## A METHOD OF TRANSMITTING THE TELEGRAPH ALPHABET APPLICABLE FOR RADIO, LAND LINES, AND SUBMARINE CABLES.

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Due to the rapid expansion of the use of radio telephony and telegraphy, the problem of interference, both natural and artificial, is becoming each day more and more pressing for solution. The conservation of the ether lanes is suddenly rising to international importance. In addition, the daily growing uses of radio for the solution of auxiliary problems such as range finding, navigation, beacons, etc., further serve to complicate the problem, and furthermore, it is believed that we are on the threshold of another development, viz., photo-broadcasting, which will require and demand still additional ether channels to serve the public of the near future. It may be said, therefore, that the fundamental problem for the radio engineer is to devise methods to utilize these limited channels to the greatest extent possible, and to bend his efforts to the extension of their limits, both high and low.

In the case of artificial disturbances the chief offender, from an engineering standpoint, is the radio telegraph practice as it is universally conducted at present. Radio telephony and music of all classes have a form of modulation which is scientifically more sound than that of telegraphy. It is impossible at present to tune out the high-power radio telegraph stations, especially when a receiving station is in close proximity. Such stations, as at present operated, produce a veritable eruption in the ether, creating disturbances over a wide range of frequencies, and these serve to ir' fere with any form of radio receiver yet devised. Who has not ex- p iced this in the operation of his radio receiving set? Radio telegraphic tra..smission, therefore, demands new consideration and new study from a scientific standpoint.

About eighty years ago Morse invented the telegraph alphabet of dots and dashes, and the modification of it, known as the International Morse, is now the universal method of international radio telegraphy. This method is believed to be fundamentally unscientific, and the time has come to thoroughly consider a radical revision of the method of sending telegraphic messages. I do not here refer to an actual change at present in the Morse alphabet as regards the combinations of dots, dashes and spaces assigned to each letter, but I refer to the study of the correct method of sending these combinations in any circuit, whether radio, land lines or submarine cables. The problem is the same in each of these three branches, but it is much more serious in radio for the reason of the necessary broadcasting properties thereof.

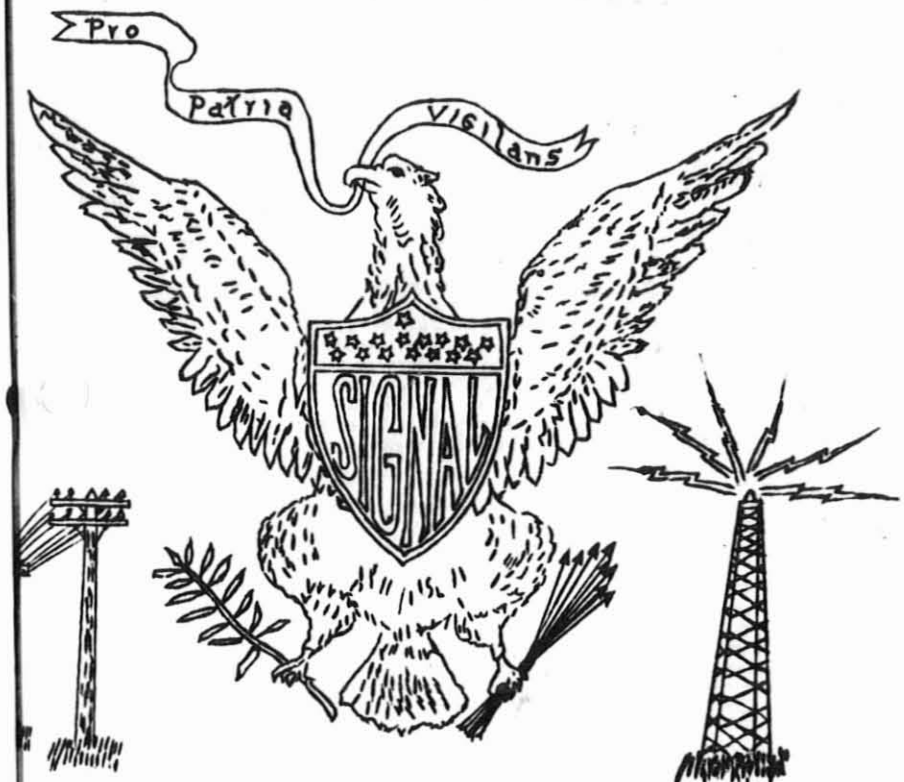
The rapid increase in the use of printing telegraphy makes it possible to further consider the telegraph alphabet from the standpoint of the number of the elements and the combinations thereof for each letter. This phase of the problem is now being studied by the Code Section of the Signal Corps.

In the Morse alphabet we find the principle of different time units for dots, dashes and spaces, as the basic idea of the system. In Standard Morse a dash is three times the length of time of a dot, and the spaces between letters and words are timed correspondingly.

