter is ever represented twice by the same character. Out of a thousand individuals 999 would at once pronounce this mode inscrutable. It is yet susceptible, under peculiar circumstances, of prompt and certain solution.[10]

In the first place, even in Poe's day to say that the *chiffre quarré* "is the nearest approach to perfection in this matter" was absurd, for almost any example of it could have been solved within an hour or two by anyone who was worthy of being considered an expert

[10] Ibid., XIV, 148.

cryptographer. In the second place, the *chiffre quarré*, which Poe attributed to the French Academy, was first illustrated by Vigenère in 1586. Note that I say described, and not invented, for to all intents and purposes the same method, without actually employing the square table of Vigenère, was occasionally used at least as early as 1560 by certain Italian cryptographers in the employ of the papacy. In the third place, to say of the method that it is one in which "no letter is ever represented twice by the same character" is entirely incorrect. Furthermore, Poe's statement relative to the possibility of solving this type of cryptogram leaves room for doubt as to what he meant to convey by the qualifying phrase "under peculiar circumstances"—if he intended to give the impression that the circumstances are unusual, his statement is erroneous.

Another, almost glaring inaccuracy of Poe's is found in connection with a reference made by him to the Francis Bacon cipher. In the August 1841 number of Graham's Magazine, Poe begins with the following words:

> Our remarks on this head [secret writing] in the July number have excited much interest. The subject is unquestionably one of importance, when we regard cryptography as an exercise for the analytical faculties. In this view, men of the finest abilities have given it much of their attention; and the invention of a perfect cipher was a point to which Lord Chancellor Bacon devoted many months—devoted them in vain, for the cryptograph which he thought worthy of a place in his De Augmentis, is one which can be solved.[11]

Again, in the December number in connection with the question of the so called indecipherable cipher, Poe writes:

> Perhaps no good cipher was ever invented which its originator did not conceive insoluble; yet, so far, no impenetrable cryptograph has been discovered. Our correspondent will be the less startled at this, our assertion, when he bears in mind that he who has been termed "the wisest of mankind"—we mean Lord Verulam—was as confident of the absolute insolubility of his own mode as our present cryptographist is of his. What he said upon the subject in his De Augmentis was, at the day of its publication, considered unanswerable. Yet his cipher has been repeatedly unriddled.[12]

It is rather a late day to take up the cudgel for the Lord Chancellor, but to do him justice I will say in the first place that he certainly did not present his mode of secret writing accompanied by any assertion relative to its indecipherability he merely said that he had invented it while a youth in Paris, and that [45 years afterward] he still thought it worthy of preservation. In the second place, the cryptogram he presented as an example was accompanied not only by a full explanation of the system, but also by the key. Poe's remarks lead one, indeed, to believe that he could not himself have examined Bacon's

[11] Ibid., XIV, 133.
[12] Ibid., XIV, 147–148.

cipher in the De Augmentis, but was writing upon the matter merely from hearsay.

In the course of this discussion only casual reference has been made to The Gold Bug. It is fairly certain that Poe identified himself with its principal character Legrand, whose very name is significant. Regarding the cryptogram in this tale Poe says that it "was of a simple species", that he solved it "readily", and that he had "solved others of an abstruseness 10,000 times greater."

We have seen that so far as the actual record goes it is doubtful whether Poe ever solved any cryptogram that can properly be said to fall outside the class of simple substitution. The Frailey cipher, which was the most difficult of those shown by the record, and about which Poe wrote so enthusiastically, was but a little more complicated than that in The Gold Bug, of which he himself made light. Therefore, to say that he had "solved others of an abstruseness 10,000 times greater" is a considerable exaggeration, even in a tale of pure fancy.

It cannot be denied that Poe was greatly given to exaggeration. It was this foible which led him to make his most famous, and, for him, a most unwarranted, dictum on cryptography namely, that relative to the impossibility of devising the so-called indecipherable cipher. It will be well to give the exact form in which he made the assertion. In A Few Words on Secret Writing, published in Graham's Magazine for July 1841 he stated:

> Few persons can be made to believe that it is not quite an easy thing to invent a method of secret writing which shall baffle investigation. Yet it may be roundly asserted that human ingenuity cannot concoct a cipher which human ingenuity cannot solve.[13]

He repeated the declaration in one of his supplementary articles, and, again, in practically the same form, in The Gold Bug. Even to critical readers without cryptographic training[14] it is apparent that his dictum goes far beyond what he actually demonstrated in any of his cryptographic writings; and to the professional cryptographer it appears about time that Poe's assertion be challenged.

So far as the professional cryptographer is concerned, there has never been any question about the theoretical possibility of constructing at least one or two cipher systems, which are mathematically demonstrable as being absolutely indecipherable. It is far from being the case that the invention of such ciphers had to wait modern advances in cryptographic science; their devising was possible from the very earliest days of secret writing. The difficulty has been to

---

[13] Ibid., XIV, 116.

[14] For example, Krutch, op cit., p. 107, says: "In the course of the articles on cryptography his speculations went far beyond the concrete demonstrations which he affords. 'Human ingenuity', he declared triumphantly, 'could not devise a cypher which human ingenuity could not solve' * * *."

make such systems practicable for regular usage by persons having a need for the highest degree of cryptographic security.

A system which is now considered to be one of the very best for practical usage was discovered recently to have been invented by that amazing American genius Thomas Jefferson.[15] There can be no question that had Poe been cognizant of the method proposed by Jefferson he would have pronounced it absolutely inscrutable, for, as compared with the chiffre quarré (of which it will be remembered he said that it was the nearest approach to perfection), Jefferson's system is of a very much greater security. In fact, some of the American patriots of Revolutionary days were far better informed on secure methods of secret writing than was Poe.

It may perhaps be charged that it is unfair to expect of Poe a knowledge of the modern intricacies of a science which, like other sciences, must have undergone rapid development in the past half-century. On the contrary, although it is true that the state of the science is greatly in advance of what it was in Poe's day, long before his time it was much beyond what his remarks lead one to assume. As has already been intimated, 400 years before Poe lived, professional cryptographers were daily employing and solving ciphers of much greater complexity than any which Poe illustrates and terms intricate. The basic principles for solving the type of ciphers Poe discusses were described in detail in papers written by Italian cryptographers before the dawn of the sixteenth century.[16]

The serious student of cryptography can, if he takes the trouble, see in Poe's essay and in his other writings on this subject many things which are not apparent to the layman. Against his will he is driven to the conclusion that Poe was only a dabbler in cryptography. At the same time it is only fair to say that as compared with the vast majority of other persons of his time in this or in foreign countries, his knowledge of the subject, as an amateur, was sufficient to warrant notice. Had he had opportunity to make cryptography a vocation, there is no doubt that he would have gone far in the profession.

THE EVOLUTION OF COMMUNICATION*

By FRANK V. RHODES, *Consulting Engineer, San Francisco, Calif.*

Before man learned to talk, he communicated with others through signs, sounds, and gesticulations. This finally gave way to a recog-

[15] Jefferson's Papers, vol. CCXXXII, item 41575. Library of Congress, Washington.

[16] Aloys Meister, Die Anfänge der modernen diplomatischen Geheimschriften (Paderborn, 1902).

*Reprinted, by special permission, from issue no. 161, vol. XXVIII, of The Military Engineer. The Mills Building, Washinton, D. C.

nized system of inflected voice utterances, which we call language. It was not until long after spoken language had developed that a means of recording it came into use.

As man developed and moved from place to place, means of communicating with his old home, parents, and friends became necessary, and through the ages various means of communication have been required, and generally have been evolved, to meet the necessities of the times, until, at present, methods have been developed far beyond any dreams of a few years ago. There are now sufficient varied methods of communication to satisfy even unreasonable demands, but still individuals and large organizations are centering their effort upon improving the wonderful means which we have today.

The methods of communication used in ages gone are of much interest, for from them have evolved those in use at present.

Among the ancients.—In 1084 B. C., Agamemnon, in his siege of Troy, placed material for beacon fires on the tops of Mounts Ida, Lemnos, Athos, Cithaeron, the Arachnaean Heights, and other intervening mountains. A man was stationed beside each beacon with instructions to keep his eyes toward Troy. When Troy fell, a fire was kindled on the mountain nearest to the captured city, signaling to the man on the next mountain to start his fire, and so on across the hills to Greece, thus conveying the news. Even ages earlier than the siege of Troy, fire and smoke had been used as signals of communication at a distance. The towers along the Chinese wall were signal towers as well as watch towers.

Theseus, eldest son of the King of Greece, who later became the hero of the Argonautic expedition to secure the Golden Fleece, was, as a boy, sent with a group of other young Athenians as a war indemnity to be sacrificed to the minotaur, the flame-spitting bull of Marathon, which made its home in the labyrinth. The ship carrying these victims was equipped with black sails in token of death, but Theseus had agreed with Aegeus, his father, that if he were victorious in his proposed fight with the minotaur, he would, upon his return, replace all of the black sails with white, emblematic of life. Theseus was victorious over the minotaur but, in his elation, he neglected to replace the black sails with the white, and Aegeus on a high rock overlooking the sea, awaiting the return of his son, saw the black sails returning. This conveyed to him the message that his son was dead and he cast himself into the sea and was drowned. The sea was ever after called the Aegean.

A Persian king, in order to improve on the courier plan which had been in existence prior to his time, placed sentinels all along the route over which he desired messages carried, and instead of a courier running a certain distance and then passing the message to the next, each

sentinel remained at his station and shouted the message to the next, and so on until the message reached its destination. The ancient Gauls also used this method. Caesar probably used it in transmitting news of the massacre of the Romans at Orleans, as it reached Auvergne, nearly 150 miles distant, the same day.

Even in very early days, flashes of light were used to convey messages. The Pharaohs and the Persians used mirrors to flash light for signaling purposes. The shields of the soldiers were used to flash the news of the Battle of Marathon, thus anticipating the heliograph.

The heliograph is still in use. This is an instrument having mirrors which reflect the rays of the sun and cast them to a distant receiving station. A shutter is used to interrupt the beam of light, and thus, by a system of long or short flashes, a message is sent, usually in Morse code. The British Army has used the heliograph in India and Africa, and in some cases has transmitted messages more than 150 miles without their being relayed.

Alexander the Great used a gigantic speaking tube or trumpet, called a stenorophonic tube, which would carry the voice many miles.

Another peculiar signaling system used by the ancients was the clepsydra. A tall glass tube of water, with an opening or faucet at the bottom, would be placed on a hilltop; an identical tube, containing the same amount of water, was placed on a hilltop some distance away. Messages were inscribed at varying heights on each of the tubes. At a signal from the attendant at one tube to the attendant at the other, both would open the faucets. The water, leaving both tubes at an equal rate, was lowered to a given point or message at the same time at both stations. When the water reached the level of the message that was to be conveyed, a second signal would be given, indicating that both faucets were to be shut off. The attendant at the receiving station could then read the desired message at the level of the water.

The Roman and Gallic towers, whose ruins are still seen in France, were originally used as signal towers. Hannibal erected towers in many conquered countries. Colored tunics and spears were used in signaling from them.

Indian signaling.—The American Indians used puffs or rings of smoke for signaling in the daytime, and arrows of fire at night. Puffs of smoke were made by placing a blanket over a fire of damp wood or grass. The blanket would hold the smoke for an interval and would then be withdrawn in order that the smoke might rise in a puff or ring. By repeating this process, the desired number of distinct puffs could be produced. A continuous column of smoke indicated that an enemy was in the vicinity. One puff or ring meant

"Attention"; two puffs indicated that the signaler would sleep at the place of his fire, et cetera.

Signaling with arrows of fire was arranged by dipping the arrowhead in some inflammable substance and igniting it before release from the bow. One fire-arrow discharged vertically into the air signified that the enemy was near; two meant danger; and three, great danger. When many such arrows were fired in rapid succession, it was a call for aid—"enemies are too many." An arrow of fire discharged horizontally across the sky indicated, by the direction of its flight, which way the sender was preparing to travel.

The Incas of Peru at the time of the Spanish conquest had a road system rivaling that of the Romans. Relays of runners were maintained at approximately 5-mile intervals throughout the whole system. By this method of 5-mile relays messages could be carried 150 miles or more in a day. These Inca messages were generally sent by means of the quipo, which was a long cord from which hung, at certain distances, smaller cords of various colors, each having a special meaning. Knots were tied in the smaller cords to indicate the particular message desired.

Early naval signaling.—Prior to the past 100 years, there were many types of signaling or communicating systems in use in various navies of the world. After cannon were introduced on naval ships, their fire was used for signaling as early as the sixteenth century.

Communication between square-rigged ships was carried on by raising and lowering a sail from the yardarm. In the seventeenth century officers of the British Navy worked out a definite signaling system for conveying messages through a code of communication which consisted of varying the position of a single flag. In 1780, Admiral Kempenfeldt introduced the system of using several flags, instead of varying the position of only one flag. From Admiral Kempenfeldt's scheme was evolved the wigwag flag signals now generally in use throughout the world. Admiral Philip Colomb developed a code of light flashes for use during the night.

A system similar to the wigwag was used more than a century ago in France, the signaling being accomplished by large semaphores placed on towers. This was called a "telegraph", even then. Alexandre Dumas, in his Count of Monte Cristo, describes the use of the French semaphore telegraph.

The pony express.—Marco Polo relates that Genghis Khan, ruler of Chinese Tartary, had a courier service similar to the pony express, nearly a thousand years ago. Relay stations were provided about 25 miles apart, and horseback riders, by changing mounts at each station, could deliver messages as far as 300 miles in 1 day.

More than 100 years ago, systems of pony express were in vogue not only in various countries of Europe, but even by newspapers in New York. Richard Haughton, political editor of the New York Journal of Commerce, used a pony express communicating system as early as 1830. By making use of relays of fast horses and a few short railroad lines operating in Massachusetts, Haughton was able to print in New York, by 9 o'clock in the morning, the Boston election returns of the previous day.

In 1832, James W. Webb, editor of the New York Courier and Enquirer, had a pony express system in effect between New York and Washington, which gave much prestige to his paper. In 1833, the Journal of Commerce in New York started a rival pony express, and published news from Washington within 48 hours. In this way the Journal was able to obtain big "scoops" over other publications, and the newspapers in Norfolk, Va., some 230 miles southeast of Washington, received Washington news through the New York Journal of Commerce, which sent it by ocean route from New York faster than the same news from Washington could be sent direct to Norfolk by boat on the Potomac River.

The pony express across the western half of this continent, from the Missouri River to the Pacific coast, reduced the time of communication between coasts by more than 10 days. There were many trials and tribulations in the inauguration of this pony express, and then it lasted only approximately 16 months, as it was replaced in 1861 by a transcontinental telegraph line.

In 1854 Jefferson Davis introduced a bill in Congress asking for an appropriation with which to purchase camels to use for fast transport and communication across the desert wastes of the Southwest. The bill did not pass. In 1855 a Los Angeles newspaper, the Star, had an editorial advocating the use of camels for a 5- or 6-day pony express between Salt Lake City and Los Angeles and 15 or 16 days between the Missouri River and Los Angeles.

Shortly after this the Government appropriated $30,000 to buy camels for fast transport for the Army. Col. David D. Porter was sent to Egypt, where he obtained and brought to the United States 33 camels. On a second trip he brought some 40 more camels. These were all put to work for the Army, and in January 1858, a train of 14 camels walked up Los Angeles' Main Street. So Los Angeles got its camels, but not for the exact use for which it desired to bring them into service.

The Posts.—

> So the posts went with the letters.
> So the posts passed from city to city.
> II Chronicles 3: 6 and 10.

Sending a special messenger was the only manner in which letters could be delivered in very ancient times. Such a messenger was required to be familiar with the country and able to defend himself against brigands and wild beasts. He was well paid for his risks. If a slave were sent, and the journey long, there would be doubt as to the delivery of a letter as he might endeavor to escape to his own country.

All of the early rulers had their own courier systems for bringing information from various parts of their countries and for dispatching edicts thereto. No doubt these couriers often carried private messages between individuals, with or without the knowledge of their kings. This gradually developed to the point where influential persons and, later, anyone who would pay for the privilege, were permitted to use the courier systems. It is recorded that in the third century the emperor Diocletian had a definite postal system for his private use.

One of the earliest posts was a courier system maintained in the thirteenth century by the University of Paris for its students. As there were many students from all parts of France, and some from other countries in Europe, it appears that the system was quite extensive. Students turned all their letters over to a designated courier chief who handled their dispatch.

On June 19, 1464, Louis XI of France issued an edict establishing post stations on all of the principal roads of the country, with a courier system between stations. This was for Government use but these royal couriers gradually undertook the carrying of messages for private individuals. This developed to a more or less recognized practice, until the point was reached where, under the reign of Louis XIII, a "comptroller general of the post" was appointed.

It is recorded that, as early as the year 1544, two of the European governments permitted state couriers to carry private dispatches, and within a few years following, they actually legalized the practice and created a monopoly for such, with Government regulations controlling their use.

Richard Fairbanks was probably the first "postmaster" in America. The General Court of the Colony of Massachusetts in 1639 ordered that "all letters from beyond the sea and all letters sent thither, be left with him at his house", and he was allowed a penny for each.

In 1683 William Penn established a weekly pony express mail service between Philadelphia and various nearby towns and communities, followed a little later by regular post routes to the more distant points of the colony and even to some points in Maryland.

On April 4, 1691, the Royal Postmaster General of England appointed Andrew Hamilton as Postmaster General of America, to

serve, of course, under the Crown's post office. Apparently he was given much freedom of action. Hamilton visited all of the colonies in arranging for an intercolonial post and received the cooperation of all. The intercolonial post service was started May 1, 1693, with weekly service between Portsmouth, Saybrook, New York, Philadelphia, and some points in Maryland and Virginia. During the winter this service was fortnightly instead of weekly.

In the year 1707 the Crown's General Post in London took over the active control of our post system and retained it until about a year prior to the revolution.

In 1737 Benjamin Franklin was appointed postmaster at Philadelphia, and, not long after, on the death of the Crown's Deputy Postmaster General of the Colonies, Franklin was appointed to that position, being removed in 1744 due to some difficulty with the Governor of Massachusetts.

In the second session of our Continental Congress, in July 1775 it was resolved to have a post-office system of our own and Benjamin Franklin was selected as Postmaster General. He was voted a salary of $1,000 a year.

During the period that our posts were under the Crown, and until 1799, there had been a penalty of death for robbing the mails, but, in the year mentioned, the penalty was changed to flogging. Later the penalty was changed to imprisonment.

Under our first Postmaster General, postage rates were fixed in accordance with the distance carried and the number of "sheets" sent. It cost 6 cents to send one sheet 30 miles; 10 cents for 80 miles; 18¾ cents for 400 miles; and 25 cents for greater distances. Stamps were not in use and the postage charge could be paid either in advance by the sender, or on delivery, by the recipient. However, as early as 1825, Congress had provided for delivering letters in certain cities, with a charge of 2 cents to be paid on delivery. In 1863 a free delivery service was authorized for cities having 50,000 population or more. From time to time after that, modifications were made until at present there are some 2,500 cities in the United States having free delivery of mail.