..ese signals in International Morse are universally emitted into the ether from the transmitting antenna in the form of sudden interruptions in the antenna current, or sudden variations in this current. This method produces about the worst possible source of disturbances in the ether space

WAR DEPARTMENT
Office of the Chief Signal Officer
WASHINGTON, D. C.

[redacted]

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for the reason, among others, that the disturbance has no regularity of any kind, and the speed of operating the sending key has a marked influence on the whole phenomena. Present practice is drifting away from the complete interruption of the antenna current which is the worst from an interference standpoint, but even the present methods of irregular and sudden variations of the current are still a long way from the possible scientific solution.

In 1915[1] the writer was considering the general problem of improving the transmission system for submarine cables, and in connection therewith gave study to a new form of alphabet suitable to such a circuit. The system devised at that time may be described briefly as a continuous wave system: "c.w." versus the "spark" system of the present cable practice. A method was developed of sending an unbroken alternating current through the cable, and means provided for interpreting this alternating current into intelligible signals. This system abandoned the Morse principle of different lengths of time for the signals as being fundamentally inefficient, and adopted the plan that all individual signal units should occupy equal lengths of time, and have equal importance, whether they were dots, dashes or spaces. The signals were distinguished by varying the intensity of the individual sending elements, i.e., a dot, dash or space occupied equal time lengths, but were of different intensities. The variation in intensity for signaling was effected at the transmitter at the zero phase of the resultant current flowing into the cable, so that, theoretically, at the moment of any operation upon the current there was no current to operate upon.

A point of fundamental importance in this method is that no two adjacent signals are of the same sign, since each semicycle is utilized to effect signalling, giving a dot, dash or space. Other things being equal, the variations in intensities for each of the three elemental signals are reduced to a minimum on the theory that the minimum possible change of the fundamental wave should be made. The reason for this is that an alternating current in the steady state, which amounts to a series of the present cable letters "a" or "n" strung together without space, can attain a speed in any form of telegraphy many times greater than any practical system. A sinusoidal wave is transmitted through any form of electrical circuit without distortion of any kind, and, in fact, is the only type of wave that is so transmitted.

A still more important point to be considered is the transmission of the largest volume of telegraph business with a minimum number of signals, and from this angle the new form of alphabet has most striking advantages.

Fig. 1 exhibits graphically the relative speeds of the International Morse alphabet, the present cable alphabet, and the alphabet proposed here. It will be noted that by the employment of the alphabet proposed here we gain immediately over 150 per cent. in the speed of transmission of signals: the ratio of 8.5 to 3.2, as shown in Fig. 1, is 2.65.

Referring to the cable Morse alphabet, the ratio of 3.67 to 3.2 does not indicate the real advantages of the proposed alphabet. In the present cable Morse alphabet, although the signals occupy equal lengths of time, some of the letters are transmitted by adjacent signals of the same sign. In letters such as "s" or "h", for instance, three and four consecutive signals have the same sign. The additional

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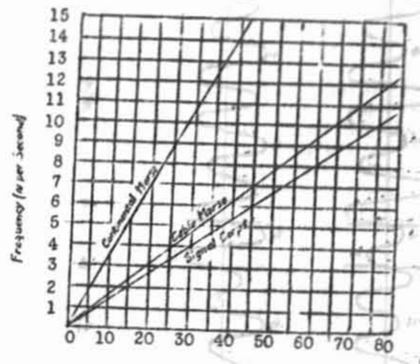
[1] "On an Unbroken Alternating Current for Cable Telegraphy," Proc. Phys. Soc. of London, 27, Part V, August 15, 1915. U. S. Patent No. 1,233,519, July 17, 1917.



principle of the Signal Corps alphabet that

Fig. 1.




Words per Minute (5 Letters Including Spacing)

Note: Based on operating experiences with traffic in plain English text.
erage time units per letter as follows:
ntinental Morse, 8.5; Cable Morse, 3.67; Signal Corps, 3.2;
Ratio of 8.5 to 3.2 = 2.65.

no two consecutive signals shall be of the same sign permits, for the first time, a continuous wave of one definite frequency being employed for the alphabet. This makes it possible to utilize, effectively, electrical and mechanical tuning, either or both.

Fig. $2_B$ illustrates graphically this method of modulating a single frequency wave, and shows the words "Now is the time" as they would be transmitted by this method, in which we arbitrarily assign the largest amplitude for a dash, the next size amplitude for a dot, and the smallest for the spaces between.