In England, postage stamps had been used, with great success for some years, so a number of our local city postmasters began issuing them also, to the general satisfaction of the populace. Shortly after this, in 1847, the Postmaster General was authorized to issue stamps. The first were those of 5- and 10-cent denominations, bearing portraits of Franklin and Washington, respectively. During the year ending June 30, 1935, there were over 17,000,000 stamps, stamped envelopes, etc., issued to the post offices of the United States. The annual per capita purchase of postage stamps and other postal services for the same period was about $4.75.

In 1837 there were less than 12,000 post offices in the United States, with total annual revenues of approximately $4,000,000 while in 1935 there were some 45,700 post offices with annual revenues of over $630,000,000. In addition, there are 35,000 rural postal routes covering regularly over 1,300,000 miles.

During the year ending June 30, 1935, the more than 225,000 employees of the postal service handled, in addition to the billions of messages delivered in the United States, some 300,000,000 pieces of mail (exclusive of parcel post) destined to foreign countries. The railway post office car, some 4,000 in number, traveled over 450,000,000 miles in the same year, while air-mail carriers flew over 29,000,000 miles on regularly scheduled air-mail routes.

Electrical communication.—Until some mastery was obtained over the use of electricity in connection with communication, it may be said that, comparatively, all other communication systems were slow.

There is some evidence that both the Hindus and the Egyptians had developed systems of electric communication many centuries ago. In Pre-Adamite Man, a book written by P. B. Randolph long before the telephone was invented, it is stated that there is good evidence that "one of the Cleopatras sent news by a wire to all the cities from Teliopolis to Elephantine, on the Upper Nile."

The first modern suggestion of an electric telegraph was contained in an article signed "C. M." which appeared in Scots Magazine of February 17, 1755. The author was probably Charles Morrison, a Scotch surgeon, who had a reputation for his experiments with electricity. The idea that he described in his article was to have a separate wire for each letter of the alphabet, the wires to be charged in any desired order in accordance with the spelling of the word to be transmitted. The distant end of each of these wires would attract pieces of paper marked with the letter which each wire represented. In this way, any message desired could be spelled out. His idea was never applied. However, it set others to thinking, and one after another various electrical communicating devices were tried.

Harrison Gray Dyar, of New York, was compelled to discontinue his experiments with the electric telegraph and flee the country, as he was being accused of conspiracy to carry on secret communication. His device was a sort of chemical telegraph in which a transmitted electric spark decomposed an acid which had been applied to paper.

A Frenchman, named Ampère (his name now used as a measure of electricity) found that when electricity was sent through a coil of wire, magnetism was increased. He saw the possibilities of using the deflection of a magnetic needle for conveying messages, and he

made experiments along those lines. He exhibited a model of such a communicating system in London.

Faraday, in 1831, discovered that the motion of a magnet would generate electricity in a wire (the basis of our modern dynamo). Two German professors, Gauss and Weber, of the University of Göttingen, were experimenting with electrical communication and using a battery as a source of current. They now adapted the generator to an experimental line between their laboratories. Current was generated and passed over the line and through a coil at the further end, moving a magnet to right or left, depending upon the direction of the current flow through the wire.

In Munich, an experimenter named Steinheil improved on the Gauss and Weber system by having a moving needle at the receiving station mark down dots and dashes on a strip of paper. This experimenter was the first to utilize the earth for a return circuit, in place of a second wire.

The first electrical telegraph that was placed in service for use of the public was developed by Charles Wheatstone (a familiar name in the present day electrical industry) and William Fothergill Cooke, both Englishmen. However, it did not make a commercial success. Wheatstone, who was born near Gloucester in the year 1802, obtained a patent on a needle telegraph in 1837 and constructed an experimental line in London. (This was the same year in which Morse was making his models.) With the assistance of one of the railroads, Wheatstone erected a line for a distance of 13 miles, but until its usefulness was demonstrated in assisting in the capture of a murderer, it was slow to receive the patronage of the public.

Morse code telegraphy.—At the time when Wheatstone was experimenting with the telegraph, Morse was also working along very similar lines. Samuel Finley Breece Morse was born in Massachusetts in the year 1791. Returning from France, where he had been studying art, another passenger on the ship *Sully* showed him an electric magnet which he had secured in Europe, from which Morse saw, almost at once, the possibilities of its use in connection with a telegraph. Upon arriving home, he set to work in earnest to develop an electric signaling system. His finances were low and he was required to spend much time in painting. He was given an appointment as a professor of the literature of the arts of design in the University of the City of New York. He set up his crude telegraph apparatus in a room at the college and was soon able to send messages. This was in the year 1835. A Mr. Gale, also a professor at the college was interested in Morse's apparatus and assisted him considerably, later becoming his partner.

By 1837 Morse had greatly improved his apparatus, making use of the electric magnet as a receiving instrument. The same year the national House of Representatives ordered the Secretary of the Treasury to look into the matter of establishing a national system of telegraphs. This urged Morse forward in his experiments in order that he might show the first practical working system. He had much difficulty, however, due to lack of funds.

In September 1837 while he was exhibiting his model telegraph to an English professor in Gale's laboratory, Fred Vail (cousin of Theodore N. Vail) happened in. He was much impressed with the demonstrations and realized immediately what it might mean to the world. Vail asked Morse if he intended to experiment with longer lines, to which Morse replied that he did as soon as he could secure funds. An agreement was reached between the two that if Vail would put in $2,000 with which to make instruments and secure patents, he would be given an interest in the telegraph.

Vail secured $2,000 from his father and started at once, with only the assistance of a boy, to construct a telegraph apparatus to be exhibited to the Postmaster General. The first apparatus that Vail made followed the pattern of that made by Morse, but had a number of improvements, and it was Vail who improved the message code over that designed by Morse, until many feel that the code should have been termed the "Vail code" rather than the "Morse code." It is that code which is in use today. In the latter part of the year 1837, Morse and Vail filed a protecting notice with the Patent Office as to their impending invention.

A patent on the telegraph was issued to Morse in 1840. Congress also appropriated money for building an experimental line between Washington and Baltimore, the line being completed May 23, 1844. It was not put on a commercial basis, however, until April 1, 1845, when service was offered to the public at the rate of "four characters for 1 cent." Under the terms of the agreement by which Congress appropriated money for the experimental line, the Government was given the first right to purchase Morse's invention. It was offered to the Government for $100,000, but the Postmaster General, Cave Johnson, declined the offer.

Telegraph lines continued to be built throughout the eastern portion of this country until, by the year 1851, there were more than 50 telegraph companies operating in the United States, most of them under license to use the Morse patents. In the year 1861, through help of an appropriation by Congress, a line was completed to the Pacific coast. This was the last obstacle of the pony express, and the one which it could not surmount.

The transcontinental telegraph line was no more than completed until there was demand for wire connections with Europe. It was thought, of course, that the most feasible plan would be to go by the way of our Pacific coast up through Canada and Alaska, then across Bering Strait to Asiatic Russia, and through Siberia to Europe, 16,000 miles in all. Our Government appropriated $50,000 for the survey of the route across Bering's Strait. The work of building that line was enthusiastically going forward on both sides of the Pacific, when announcement was made of the successful laying of a trans-Atlantic submarine cable. Although some 850 miles of line had been built on this side of the Pacific, and much work also done on the other side, the project was abandoned.

The telegraph patents and business which the government declined to purchase for $100,000 have grown in worth to where one American telegraph company now has assets of nearly $400,000,000 and has more than 21,000 public offices, handling hundreds of millions of messages annually.

The telephone.—Charles Borseul, in experimenting with the telegraph in 1854, had a theory of how speech could be transmitted, but his theory was never put into successful operation. However, in 1861, Philip Reis, a German, following out Borseul's theory, produced a mechanism that would transmit pitch, but it was never developed to the point where speech could be transmitted.

Alexander Graham Bell, a young teacher of deaf mutes, also a student of acoustics and electricity, had been carrying on experiments with what he termed "harmonic telegraphy." Bell was born in Edinburgh, Scotland, on March 3, 1847. He moved to Canada when he was 23 years of age and, a year later, moved to Boston.

He discovered his principle of the telephone on June 2, 1875, and continued his experiments along the lines of his discovery until March 10, 1876, when he had an instrument that would talk to the extent of transmitting a complete sentence. His principle, and the theory that he was endeavoring to perfect, was, as he stated it:

> If I could make a current of electricity vary in intensity precisely as the air varies in density during the production of sound, I should be able to transmit speech telegraphically.

On March 7, 1876, Bell was granted his original telephone patent and in the summer of that year had his apparatus on exhibition at the Centennial Exposition in Philadelphia, where it attracted little or no public attention. Men of science realized by his demonstrations that he had accomplished a wonderful thing, but practical men thought it only an interesting toy.

Bell himself realized what he had accomplished. In order to create interest and to secure financial assistance, he gave lectures ac-

companied by demonstration, members of his audience being permitted to talk with each other. He did secure some backing, however, and before a year elapsed after the securing of his patent, a number of telephones were in actual service. Bell's experimental telephone of 1876 has increased, during the intervening 60 years to 1936, to more than 17,000,000 telephones in the United States alone.

Theodore N. Vail, for many years the outstanding figure of the telephone industry, could see far beyond the present. He prophesied a common language for this whole earth made necessary by a world-wide telephone system.

One telephone company in the United States now has 275,000 employees who handle 50,000,000 communications each day, and has assets of some $5,000,000,000. Its most valuable asset, however, is its spirit of striving toward the goal where any two persons, anywhere on earth, may, at the limit of speed, which is that of light, be face to face, yet still far apart.

RESERVE OFFICER TRAINING IN THE THIRD CORPS AREA

By Capt. Robert G. Swift, *Signal Reserve*

The progress that has been made in the type of active duty training given to Reserve officers of the Signal Corps, in the past 10 years has been little short of a revelation to those who have been fortunate enough to maintain their contacts in the Reserve corps during this period. Prior to 1927 a 14-day active duty tour consisted largely of listening to a series of lectures on appropriate subjects, and delivered under conditions that defied the efforts of the best instructor to hold the attention of his audience for two daily sessions. Today Reserve officers are entrusted with the operation of companies of C. M. T. C. students with full responsibility for the maintenance of discipline and the conduct of both the military and technical training program.

Only one who has served a tour of active duty under each of these extremes is in a position to appreciate the debt of gratitude that the Signal Corps Reserve owes to that small group of officers of the Regular Army who brought about this transition in training methods. The change in the program was not an overnight accomplishment. Each step represented a victory over established custom and prejudice concerning the abilities and desire of Reserve officers to assume the responsibilities that are entailed in the present program. The lions share of the credit belongs to the Regular Army officer who was detailed as instructor with the Signal Corps Reserve units in the Third Corps Area during the period. He fought two

battles simultaneously and emerged the victor in the both of them. He conceived and sold his training ideas to higher authorities and at the same time carried on a successful campaign to revive the lagging interest in the inactive duty programs of his reserve units. He had the enthusiastic support of the commandant of the signal school at Fort Monmouth and a few other officers of the Signal Corps who appreciated the value and need for such training for the organized reserve.

In the summer of 1928 the Reserve officers were given their first opportunity to work with troops. During this camp they were entrusted with the technical instruction of the C. M. T. C. students at Fort Monmouth. The following year their responsibilities were further increased and under the supervision of Regular Army officers the Reserves conducted the entire C. M. T. C. program, which culminated in an overnight maneuver away from the post.

During the summer of 1930 a C. P. X. was staged at Fort Meade and it was here that the skeptics were convinced of the value of giving this type of training to signal Reserve officers in the Third Corps Area. With Reserve officers in command of signal C. M. T. C. companies, augmented by a number of R. O. T. C. students, communication was furnished for the problem over a wire net that extended for a total distance of 20 miles from the post. The Reserve officers performed their duties in such a creditable manner that continuation of the policy of training them with other components was assured. Since this time each officer detailed as unit instructor for the Reserve components has furthered the policy by delegating increasing responsibiliy to the Reserve officers. No incident has yet arisen to show that the confidence of the unit instructors has been misplaced.

An additional factor has contributed much to the desire of the Reserves to get an active duty assignment at a C. M. T. C. camp. This has been due to the reduced appropriations for training Reserve officers several years ago. The number of men that were ordered on active duty was usually not in excess of those required for proper training of the companies and as a result every officer was kept fully occupied. However, during the past several years this condition has reversed itself, and the increased appropriations for training Reserve officers has not been met with corresponding increases in the number of C. M. T. C. students to be trained. The result has been a surplus of officers over and above the number needed for the administrative handling of the C. M. T. C. companies.

The present Signal Corps instructor was equal to the occasion. He modified the customary schedule, making all officers available for the morning technical training, and then laid out a series of tactical

147970—37——5

problems that were conducted in the afternoon by the Reserve officers who were not assigned to administrative duties with the C. M. T. C. units. While this plan has met with the general approval of the Reserve officers, the men selected to command the C. M. T. C. companies are considered to have drawn the more desirable assignments.

Several contributing factors are operating to widen the intervals between assignments of officers to troop duty, and are working to increase the time between such periods in coming years. These are:

(1) That the number of officers of the signal reserve ordered to active duty has ben steadily increasing.

(2) That the number of students to be trained has not been increased proportionately.

(3) That the new divisional organization, if adopted, will result in an increase of approximately 100 percent in the number of officers whose training will be a responsibility of the Signal Corps.

The subject of summer training is a popular one at inactive duty training conferences and the conclusions drawn from these informal discussions merits official consideration. Briefly they are:

(1) The present duty with the C. M. T. C. units, however restricted, is the best training that can be given a Reserve officer and that any alternative or supplementary program should not be permitted to prevent a maximum number of officers being assigned to troop duty with the civilian components.

(2) A progressive training program covering a period of years be developed that will be, in a sense, a laboratory period supplementing the work covered in the correspondence courses conducted by the Signal Corps school.

It is an elementary fact that the success of such a supplementary program would, in a large measure, depend upon the availability of laboratory facilities and a supply of modern Signal Corps equipment. The work must cover more than how to connect up a switchboard or test a telephone. It must provide an opportunity for the study of the circuits of the instruments commonly associated with Army communications work and give the student officers the technical background that is essential to one charged with directing communication unit activities. The writer has in mind a training program based on certain phases of the course of study covered by the students of the National Guard and Reserve officers course at the Signal Corps school.

Reserve officers in the Third Corps Area are peculiarly situated to assure the success of such a plan. Their proximity to Fort Monmouth affords them access to all the facilities necessary for this type of training and the travel time and the cost of transportation would

be little more, if any, than is involved in reaching their present training area at Fort Meade.

Many objections, no doubt, will present themselves to such a plan, and among the more outstanding and reasonable ones will be the lack of instructors to care for this additional burden if placed on the present faculty of the Signal Corps school. This may or may not be a valid limitation. It is a fact however that among the members of the Officers Reserve Corps are a number of graduates of the Signal Corps school and men whose professional training and vocations fit them to instruct in certain subjects and they could relieve the regular staff of the greater share of this work.

The plan presented above may not represent the concensus of opinion of the majority of Reserve officers who have given any thought to this subject. It is, however, offered as a remedy for a condition that promises to become acute in the near future.

THE BATTALION HEADQUARTERS COMPANY

By First Lt. Arthur A. Holmes, *Michigan National Guard, Hq. Co., 1st Bn., 125th Infantry*

The organization that I command is located in Detroit and the biggest problem is the recruiting and drill attendance of members. Some months ago I ordered an inspection for 8 p. m. and at that time had only 14 men out of the 32 on the rolls present. At once an investigation was made to determine the cause and I found that every excuse possible was given by the members who were either late or absent.

This started me thinking and I decided that in order to have a successful company, drill attendance must be enforced. With this in view it became the policy to accept no excuses for absence and within a month our attendance was never less than 29. It was necessary to refuse to listen to such excuses as working nights, sickness, and other causes, but to demand attendance to drills as required by the regulations. If any member presented the working night excuse he was given 1 week to contact his employer and inform him that he was required at the armory and in almost every case the cooperation of the employer was secured.

Next, a policy of strict compliance with the regulations was followed in recommending the discharge of any member, and it is now the exception to transfer or discharge any member except for expiration of service.

With the above program of enforced drill attendance it occurred that we might have several members who were attending drill because they were forced to and not because they were interested in

the National Guard. Therefore the next step was the preparation of a schedule that would create an interest for all members and this has been done to the extent that the majority of members now report at the armory 2 nights every week and every other Sunday afternoon.

Our schedule is based mainly on the training of the various specialists but it also includes a lot of close-order and extended order drill. Being armed with the rifle we are able to not only drill but also offer our men the chance to fire and qualify, which is done every other Sunday afternoon.

Our schedule of the training of the specialists is based on the actual duties in the field of the various sections. First we determined, through questioning the members and our knowledge of their past performance, what assignments to make. In order to make sure that every member had the best assignment possible we devoted 1 month to this phase, allowing one drill to the brief explanation and a demonstration of the various duties of each section.

After the assignments were made we devoted the next month to the training by the individual section leaders of their own sections. The subjects covered were outlined and very closely supervised by the officer personnel. It was necessary to borrow additional radio equipment in order for the radio operators to be able to send and receive, using the actual sets that they would be required to use in the field.

The next month was scheduled to be devoted to the training through the group class method, that is, we planned on having three classes each drill, the members attending all three classes during the drill. For instance we planned on holding one drill night classes in the following subjects: Map reading, wire splicing, and organization of the Infantry. The company was divided into three equal parts, regardless of sections, and under the best possible instructor they received 30 minutes of instruction in the above subjects and then changed with one of the other groups. However, because of our mobilization this phase of the training was not completely carried out, although we were able to devote some time to this part of the training.

After return to our home station from the mobilized duty, we picked up our training plan where we left off and the next month was devoted to the installation and operation of the various signal and intelligence posts.

On conclusion of the above schedule for the training of the specialists we started the training of combined communications and intelligence problems in order to bring out the team work necessary in a well organized battalion headquarters company.

This part of the training was given by the company officers and covered all types of problems. For example, the first problem was

one of communication on the march, and to cover this we instructed the members in approach-march formations, the use of the radio and messengers on the march, and the duties of all communication personnel while marching or approaching positions, and the duties of the intelligence section on the march. The next problem was the use of communications and the duties of the intelligence section in defensive combat, followed by a problem in offensive combat.

In the preparation of these problems a great deal of care was given to insure that they were not too complicated and at the same time that they were very thorough in the work required. The problems were based on a written field order and all section leaders were required to plot the information on maps prior to drill, which is usually done at noncommissioned officers' schools. As an annex to the field order a complete group of signal instructions were given, designating telephone codes, service codes, line route numbers and radio call signs.

During the actual progress of the problems the various personnel responsible were required to have prepared by members of his section the following: Situation maps, enemy information or intelligence maps, line route maps, traffic diagrams, runners' schedules, circuit diagrams, and the station logs and test and trouble records.

During the progress of the problem messages were sent, which were prepared in advance by the officers, and these messages are followed through to check and see if the proper procedure had been followed. The movement of the command post without interruption to communication was checked closely and each time a move was made the speed was also checked.

In addition to the above schedule we held a company inspection every drill night and at least 15 minutes were devoted to the school of the soldier and other basic subjects.

The above training plan has worked very satisfactorily due to the fact that the problem can be stopped at any time and continued the next week. This means that if any man is absent his work is not completed and his section suffers; consequently other members of his section are sure to remind him of this fact.