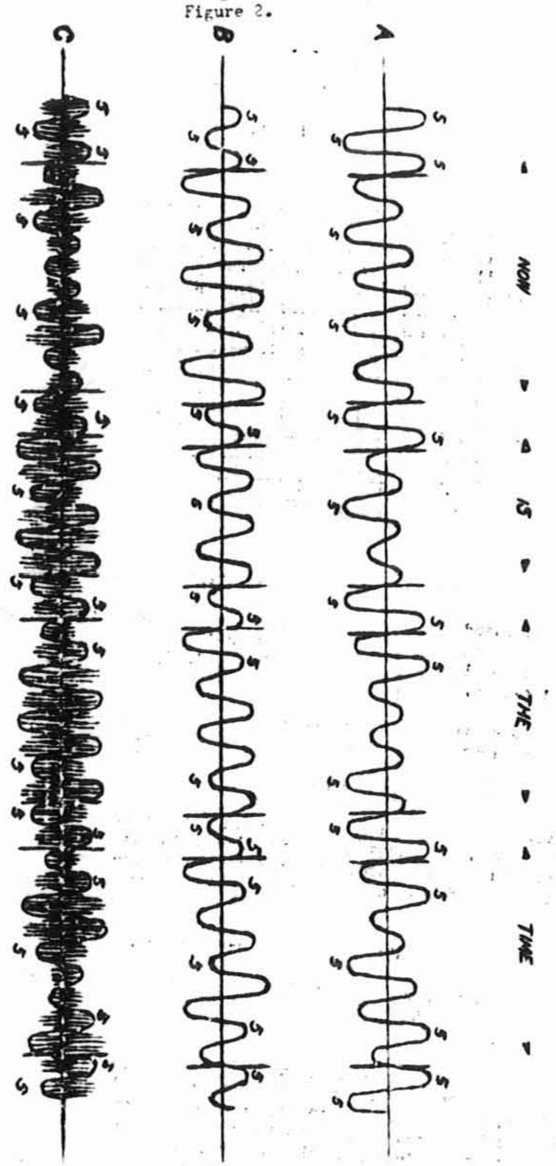
Figs. $2_A$ and $2_C$ show two other combinations.

The particular combination $2_B$ has been tried out in actual practice on the cables, and has been tested by the engineers of the British Post Office.

If we consider the present method of operating the large radio telegraph stations we find that the method of sending, whether automatic or by hand, has no relation to the phase of the current flowing in the antenna, with the result that in the ordinary transmission of a message the large current flowing in the antenna, sometimes as much as two or thr-- hundred amperes, is suddenly interrupted or changed in a perfectly ha rd manner. The transmitting key is closed or opened at any ind. nite point of phase, with the result that in the same letter or message a large flow of current is interrupted or changed at all possible values from zero to a maximum, positive or negative.

It is well known that the sudden breaking or introduction of high impedances in an alternating current circuit produces transient phenomena which results in a whole group of harmonics being transmitted. Add to this the practical condition of performing this operation upon a current ranging

Figure 2.




| | | | |
|---|---|---|---|
| (A) Dot - smallest amplitude. | Dash-medium amplitude. | Space-largest amplitude. |
| (B) Space- " " | Dot - " " | Dash - " " |
| (C) Dash - " " | Space- " " | Dot - " " |

There are three other possible permutations of amplitudes not shown here. Ratio of amplitudes of signaling units arbitrarily assumed as 1:2:3.



all the way from zero to hundreds of amperes, and it is easily seen that the e of space is bombarded with a mass of frequencies never twice alike even i e same letter. It is little wonder, therefore, that no method has yet been devised to prevent such a disturbance from interfering radically with the reception of radio signals. Entirely apart, therefore, from a gain of over 150 per cent. in the transmission speed, from an interference standpoint the present method is about as bad as it could well be.

The other source of disturbances in radio is natural disturbances, generally designated as "static" or "atmospherics." Here again it is believed that the solution may be found in the method of sending proposed here, for the reason that the modulating frequencies employed are of a very low order, and it should be comparatively simple to devise instrumentalities which will enable us to differentiate between these low modulating frequencies and the higher frequencies of the "static" or any other natural disturbance. To emphasize my point, by an examination of Fig. 1 it is seen that a modulating frequency as low as 10 per second, which is a very high frequency for ocean cable practice, corresponds to 75 words a minute, which is far higher than any form of sound reception. A modulating frequency of 60 cycles per second, the normal power frequency, corresponds to a speed of 450 words a minute, of 5 letters each.

If this speed, for traffic reasons, is too great, it is only necessary to make the same perforations in the transmitting tape correspond to a suitable even multiple of a semicycle to reduce the speed to any desired value. For instance, by making each of the signaling units correspond to six complete cycles of current instead of one semicycle, the speed of signaling is reduced to 37½ words a minute, a commercial speed of signaling. In this method of ing the alphabet, wave trains are employed as the signaling elements.

The ratio of the lowest frequencies employed in radio to the modulating frequencies here considered is of the order of thousands.

At present the radio engineer has utilized and made his own all of the audio-frequency range and at least several octaves of the radio-frequency range, and has devised apparatus for the amplification and rectification of both of these ranges, audio and radio. This plan proposes to enter the unused infra-audio range, which would not only add a most useful band of frequencies to those now used, but would give a band below the range of the human ear. If this band were employed for telegraphy, an additional advantage would be that it could not interfere with any radio receiving. This method of eliminating interference would be most effective.