I am glad to say that, as far as I am able to determine, the above has proven very successful, as our attendance for the past 2 months has been 100 percent and it is no longer necessary to remind the members every drill night that they are required to attend drill regardless of anything else. However, the above training could not have been carried out successfully without good drill attendance.

The above takes up the entire time of the organization and no time is left for the care and cleaning of clothing, arms, or equipment. This is left to the first sergeant and supply sergeant who are notified

if any member is not satisfactory at the company inspection and they see to it that the necessary corrections are made prior to the next drill.

It is my belief that at least 90 percent of the members now come to drill because they are interested, as shown by the increase in voluntary attendance without effort and also through the purchase of individual items of equipment, such as patent leather peak caps, boots, and collar ornaments which members would not purchase unless they were interested in their work.

C. C. C. RADIO COMMUNICATION IN THE FOURTH CORPS AREA

By Capt. D. W. PHILLIPS, *Signal Reserve, 16th R. I. Company, District G, Signal Officer*

The delivery in January 1936 of 13 Clough-Brengle 40-watt transmitters to districts I, E, and G marked the beginning in this corps area of C. C. C. radio communication.

District G having an officer available in the district at the time the decision was made to give a try-out to radio communications, this district had taken some preparatory steps and was the first to make a field installation and first to complete the whole net installation. This advantage was slight however, and district E checked complete shortly thereafter, under the leadership of Capt. Walter E. Dobbins followed closely by First Lt. Theodore B. Winstead of district I.

At present district I has a net consisting of 8 stations, district E 16, and district G 13 stations, as shown in figure 1.

The nets are as follows:

District I	*District E*	*District G*
WUGU, N. C. S., Fort Moultrie.	WUGA, N. C. S., Camp Beauregard.	WUGK, N. C. S., Fort Barrancas.
WUGV, Cheraw, S. C.	WUGB, Vicksburg, Miss.	WUGL, Morton, Miss.
WUGW, Newberry, S. C.	WUGC, Lafayette, La.	WUGM, Biloxi, Miss.
WUGX, Kinks Mountain, N. C.	WUGD, Kentwood, La.	WUGN, New Augusta, Miss.
WUGY, Edisto Island, S. C.	WUGE, Calhoun, La.	WUGO, Laurel, Miss.
WUGZ, Myrtle Beach, S. C.	WUGF, Chestnut, La.	WUGP, Collins, Miss.
WUIM, Winnsboro, S. C.	WUGG, Chatham, La.	WUGQ, Forest, Miss.
WUIN, Newberry, S. C.	WUGH, Pleasant Hill, La.	WUGR, Selma, Ala.
	WUGI, Durant, Miss.	WUGS, Greenville, Ala.
	WUGJ, Knoxville, Miss.	WUGT, Niceville, Fla.
	WUIA, Olla, La.	WUIH, Andalusia, Ala.
	WUIB, Leesville, La.	WUII, Citronelle, Ala.
	WUIC, Jackson Barracks, New Orleans, La.	WUIJ, Linden, Ala.
	WUID, Minden, La.	
	WUIE, Ruston, La.	
	WUIF, Mt. Hermon, La.	

There are many advantages of direct radio contacts over and above the usual commercial facilities. Below are listed some of these advantages.

(1) Monetary savings as indicated in figure 2.

(2) Training of officers and personnel.

(3) Time element (delay in telegraph delivery).

(4) No limitation on words per messages thus permitting full and complete handling of message subject matters in contrast to telegraph limitation due to financial reasons.

(5) Rapidity of question and answer between parties concerned.

(6) Reliability of radio communication as contrasted with failure

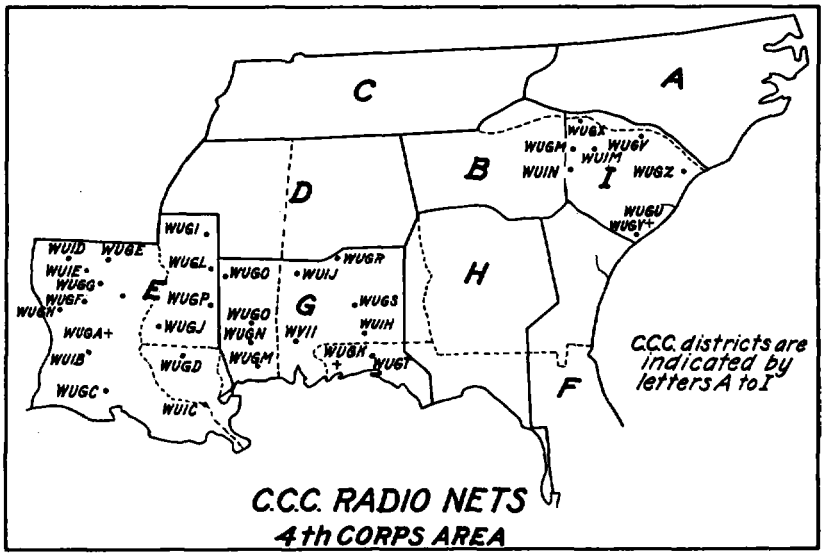


FIGURE 1.

of telephone and telegraph facilities, especially of forestry telephones in stormy weather and during the fire season.

In addition to this there is quite a worthwhile value both commercially and as an emergency reserve in having a corps of trained operators as of October 15, 1936, the following table indicates the progress along these lines.

	District E	District G	District I	Total
Number trained and now operating	29	30	18	77
Number now in training	63	25	25	113

The three district nets handled 10,728 radiograms between Februray 1 and October 1, 1936. The money value of the radiograms in

question, of commercial communication, and of the total cost of communication are shown respectively by graphs B, A, and C of figure 2.

The experience and training gained by the officers concerned materially increases the officer's value as an instructor due to the constant training of the signal personnel. This requires continued variations in the training schedule and close supervision of all instruction. The district signal officer being a member of the District commander's staff, the training thus received will prove valu-

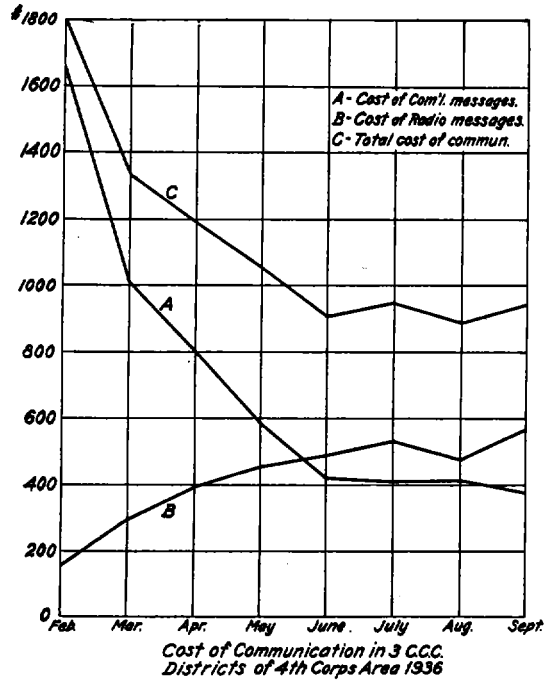


FIGURE 2.

able in an emergency. It is also valuable training in connection with the future advancement in grade of the individual concerned.

It is contemplated that additional nets will be established if and when the Civilian Conservation Corps has been given a definite and permanent status.

All of the signal officers on duty in this corps area have previously been intensely interested in radio from an amateur standpoint. The experience in operation of nets under specific Army procedure has added very valuable training. Procurement, installation, operation, and maintenance has been his lot and a more thorough experience could hardly be obtained.

Practically all qualified operators of the nets are also members of the A. A. R. S. which also gives them additional training.

In district G one technician operator has been lost to commercial service. Four have taken the commercial examination.

These losses are made up by various means. District E operators at net stations train additional men as replacements. District G operators teach classes in the various camps and when the man has learned the Z signals and some procedure, and has attained a code speed of 10 words per minute in the reception of code groups he is transferred to the district radio school at Fort Barrancas, Fla., for completion of his training. When a code speed of 18 words per minute has been attained and satisfactory tests are passed on procedure, Z signals and transmission, he is assigned to a net station and classed as a junior operator. When sufficient proficiency has been attained as a junior operator, he is rated a senior operator and assigned the first available vacancy.

Many thanks are due the various post signal officers and especially the corps area signal officers, Col. O. S. Albright and Col. J. H. Van Horn and assistant C. A. S. O., Capt. H. L. Vitzthume for their very enthusiastic cooperation at all times.

I trust that this short article covering in a rather brief and non-technical manner the radio operations of the Civilian Conservation Corps in the Fourth Corps Area, may prove of some interest to the officers of the Signal Reserve and of the Army in general.

SIGNAL ACTIVITIES DURING THE 1937 FLOOD IN SOUTHERN ILLINOIS

By Major A. V. Eliot, *Signal Corps*

GENERAL

At conferences held at headquarters Sixth Corps Area in early 1936, it was tentatively decided that should a flood strike in southern Illinois, the greatest reliance for signal communication would be placed as far as possible on amateur radio stations in the vicinity. This was largely due to the fact that little was known as to what local conditions might be expected should another flood take place.