Finally, it is seen that by the method proposed here it is possible to modulate a single radio frequency by a number of modulating frequencies, and thus multiply the capacity of each radio frequency channel.

In 1921 the writer attended at Paris an international technical conference on outstanding radio problems, and for two months special delegates of the five great powers gave consideration to technical points connected with international radio telephony and telegraphy. Such matters as interference, logarithmic decrements, disposition and allocation of wave-lengths, radiation, etc., were considered. It is now proposed that the general subject of a suitable method for transmitting telegraphic signals either for radio, land lines or submarine cables be considered at the next international technical conference, with a view, if possible, of ving all branches of telegraphy using the same system of modulation for e signals.

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## PRESERVATION OF PICTORIAL WAR RECORDS.

One of the important, though less known, functions of the Photographic Section is the storage and preservation of a vast quantity of motion picture negative film and the still negative-plates and films which form the basis of the pictorial history of the World War, the Civil War and the minor wars in which the United States has participated since the invention of photography.

Because of the value of this material, much of which was obtained by Signal Corps photographers at risk of their lives, every care is exercised in order that the pictorial records may be handed down to posterity without loss or impairment.

A fireproof concrete building was erected on the grounds of Washington Barracks for the sole purpose of storing the motion picture film of the recent war which totals in excess of 1,000,000 ft. This building contains a series of individual rooms which resemble bank vaults. The vaults are equipped with steel fireproof doors with combination locks and have steel racks upon which the films, in metal containers, are stacked. As an additional precaution, an overhead sprinkling system is installed in each vault. Provision is made to keep the film at an equable temperature and to avoid extremes of heat or cold.

The containers in which the films are placed before being stored on the vault-racks are cylindrical in shape, about 10½ inches in diameter by 2 inches deep and are made of sheet metal with corrugations on top and bottom to prevent the cans from coming into close contact when stacked vertically side by side. Each can contains a reel of 1000 feet.

Motion picture film is inflammable and explosive under certain conditions. It is on this account that the precautionary measures outlined above are necessary.

Still negatives are vitrually non-inflammable when in the form of glass plates but are subject to destruction by fire when they are in the form of gelatine films. The danger of destruction from this source, however, is not nearly so great as in the case of motion picture films.

Probably the most interesting set of negatives, from the photographic viewpoint, in possession of the Signal Corps is the historical Brady Collection taken during the Civil War. All of these plates are of the wet collodion variety and many are of plate-glass, one fourth of an inch in thickness. The difficulties involved in the making of these negatives would be regarded as almost insurmountable in these days. The plates had to be coated with emulsion immediately preceding exposure and used at once while still wet. Accordingly a portable dark room was an indispensable accessory to photography. Exposures were necessarily much longer than at present and no instantaneous exposures or "snap shots" were possible.

The original plates of the Brady series, 6,300 in all, are filed in steel cases at the Motion Picture Laboratory, Washington Barracks. As a further precaution against the loss of this collection each of the negatives has been carefully duplicated and the "dupe-negatives" are filed in the fireproof Still Laboratory in Temporary Building No. 6, 19th & F Sts., where they are available for use in the production of prints.

Photographs of the Spanish-American War, the Boxer Insurrection, the Russo-Japanese War are similarly preserved.

The negatives of the World War, 75,000 all told, are stored in the Still Laboratory, each in a separate manila container. A duplicare negative has been made from each original on heavy cut film and these duplicate negatives are always used in the production of finished prints except when prints from the original negatives are specifically ordered. The reason for this procedure is to minimize the danger of loss through breakage as a large number of the original negatives are glass plates.

As a still further insurance that the World War pictures shall never be lost, the Signal Corps has furnished a print from each of the negatives to the Historical Branch of the General Staff, which organization has filed them in a fireproof building at Sixth & B Sts. If both the original and the duplicate negatives should be destroyed, it would be possible to produce a new set of negatives by copying the prints in the possession of the Historical Branch. The perpetuation of the pictorial record of America's achievement in war according is assured.



## Meteorological Repair Shop and Laboratory.

The Meteorological Section of the Signal Corps was organized for the purpose of furnishing meteorological data to all branches of the army. This Section requires for its operation instruments with which to measure all the meteorological elements. It also requires apparatus with which to calibrate all these instruments and a shop in which they may be repaired. Therefore, this shop and laboratory was organized for the purposes mentioned above, and also for the purpose of developing instruments, having special reference to military meteorology. The equipment of the shop includes a precision lathe, milling machine, speed drill, precision measuring instruments, and all of the small hand tools such as taps and dies, drills, files, etc. necessary for the making of parts for all the instruments, including those pertaining to clock work, optical work and all the parts of meteorological apparatus.

The instruments for use at the various meteorological stations of the Signal Corps are shipped from the Depot at Washington and are put into use at these various stations. Due to accident or the moving of a station from one part of a Post to another, as sometimes happens, the instruments are often subjected to rough handling which may result in damage, sometimes slight and sometimes serious. In any event they are sent to the Meteorological Section at Washington, repaired in the shop and made ready for issue in a condition practically as good as new.