When the 1937 flood occurred in the month of January, it was soon seen that no indication as to what course the flood might take could be foreseen. The signal officer, therefore, decided not to depend too greatly on the amateurs in the vicinity, primarily due to the fact that most sets of this nature require alternating current for operation, and it did not seem advisable to rely on the possible availability of such current. Therefore, steps were taken to lease

such telephone lines as were needed and to send groups of Army and C. C. C. radio sets which might be useful to the flooded area, together with necessary transportation and operators, the operators in charge being directed to report to Lt. Col. Edward H. Bertram, Sixth Infantry, at Army flood relief headquarters at Marion. The purpose of this latter move was to permit the commander in the field to utilize the sets as the occasions arose and in the places where the sets in question were most suitable. Under this plan two radio sets SCR–136 were immediately sent down from the Sixty-first Coast Artillery, and were later followed by three radio sets SCR–178's one SCR–177 from the Sixth Field Artillery Brigade, four SCR–161's from the Third Field Artillery, three SCR–171's from the signal section, Chicago quartermaster depot, three SCR–183's from Chanute Field, and several 60-watt amateur sets from C. C. C. camps complete with gasoline-driven generators. Added to these were the radio sets SCR–131 belonging to the Sixth Infantry, which was handling flood relief in the area.

In addition to sets actually sent to the flooded area, the Forestry Service, through their Milwaukee office, made available to the headquarters Sixth Corps Area, four radio sets capable of transmitting over 50 miles, four trucks, and four operators. These were directed to be held in readiness in case of necessity. Six operators of the Air Corps technical school were also held at Chanute Field pending orders for them should they be needed. The need for these sets and operators did not arise.

TELEPHONE

A line was leased from the Illinois Bell Telephone Co. and the A. T. & T. Co., running from Chicago to the Army switchboard at Jefferson Barracks, thence to the camp switchboard at Marion headquarters. Lieutenant Colonel Bertram and officers of his command were authorized to order such additional local service as should be necessary in emergency, such orders to be followed by confirming orders from the signal office, Sixth Corps Area. The telephone arrangements worked well throughout, in spite of the fact that many local lines in the vicinity were down. Dependence in these localities for communication was, therefore, placed on radio communication.

RADIO

A survey of the radio facilities in the vicinity showed that in addition to the Army sets placed by Lieutenant Colonel Bertram, there were numerous sets of the Illinois National Guard, United States Coast Guard, United States Naval Reserve, United States

Engineers, and a considerable number of amateur stations which continued operation during the emergency. In addition to these fixed stations, Coast Guard, Naval Reserve, and United States Engineers had a number of sets operating from vessels on the Ohio and Mississippi Rivers. Contact was gained and maintained from the Army Amateur Radio System station WLT/W9ANR headquarters in Chicago with the flooded area. This station operated on a 24-hour schedule after extra operating personnel had been detailed. Radio station WVT, the official radio station, Sixth Corps Area, also had its operating personnel augmented, by withdrawals from other stations and by the detail of C. C. C. operators. This station operated on a 24-hour schedule and handled the largest volume of business in its history. One day more than 31,000 words for over 600 messages were handled. Further, in accordance with its usual schedule, WVT maintained communication with Washington, with Jefferson Barracks, Scott Field, Chanute Field, and other stations in the corps area.

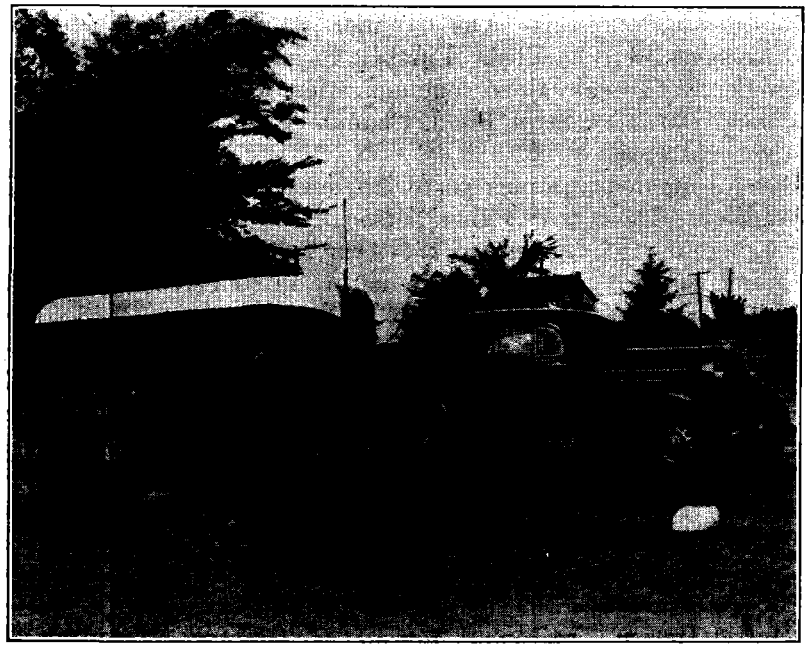
Several amateur stations performed excellent service during the emergency. These were either personally owned stations or those belonging to organizations of the Army. Probably the most outstanding voluntary service of this nature in connection with Army activities was that of radio station WGBE, which is a field station of WFBL, a commercial radio station of Syracuse, N. Y. The field station consists of a radio trailer, completely equipped and self-sustained, and operated by Mr. Samuel Woodworth, electrical engineer of the Onondaga Hotel, Syracuse, N. Y., and Mr. D. Langham. As soon as the emergency arose, this trailer was immediately sent to Mr. Leigh Harris of the American Red Cross in St. Louis to assist in the flood area. Mr. Harris turned it over to Colonel Kennedy of Scott Field, who, in turn, sent it to Colonel Atkins of the Sixth Infantry. The latter directed it to proceed to Marion, Ill. The station had special permission from the Federal Communications Commission to operate on 1646, 2090, 2190, and 2830 kilocycles, and, due to its flexibility, during the course of the entire emergency operated as net control station for practically all nets in the threatened area. The service of this station and the operators in question is considered outstanding.

One point forcibly brought to the attention of the undersigned early in the period was the fact that amateur radio stations all over the country were endeavoring to assist in any way possible, but due to their lack of understanding of conditions in the vicinity were frequently extremely detrimental, since they interfered to an extent which caused frequent delay, if not entirely stopping important radio traffic. It is understood that a study is now being made by the

American Radio Relay League, and probably also by the Federal Communications Commission, to keep off the air in a future case of this kind, all stations not actively engaged in official flood traffic in designated vicinities.

CONCLUSIONS AND RECOMMENDATIONS

From February 4 to February 6, 1937, the Sixth Corps Area signal officer visited the flood area and Jefferson Barracks to make a survey of signal communications. Conferences with the commanding officer, Sixth Infantry, and Lieutenant Colonel Bertram, commanding the



flood area, showed the advisability of immediately sending all available radio equipment to the commander in the field so as to permit him to utilize the sets best suited for given work, rather than attempting to detail from a distant headquarters sets to given locations. This trip also pointed out the urgent need for early coordination, preferably under a neutral coordinator, so that radio of the Army, State troops, Naval Reserve, Coast Guard, Engineers, and amateurs are properly coordinated from the beginning of operation. A Signal Corps officer should be detailed to the field in the early stages.

While cooperation was always intended, occasional misunderstandings of the importance of the mission of others caused some difficulty

in clearing traffic. This was eventually rectified. In this connection, it is believed that in future floods, a request should be sent to the commanders of all of these official activities that they send information as to their call letters, frequencies, and location of stations to a specified central headquarters so that the information may be available to all concerned. It is also believed that similar information with respect to amateurs can be obtained by the A. R. R. L. headquarters at West Hartford, Conn., and sent by them to central headquarters mentioned.

While several types of Army radio sets proved invaluable in this emergency and all served useful purposes, it is believed that the entire experience showed the inadequacy of ordinary Army field radio equipment for purposes of this kind. It is believed that a radio set, such as the SCR–177, mounted in a truck, completely self-sustained and containing an auxiliary-engine driven generator, is the most valuable set for the purposes. It would probably be advisable to have a light and a heavy type, the lighter one capable of transmitting up to 50 miles, c. w. or voice, and the heavier up to 300 miles on c. w. or voice. Probably the most useful sets in this particular case were three SCR–183 radio sets mounted in trucks equipped with an extra battery and a Tunger rectifier. These would have been most useful had they been equipped with a gasoline-driven generator and thus avoided the necessity of returning to a source of 110-volt alternating current, to recharge the batteries. While more interference is probably obtained where voice radio is used, its value unquestionably far exceeds that of c. w. transmission in this type of emergency. Regardless of the general type of set used and in spite of the added chance of interference, it is believed that voice radio is far more valuable than c. w. for the use mentioned.

Early in the emergency period, when operators had to be rushed to the area with radio sets, frequently not their own, there was some confusion as to the use of frequencies and call letters. This is understandable when it is considered that the main mission was to obtain communication at once and at all costs, and this office took the responsibility of authorizing those concerned to proceed regardless of existing restrictions, and stated that any errors would be corrected later. There was surprisingly little complaint, and all stations were eventually assigned correct call letters and frequencies which were workable.

During the trip of the signal officer to the flood district, information was obtained from the local telephone company and the Western Union office at Marion, showing the status of their lines during the flood.

CURVES AND FAST BALLS AT LEAVENWORTH [1]

By Maj. E. D. Cook, *Infantry*

Capt. Bill Busher was nearing 40 when he received his orders for Leavenworth. Despite a thin spot in his hair and a couple of partial dentures among his molars, Bill experienced something of the feeling of a small town player going up for a try-out in the big leagues.

Not that Bill hadn't expected the call. He and Mrs. Busher had scrutinized the names of all students in previous years and each time had secretly assured themselves that Bill was as good as any man on the list—and maybe a damn sight better. Nevertheless they could not suppress a certain smug satisfaction over knowing it was in the bag.

When his contemporaries congratulated Bill on his orders, he assumed as modest an air as possible. But he was baffled by a puzzled gleam in their eyes until he suddenly recognized what would have been his own outlook under reverse conditions. His brother officers were wondering by what freak of chance Bill Busher had been chosen for Leavenworth when they had not. "Never mind", said Mrs. Busher, in discussing the lack of appreciation displayed by their friends, "You will show them when you get to school." "Sure", Bill promised, "I'm all set to burn up the course."