Among the instruments which are used the most is the theodolite. This very expensive instrument is used to follow pilot balloons; it measures the angular elevation of the balloon together with its azimuth at such times as the necessity of the observation may require. It is necessary for the accuracy of the observation that this instrument be kept in the very best condition and be accurate in every detail. However, being used outdoors every day in the year, and generally four times a day, it is subject to deterioration by the weather so that the lenses, which are made in two pieces, come apart; that is to say, the Canadian balsam with which they are cemented together deteriorates and the lenses must be recemented and replaced in the theodolite. As a matter of fact when instruments are received in the shop they are entirely rebuilt, which means that they must be relacquered and the wornout parts replaced by new parts and in every way made, as far as operation is concerned, as good as new. Barographs, thermographs and hygrographs, all of which are equipped with clocks, have to be gone over the same as theodolite, that is, taken down in every detail, refinished and rebuilt.

Another very important function is that of calibrating the instruments in the laboratory, which is a section of the shop. Some of the instruments used in connection with the work of calibration are standard barometer, standard thermometer, precision manometer, collimator, apparatus by which thermometers and thermographs may be cooled to a low temperature and heated to as high temperature as necessary. All instruments after being received from the manufacturers must be tested as to their operation, and all instruments which have been rebuilt and refinished must also be tested.

When barometers are received from the manufacturer they are carefully tested for vacuum, and all other defects that may be detected by an eye-examination. They are then compared with the standard barometer over a sufficient length of time to determine their reliability. This work must be done by an observer skilled in handling barometers.

Thermometers used in the Signal Corps are of three types: maximum, minimum, and exposed. They are tested for scale errors and rejected if more than one-half a degree off.

The precision manometer is useful in measuring all spaces of any degree of evacuation, and is particularly useful in studying balloons.

All theodolites, before being placed in the hands of the observer, are inspected very carefully as to mechanical defects and in addition are tested as to: 1st, the adjustment of the levels; 2nd, the adjustment so that the base plate is horizontal; 3rd, the adjustment of the instrument so that the vertical axis is perpendicular to the vertical axis; and 4th, to check the zero of the vertical circle.

Aneroid barometers are placed in bell jars and compared with a mercurial barometer under all conditions of pressure likely to be experienced.

Thermographs are tested throughout their entire range by placing them in chambers whose temperatures can be varied from the lowest to the highest to which they are likely to be subjected, and the records obtained therefrom are compared with the record made by an accurate resistance recording thermograph.

It is only by actually calibrating all instruments that accuracy in records may be secured; and while every effort is made in the laboratory to calibrate all instruments, they are in addition given occasional tests while in operation in the field.

The personnel to operate this shop and laboratory must have a wide range of experience on precision work, such as fine optical work on theodolites, special clock movements used on self-recording meteorological instruments.

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Extract from Air Service News Letter No. 10,
dated May 15, 1923.

## FLOODLIGHT USED AS A SIGNALING DEVICE.

An interesting experiment, and one which may prove of permanent value, was recently tried out at Mitchell Field, L.I., New York. An ordinary floodlight was connected with an electrically driven device which automatically made and broke the circuit. By flashing two dashes of three seconds each and two dots of one-half seconds each it was possible to spell out M I, the first two letters of the word MITCHELL in the Morse International Code at intervals of twenty seconds. So far as is known, this is the first attempt made to positively identify a landing field to a pilot flying at night. In addition to the fact that the International Code is universally recognized, this system has economy in its favor, as the one light is lit less than one-half the time.

To accomplish this result by other means it would necessitate spelling out letters and symbols which would require several lights of the same candle power to secure equal visibility. A disappearing light would also be much more apt to catch a pilot's eye than a permanent light, due to the number of permanent lights which are visible in certain localities.

Captain Ira C. Eaker flew for nearly an hour to determine the effectiveness of the signals and upon landing stated that they were easily read from comparatively close range. The lack of range is attributed to the low candle power of the light used and the inability to secure a proper searchlight effect.

Plans are under way to use a stronger light and with certain improvements suggested by the experiment conducted, it is hoped to attain a visibility of ten miles. When same is achieved, it is believed that this system will be a valuable aid to night flying.

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## SIGNAL CORPS PURCHASING METHODS OF OFFICE OF THE CHIEF SIGNAL OFFICER OF THE ARMY.

Requisitions from the field directed to this office for supply or requisitions arising within the office proper are routed directly to the Ware and Issue Section. Here items are extracted which may be stocked any of the five Signal Corps Depots, and then the requisition is sent to the Editing Section, which determines whether the balance of the items are to be purchased or canceled. Should it be decided the items are to be purchased, they are in turn edited for purchase, given an estimated cost, assigned a Purpose number and forwarded to the Finance Section for funds.

The requisition is then directed to the Purchase Section for procurement. The method of buying varies, depending largely on whether the items come within any one of the following headings:

1. Material urgently needed.
2. Material patented or manufactured by one concern only.
3. Replacement parts.
4. Cost $500. or over.
5. Cost under $500.

Items for which an emergency exists are ordered immediately by letter or telegram.

Items which are patented, manufactured, or sold by one concern only, are purchased from the manufacturer owning the patent, from the sole manufacturer, or sole selling agency, as the case may be, provided that the requisitioning officer will certify "that no other material will meet the requirements of the Signal Corps."

Items of spare parts for apparatus already in use are, as a general rule, purchased from the manufacturer of the original apparatus, unless experience has shown that these parts can be procured from other manufacturers.

When the quantity of supplies to be procured does not exceed $500. in cost they may be purchased without advertising, but usually competitive bids are secured.

When it is reasonably certain that supplies on any proposal will cost over $500, sealed bids are requested. The use of the sealed proposals is for the purpose of protection to the purchasing office and fairness to the manufacturers or dealers interested in the commodities being procured.

When material has been advertised and no bids received, this office then has authority to go into the open market and purchase from any concern that offers to furnish the material at a reasonable price. If prices quoted on any proposal are unreasonable, all bids may be rejected and procurement made in the open market.

Sources of Supply. A card index is maintained, containing the names of manufacturers who have furnished a certain class of material in the past and also a list of those manufacturers who have requested proposals to be furnished them. This list at the present time contains about 5,000 names of manufacturers and is being added to from time to time as new sources of supply are developed. Purchasing directories are also consulted and n provide additional sources.

Debarred Bidders. Manufacturers whose dealings with the War and Navy Departments have been unsatisfactory, either because they have not furnished material called for on contracts awarded them or have failed to comply with their contracts in other particulars, are placed on a list of debarred bidders. No proposals are sent these manufacturers until they have been reinstated.

## MARKETS.

In spite of efforts to enlarge the sources of supply, the markets for purchasing Signal Corps supplies are in some lines rather restricted. It is believed it will be of interest to describe briefly the material in which the Signal Corps is held to a rather restricted market.

In the field of radio supplies, the basic patents on the most important radio developments are controlled by the combine which uses the Radio Corporation of America as its selling agency. By an agreement between the companies included in this combine, they deal through the Radio Corporation of America, except in their dealings with the Government, where they are permitted to enter into competition one with the other for government business. Nevertheless, in spite of this agreement, the question of securing real competition on radio supplies is a very difficult problem. Due to the boom in the radio industry during the past few years, and the consequent entry of many new manufacturers into this field of manufacture, it is felt that competition is on the increase and it may be safely said that about one-half of the orders placed by the Signal Corps for radio material have been awarded during the past year to manufacturers not affiliated with the Radio Corporation of America. The chief difficulty, however, is experienced in the purchasing of tubes for radio sets, the manufacture of which is practically controlled by three companies.

In the purchase of telephones, telephone apparatus, and switchboards, the field is rather limited, a large proportion of the orders being placed with six manufacturers. In the purchase of auxiliary apparatus, such as line construction material, wire, cords and plugs, good competitive prices have been obtained. In the purchase of telephone cable, three manufacturers have in the past controlled the field.

Perhaps the only instance which has occurred in the past few years in which the Signal Corps was unable to procure communication material of satisfactory quality to meet the requirements in the United States was on a project for the securing of new deep sea cable for repairs to the Washington-Alaska Military Cable and Telegraph System. Here the Signal Corps was confronted with the British monopoly in gutta percha, the most satisfactory insulating material yet developed for use in connection with deep sea cables. No American manufacturer could furnish gutta percha cable, which left rubber insulated cable as the only alternative. It is earnestly hoped, however, that some American manufacturer will be able to develop a satisfactory deep sea cable using rubber or some other substitute for gutta percha, as, in view of the contemplated rehabilitation of the Washington-Alaska Military Cable and Telegraph System during the next two years, the question of procurement of satisfactory deep sea cable is of paramount importance to the Signal Corps.

A very steady increase in competition in the purchase of photographic supplies has been witnessed in the past few years. It was generally conceded a few years ago that the products of one of the largest manufacturers of photographic supplies were far superior to those of other competitors. Gradually, however, by a series of tests undertaken under the supervision of this office, it has been found that other manufacturers are now manufacturing supplies which compare favorably with those of the concern which did and still holds a prominent place in the photographic industry, so that today the Signal Corps is saving a considerable amount of money by making comparative tests. In many instances it has been found that while the materials furnished do not quite come up to the standard set by the leading manufacturer, they nevertheless do the work satisfactorily and the saving to the Signal Corps is sufficient inducement to warrant their purchase.

In the Meteorological Service, due to the very small quantity of this class of material used in the commercial world, the market is restricted to three or four manufacturers. The purchase of theodolites for this service, however, affords a very recent example of the value of advertising.