The school authorities remained calmly unimpressed by the arrival in their midst of so potential a ball of fire as Capt. Bill Busher. While rated as something of a crown prince back in the old station, Bill found himself of much less importance in the Leavenworth scheme of things than the sergeant over in the book department. More than a hundred other students were present, rushing around buying supplies for the coming course. They all seemed to have been some "old man's" aide, adjutant, or favorite staff officer, but to the Command and General Staff School they were just another class washed up on the banks of the "Big Muddy."

During their first assemblies in room 240, Bill indulged in some mental calculations. From general appearances and past associations he adjudged the ability of the group and assigned to himself a class standing. He didn't give himself any the worst of it either. He compared himself to John Honest in the seat next to him. A good enough guy, but sort of dumb for Leavenworth, Bill thought. And on the other side was Charlie Earnest, with a pointed chin and his nose always buried in a book. Not much competition there. "The hardest thing about Leavenworth is getting here", Bill in-

[1] Reprinted by permission, from the September-October 1936 issue of the Coast Artillery Journal.

formed his wife. "Even the instructors are adjuvant." His later statement was correct. The officers on the platform were doing all in their power to make things easy—at first. Like all old-timers they worked the kinks out of their pitching arms gradually. They dealt gently with the new crop of recruits, coaching them in the fundamentals and basic principles—put everything right down the alley. But Bill and his classmates got impatient. They wanted to see a marked problem—one of the fast ones they had heard so much about. They itched to dig their cleats into the sod and knock the old apple right over the fence for a homer.

When the eventful day finally did arrive, Bill found himself with little appetite for lunch. Giving up as useless the attempt to force class I supplies through his esophagus, he proceeded to the problem room. Smoking an endless string of cigarettes, Bill arranged his tackle-box, Reference Data, and Staff Officers' Field Manual, all according to the approved school method. If colored pencils, trick doodads, and excess paraphernalia could solve problems, Bill had all the answers. The first situation and requirement consisted of four printed pages through which Bill read so hurriedly he had little idea of what was on them when he had finished. He went over it a second time with greater pains. Gradually the problem took shape before his eyes. It appeared quite simple, once the situation was analyzed. In fact Bill wondered why they made problems so easy. All one had to do was go forward to defend on the Bonneauville ridge, or back up and hold Littlestown. That was all, but which was correct?

In a similar map exercise the school had defended at Bonneauville, but this situation had variants that made Littlestown seem more attractive. A direct parallel of what the school had done in the I. P. should produce an S, but Bill was after bigger game. He wanted an SX. But he couldn't be sure that a U would not be waiting for the fellow who withdrew to Littlestown. Beads of perspiration sprouted gently on Bill's forehead as the well known "mental anguish" got him firmly in its grip. He sat glumly in the utter loneliness of a crowded problem room trying to make up his mind. He saw with a start that half the period was over and he had not reached a decision. Taking a desperate hold on his courage he finally drew in an MLR around Littlestown. Then his nerve departed, suddenly, like water from a ruptured paper sack. He grabbed his eraser. The line was too far back. It was a sure U. He rubbed and rubbed, replaced his brigade on the Bonneauville ridge and located the last establishment just before time was up.

Down in the assembly room at least 50 students were arguing the respective merits of Bonneauville and Littlestown. Bill regained some assurance from hearing so many in favor of the former. At 5

o'clock the school solution was issued. The overlay showed a defense at Littlestown. Mentally, Bill kicked himself all the way home. The first time at bat and he had gotten a foul tip. He tried to appease his pride with the thought that there were more problems coming in which he would do better. His self solace was negligible in view of the fact that Charlie Earnest and many others had hit it right on the nose.

The next test proved to be a question of logistics. Bill stumbled through a maze of field trains, unit reserves, collecting stations, and cemeteries. He emerged with a headache and the conviction that he must have slept through some important conferences, or else had been too dumb to understand what they had been talking about.

That week-end the social functions of Fort Leavenworth resounded with cries of "what I did." While the ladies sat meekly in corners, their lords and masters formed a circle around one pseudo general who expounded earnestly on his solutions. The others listened with strained expressions, not to what he was saying, but for him to cease talking so they could begin.

"Is it always like this?" Mrs. Busher timidly inquired of an instructor. "Don't they pay any attention to all these pretty ladies?" "For the next 6 months they wouldn't look at the Queen of Sheba", he replied, "They want to talk problems. Nobody cares what they did but the marking committee, and all solutions give them a pain."

Judging from the wails and moans that arose when the first batch of papers were returned to their authors, it was evident that the instructors had committed some part of their suffering to the students. Bill was more than satisfied to escape with two skinny S's and a lot of plain and fancy red crayon scroll work along the border of his papers. From then on problems began to come regularly at the rate of two and three a week. Between times there were conferences that went off with the vociferous vibrations of a machine gun, and map exercises which proceeded with the stately cadence of a funeral dirge. The instructors were beginning to warm up and some of them began pitching curves. After each problem there was a formal discussion. "Why they call a monologue a discussion is more than I can see", John Honest grumbled after one such séance, "And why was that fellow so sure that his solution was the only proper one?" "Why shouldn't he be sure?" demanded Bill. "He could call a strike, even if it went over the backstop. He's not only the pitcher, but the umpire as well." "Then I wish I'd had a pop bottle to throw instead of an argument. Some of his decisions were lousy." "Sure", Earnest agreed, "But a school solution has all the virtues of a textbook—approved before issued." "But how did that major know he had the right answer? He never commanded a division." "Of course not. But his problem wasn't orig-

inal. It was taken from Wilcox's delay of Sedgwick at Chancellorsville. A few tanks, airplanes, and chemicals were thrown in to make it modern. So you see, you got it by proxy from the actual commander." "Did you figure that all out in the problem room?" Bill demanded. "No, unfortunately, I thought it was Jackson's pursuit of Banks in the Shenandoah." "Then you are dumber than I am, because you read a lot of books to get a U and I just went in and got one on my own hook." "That's a nice thing about this school", said John complacently, "They talk hard, but they mark easy." "If they didn't, none of us would get to first base", said Bill.

With such banter and the interchange of ideas, much of the spirit of competition was removed from the minds of most of the students. There was more of golf and less of school mentioned at the week-end parties. A few would-be Napoleons remained, but they were more pitied than scorned. For the most part the class reaching the saturation point. They were saturated with knowledge. Their brains slowed down like a car forced into low gear on a steep grade. And just when it seemed they were completely stalled, the spring vacation gave them a short respite. "From now on we're going down hill", said Bill. "Yeah", John agreed, "I'm afraid I'm going too fast—on the toboggan slide." "Nerts", retorted Charlie; "you haven't gotten enough U's to shoe a horse." "It's not that. When I first came I expected to graduate first in my class. About Christmas I'd have been satisfied to be in the middle, and now I hope I'm not last." "That goes for all of us", said Bill; "but pull up your socks. We're on the last lap."

The last lap was a tough one. The weatherman turned on the heat and so did the instructors. In addition to the curves there were fast balls, slow balls, and even spit balls. Some of the pitchers were ambidextrous and didn't let their right hands know what their left hands were doing. Bill and his mates were still in their swinging, but they began to hope the game would soon be called on account of their getting a little dizzy. And just when the course seemed interminable, when it seemed they would spend the rest of their service in the shadows of Sheridan Ridge, the last reconnaissance was made, the last G. T. E. turned in, and Bill and his friends assembled in the club tent for a glass of beer.

"Well", said Charlie, "there goes one of the most important milestones in our military career, I wonder just how much we got out of it?" "I dunno yet", said John. "My brain has taken an awful flogging. I'm too numb to know much, if any, I've learned." "Numb or dumb, you couldn't have all that education poured over you and not have some of it stick", said Bill. "But couldn't a fellow get the same results by doing a lot of studying for himself?" Charlie wanted to

147970—87——6

know. "Maybe you could", John conceded, "but I know I never would." "Then you figure you are a better officer for having come here?" "A hell of a lot better. But that doesn't mean that I believe myself to be better than all those other fellows that haven't come here." "But you are going to have 'graduate C. & G. S. S.' after your name in the Register", Bill pointed out, "and the other fellows can't laugh that off." "What of it? I've got D. S. C. after my name, too. No one ever took exception to that." "Why should they?" said Charlie. "Sherman said you can get all the heroes you want for $16 a month." "Sure", agreed Bill, "there's a lot of difference between getting cited for bravery and having brains." "Yeah? What's so different about it?" "Well", Bill finished his beer and stood up, "if you're brave you will drive into your new station, blow cigarette smoke in the 'Old Man's' face and tell him that if he needs any help, you have just graduated from Leavenworth. On the other hand, if you have brains, you will remove your Leavenworth license tag, go to the adjutant and tell him you're reporting in from a tour of D. O. L. up in Kansas and would he please give you a job as post exchange or police officer." "All right, wise guy. I don't smoke cigarettes and I haven't graduated—yet." "Unless you play golf on the the polo field, or ride a horse over the golf greens, the chances are you will graduate", said Bill. And he was right.

Incased in heavy woolen uniforms they ascended the graduation platform, saluted, and clutched the hard-earned sheepskin in sweaty hands. They tarried not on their departure, but took out immediately for the four corners of the world. They had been to Leavenworth.

As Bill steered his car between the cannons on Grant Avenue, it gave a great forward lurch. "What was that?" cried Mrs. Busher. "It's all right, Sweet." Bill reached over to ruffle the skirt on his wife's knee, a gesture he had indulged in very seldom of late. "That was just the corps artillery, tanks, chemicals, and whatnots dropping off from around by neck. We're back in the bush leagues again."

THE EDITOR'S OBSERVATION POST

Future issues of the Signal Corps Bulletin.—With this issue the Bulletin enters the field of quarterlies. The change has been made after due consideration and will in no way affect the contents of the next two issues which will, in great part, be devoted to the First and Ninth Corps Areas.

Foreign communication items.—Foreign Communication News, published by the Bureau of Foreign and Domestic Commerce, reports that a new radio station has been put into operation in Yakutsk,

Russia, which will provide direct radiotelephone and radiotelegraph communication with Moscow, Novosibirsk, Irkutsk, and other important centers. It also reports that new television transmission lines are scheduled to be played in operation this year with television stations in Moscow and Leningrad.

Radio-meterograph system.—The Technical News Bulletin of the Bureau of Standards reports on a radio-meterograph system developed at the Bureau for use in the meterological service of the Navy. The system is expected to replace airplanes for gathering upper air data required for forecasting. The air equipment consists of a small radio transmitter and meterograph suspended from a 5-foot balloon. The equipment weighs less than 2 pounds complete and is housed in a balsa wood box 6 by 6 by 4½ inches. Ground equipment consists of a radio receiver and automatic recorders for graphically plotting pressure, temperature, and humidity, also direction-finding equipment for tracking the balloon in order to determine upper-air wind conditions. The meterograph utilizes the decrease in atmospheric pressure, as the balloon rises, to move a small switch arm over a series of contacts. A change in elevation of several hundred feet suffices to move the arm from one switch contact to the next switch contact. Each of these contacts corresponds with a definite audio note which is transmitted by radio and each note corresponds with a definite pressure. Between the switching contacts are intermediate contacts which are connected with a resistor which is controlled by the humidity of the air. In passing over an intermediate contact an audio signal is transmitted which depends on the value of the resistor and consequently on the temperature. When the arm passes over the insulating strips between contacts the audio note is determined by the resistance of a small tube filled with sulphuric acid and as the resistance varies with temperature this indicates the temperature of the air at that time. One form of instrument also measures the light intensity and thus furnishes information on the height of cloud formations. The determination of wind velocities depends on the continuous measurement of distance and azimuth. Normal methods require two or more direction-finding stations placed several miles apart; however, the present system will utilize a single ground station to measure the azimuth and angle of elevation. The latter measurement has hitherto not been considered feasible due to the electrical properties of the ground; however, a specialized method is now available.

Radio propagation.—Bell Telephone System monograph B–968 describes experiments which have conclusively established the fact that the Sommerfeld formulae and Sommerfeld-Rolf curves give field intensities which are too great by exactly the Zenneck "surface wave" component for all conditions in which the dielectric constant

of the ground cannot be neglected. Previous data have always been obtained under conditions where the curvature of the earth or the effect of the ionosphere could not be neglected, where irregularities of the earth's surface caused variations of field intensities of the order of the differences between the Sommerfeld and more recent Weyl formulae, or where the ground constants varied or were not known with sufficient accuracy. The above conditions were overcome by employing 2-meter (150-Mc) waves and propagating them over calm fresh water of considerable depth at Seneca Lake, N. Y. The tests, making use of quarter-wave vertical doublets whose midpoints were approximately one quarter wave length over the water, showed that no "surface wave" component is set up by simple antennas on the surface of the earth. Monograph B–980 indicates that when using vertical antennae over a ground of good conductivity, there is least favorable height above ground. For example when 2 communicating antennae are $1.7\ \lambda^{3/2}$ over ocean water the received field strength is one-half what it would be if both antennae were directly over the water. At heights below the critical height the field from a horizontal antenna is less than from a vertical antenna, the opposite is true above the critical height. The maximum advantage of horizontal polarization over vertical polarization occurs at twice the critical height.

Ground constants.—Ground constants are of considerable interest and importance in radio as well as in telephone and telegraph systems employing ground returns. The following data are quoted from Bell Telephone System monographs B–968 and B–980.

Substance	Dielectric constant, electrostatic units	Conductivity electro-static units
Sea water (average)	80	9×10^{9}.
Fresh water (Seneca Lake)	82.1 (at 15.3° C.)	4×10^{8}.
Moist English soil	30 to 40	1 to 2×10^{9}.
Salt marsh	30	3.4×10^{9}.
New Jersey soil near Fort Monmouth	15 to 25	1 to 2×10^{8}.
New Jersey soil near Netcong	5 to 10	1 to 3×10^{8}.
Japanese soil	15	1.8×10^{7}.
Philippine soil	12	2.7×10^{7}.
Dry ground (average)	10	1.07×10^{8}.
Rocky ground (average)	4	1.07×10^{7}.
Dry English soil	3 to 4	1.0×10^{6}.

For accurate investigations it must be noted that the dielectric constant and the conductivity of the ground vary as functions of the temperature. For water the dielectric constant in electrostatic units is $80-0.4(t-20)$ where t is in degrees centigrade, the conductivity at a given temperature is approximately equal to the conductivity at 25° C. multiplied by $1-0.02(t-25)$. To convert the conductivity, which has been obtained in electrostatic units, into mhos per meter

the former value is multiplied by 1.1×10^{-10}. Thus 9×10^{9} esu is equivalent to 1 mho per meter. It is of interest to note that the gain in decibels for reception at angles below 1° between vertical antennae over salt water is approximately 10 db compared with the same antennae over salt marsh and 24 db when over dry ground.

Broad-band carrier systems.—The Bell Laboratories Record of April 1937 describes the problems and development of various supersonic carrier transmission systems. The following points may be of general interest: That broad-band systems are applied to nonloaded conductors and that consequently transmission velocities of the 100,000 miles per second and over are obtained as compared with velocities of the order of 20,000 miles per second over long-haul, 4-wire cable circuits with their exaggerated echo and delay problems. That in carrier cable systems it is not only essential to shield apparatus in telephone offices where circuits are switched, etc., but also to apply high-frequency filtering circuits to all noncarrier pairs where a cable leaves such an office. That in cable systems the degree of amplification at repeaters is set by thermal noises and not by external interference, the thermal noises being due to the motion of free electrons in the conductors. That in cable systems it is better to use different metallic circuits for transmission in opposite directions rather than to employ different frequencies on the same pair as in the case of open wire circuits because of the greater number of repeaters required and the high cost of directional filters. That adjustable inductances and condensers between cable pairs balance out cross talk to a considerable extent. That in future, broad-band systems will use much greater frequency ranges than today and that these will be chopped up into narrow bands for telephone and telegraph purposes, also that bands of several million cycles can be made available in coaxial conductors for television purposes. That very satisfactory high-frequency conductors can be made of a pair of wires separated by spacers within a metallic shield and that such cables may be expected to be used in future systems.

Data on the standard type C open-wire system and three new systems are given below for comparison:

System	*Channels*
(1) Type C	3 carrier telephone circuits and 1 voice circuit per pair.
(2) Open-wire	12 carrier circuits, 3 type C, and I voice circuit per pair.
(3) Cable	12 carrier telephone channels per pair.
(4) Coaxial cable	Up to 240 circuits.

Frequencies	*Repeater spacing*	*Amplification at repeaters*
(1) Voice and 12 to 30 kc	50–100 miles	40–50 db.
(2) Voice and up to 140 kc	50–100 miles	40–50 db.
(3) 12 to 60 kc	16 miles	60–70 db.
(4) 60 to 1020 kc	10 miles	60–70 db.

FAVORABLE FACTORS

(1) Large gage wire, wires of pairs spaced 12 inches apart, ease of transposition.

(2) As in (1). However, wires of pairs spaced 6 to 8 inches apart giving more separation between pairs.

(3) Shielding effect of lead sheath, greater amplification possible at repeaters, low cross talk due to twisted pairs.

(4) Low attenuation permitting the use of higher frequencies and excellent shielding.

UNFAVORABLE FACTORS

(1) Difficulty of eliminating induction from power and telephone lines and outside static.

(2) As in (1). Increase of frequencies used requires more frequent transposition and more spacing between pairs.

(3) Large attenuation due to small gage wire and paper insulation, large number of repeaters required.

(4) None.

U. S. GOVERNMENT PRINTING OFFICE: 1937

30 April 1959

This document is declassified by authority of the Director, National Security Agency.

Paul S. Willard

Paul S. Willard
Colonel, AGC
Adjutant General

Readers of the Bulletin are requested to submit to the editor articles or reports on signal communication or military subjects. All items submitted should be typed double spaced and in triplicate, if practicable.

Opinions expressed and policies advocated in the pages of the Bulletin are not necessarily the opinions and policies of the Chief Signal Officer. They should be considered in each instance solely as the expression or view of the author.

Address all correspondence concerning editorial matters to the Editor, The Signal Corps Bulletin, Fort Monmouth, Oceanport, N. J. Address all other correspondence, including matters pertaining to the mailing list, to the Chief Signal Officer, Washington, D. C.

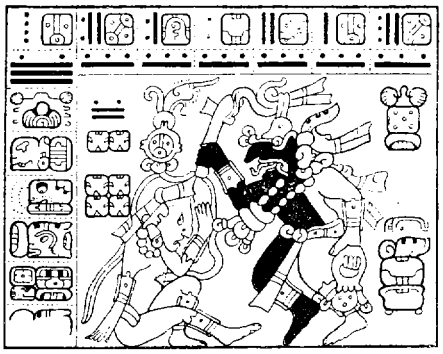
Criticisms and suggestions for the betterment of the Bulletin are invited.

Umol-huun tah-tiyal

William Frederick

yetel

Elizebeth Smith Friedman



Lay ca-huunil kubenbil tech 'same.
This our book we entrusted you a while-ago.
Ti manaan apaclam-tz'a lo toon
It not-being you-return-give it us,
Epahal ca-baat tumen ah-men.
Is-being-sharpened our-axe by the expert.