These theodolites were developed by the Government and from the time of their development were manufactured by only one manufacturer, it being generally believed that he was the only one who could satisfactorily manufacture them. His price became so high that it became necessary to try to interest others in making these instruments, so drawings and specifications were prepared and requests for quotations were sent out to the principal makers of these instruments in this country. The result was that this manufacturer, seeing that he was likely to lose his monopoly on these instruments, reduced his price by one-fifth in order to get the business.

Specifications and Drawings. Although it is the policy of this office to cover all Signal Corps material by specifications and drawings, due to the large number of new developments, the constant revision necessary on the old specifications, and a limited personnel, this has never been possible. As a result, the only possible way to describe the material when soliciting competition, drawings and specifications not being available, is to call for material of one manufacturer and indicate that a bid on equivalent material will be considered. This is very unsatisfactory as it very often happens that other manufacturers do not know the particular characteristics of apparatus manufactured by their competitors and either do not bid at all, or bid on something which does not meet the requirements. Very often also it is impossible to determine whether an equivalent material will meet the requirements without testing the same.

Advertising. All purchases over $500, which do not come under headings 1, 2, and 3, previously mentioned, are advertised. The chief medium which the Signal Corps relies on in advertising proposals are the requests for bids that it sends out to the various manufacturers. Then comes the Government Advertiser and several surety and bonding companies which advertise the Government's wants. These advertising companies are forwarded copies of all proposals for supplies on the date of issue, and, as a general rule, print a list of the material on which quotations are desired, and when the award has been made, they advise their clients of the successful bidder. These proposals for supplies are also posted on bulletin boards, both in this office and the Office of the Assistant Secretary of War, so that prospective bidders may examine them and determine whether or not they are interested.

The question is often asked:- "Why advertise when the material of such and such a concern is entirely satisfactory and their prices reasonable?" Many good reasons can be given for advertising, among them the following:

1. When a manufacturer sees that he is bidding in competition with others, he, as a general rule, gives his best price in order to obtain the business.
2. Competition forces prices downward.
3. Advertising shows manufacturers what we are buying, and that they can increase their profits by manufacturing what we want.
4. Very often manufacturers can furnish similar material which will do the work just as satisfactorily, at a lower price.
5. Certain jobbers often quote lower prices than the maker of the material, either because they are overstocked or because they are willing to give up some of their profit to get the business.

Awards. The lowest bidder does not always receive the order. In determining who is the successful bidder, price and quality are as a general rule given equal weight, and it has sometimes been found that the highest bidder is giving the Government a better value dollar for dollar than the lower. Tests over long periods of time are often necessary in some classes of material, such as dry batteries. By testing it was found that some batteries had a very short life and as a result were practically of no use to the Signal Corps.

Contracts. After determining the successful bidder the order is written. If the order amounts to over $500 and requires over sixty days for completion, a contract must also be written to accompany the order; written contracts are also required when the amount is over $5,000., irrespective of time of performance.

**Bonds and Liquidated Damages.** Performance bonds in the sum of fifteen per cent of the order are usually asked for when the amount of the order is over $5,000. or on any construction project, the cost of which is over $500. Liquidated damages are also asked for in certain cases. In case of bond, the Government has to show actual damage before it can collect, while in the case of liquidated damages, the manufacturer has to show why the Government should not collect if he is late in his deliveries.

**Expediting deliveries.** In order to see that all manufacturers live up to their agreements and deliver the material on or before the time promised, a follow-up section is maintained and close check on all orders to see that they are delivered within the time promised.

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## OCEAN CABLES.

The following changes will be made, in the near future, in the Cables of the All-American Cable Company:

> The main cables, running now directly from Salina Cruz, Mexico, to San Juan del Sur, Nicaragua, and thence to Santa Elena, Ecuador, will be removed from San Juan del Sur and brought directly into Puntarenas, Costa Rica, from Salina Cruz. One branch cable will be maintained from Salina Cruz-San Jose de Guatemala, La Libertad, San Juan del Sur to Panama.

This change was necessitated on account of the heavy traffic over the main line, and the fact that although the capacity of the Salina Cruz-San Juan del Sur line was 175 letters per minute, the maximum capacity of the San Juan del Sur-Santa Elena line was but 145 letters per minute, with the result that many times there was a block in San Juan del Sur.

The change from San Juan del Sur to Puntarenas will shorten the cable to Santa Elena some 400 miles, with a consequent increase in capacity.

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## Boys' Day Celebration added by Signal Corps R. O. T. C. Unit.

Madison Wisconsin entertained 3000 boys and their relatives at the celebration of Boy's Day, May 1st. A special feature of the afternoon's entertainment was a signal demonstration by the Signal Corps R.O.T.C. Unit representing the Military Department of the University of Wisconsin. Radio sections installed and operated two types of field radio sets; visual signaling by flags and projectors was demonstrated and a wire system was installed utilizing field telephones and a 12-line Monocord switchboard, the telephones being distributed among the youngsters to communicate with each other in various sections of the grandstand.

At the conclusion of the demonstration a bewhiskered troupe of students in resplendent uniforms of varied hue, burlesqued each of the previous signaling events, their performance ending in the explosion of a dummy radio set being installed, much to the amusement of the youthful spectators.

The demonstration was planned and directed by Captain John A. Ballard, S. C., in charge of Signal Corps training at the university.

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## CIPHER PROBLEMS. IX.

Although the problem presented in the last installment was not intended as an exercise for those following this course in cipher analysis, two com- r[illegible] solutions have been received. The interest thus manifested is ap- [illegible]ated by this office.

In the last installment it was shown how the ordinary principles of multiple alphabet cipher analysis resulted in the establishment of the following values for the illustrative problem:

Plain Text

| | | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Cipher | 1. | | | | | Q | | | W | | | | | | | | | | | | G | | | | | | |
| Alphabets | 2. | | | | | C | | | J | | | | | | | | | | | | E | | | | | | |
| | 3. | | | | | D | | | K | | | | | | | | | | | | X | | | | | | |
| | 4. | | | | | U | | | I | | | | | | | | | | | | P | | | | | | |
| | 5. | | | | | G | | | D | | | | | | | | | | | | Y | | | | | | |

Now if the student has carefully followed the details of the method of encipherment, he will realize that the sequence of letters in each cipher alphabet in this example is the same; the only difference between the alphabets is one of relative displacement, that is, position of the cipher sequence with respect to the normal sequence. For instance, if we put together in superimposed lines the cipher alphabets of the illustrative example on page 6 of the last bulletin, we have the following diagram:

Plain Text

| | | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1. | B | C | D | F | G | I | J | K | M | P | Q | S | U | X | Y | Z | L | E | A | V | N | W | O | R | T | H |
| Cipher | 2. | L | E | A | V | N | W | O | R | T | H | B | C | D | F | G | I | J | K | M | P | Q | S | U | X | Y | Z |
| Alphabets | 3. | U | X | Y | Z | L | E | A | V | N | W | O | R | T | H | B | C | D | F | G | I | J | K | M | P | Q | S |
| | 4. | E | A | V | N | W | O | R | T | H | B | C | D | F | G | I | J | K | M | P | Q | S | U | X | Y | Z | L |

Note now, that the sequences are the same, except as regards their relative positions or displacements to the right or left. It is clear, therefore, that if we know the position of any pair of letters in one sequence, and the position of one member of the same pair in another sequence, we may at once place the other member of the pair in its proper position on account of the symmetry exhibited in the various superimposed lines. Thus, if we have only the positions of a few letters on different lines in such a diagram, we may fill in many more letters in the diagram by recourse to this principle of symmetry of position.

Refer now to the diagram applying to the message being solved. In Alphabet 1 we have G, standing beneath $T_p$. In Alphabet 5 we also have G, but standing beneath $E_p$. Now D in Alphabet 5 is two intervals to the right of G, and we may at once place D two intervals to the right of G in Alphabet 1, thus giving us the value of $W_p$ as $D_c$ in that alphabet. Again, Y is 12 intervals to the right of D in Alphabet 5, so that we may at once place Y a corresponding number of intervals to the right of D in Alphabet 1, which makes $I_p = Y_c$ in Alphabet 1, and thus gives us an important value without further analysis. Again, in Alphabet 3 we see that $K_c$ is two intervals to the right of $D_c$, and we may therefore insert K in its proper place in both Alphabet 1 and 5. We may also insert Q and W in Alphabet 5. In similar manner we proceed with the remaining letters until our diagram is as follows, where the derived letters are underlined:

```
     A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
1.           Q     W Y     X               G     D     K
2.           C     J                       E
3.     G     D     K         Q     W Y     X
4.           U     I                       P
5.           G     D     K         Q     W Y     X
```

Here we have the following new values:

| Alphabet 1 | Alphabet 3 | Alphabet 5 |
|---|---|---|
| $Y_c = I_p$ | $G_c = B_p$ | $K_c = K_p$ |
| $X_c = L_p$ | $W_c = P_p$ | $Q_c = P_p$ |
| $D_c = W_p$ | $Y_c = Q_p$ | $W_c = S_p$ |
| $K_c = Z_p$ | $Q_c = M_c$ | $X_c = W_p$ |

Several important new values have been obtained in this manner without further analysis of the frequency tables.

Let us now insert these values in the message:

```
 1.   ICBJO  AILOW  LQBUQ  ICBUN  YQJPD  QBDKL  USQUO
       E        S     EP    E E   I TH   E E     ME

 2.   GKEJB  HXBIF  HVVMY  LQBUH  UQXIG  YQFJV  HIXNP
      T         H      T     E     THE   I        T

 3.   ARFPD  QCRUM  JIRAP  REKUY  QYZEF  ARGPS  YQDAY
         TH  EE E           THET  E        BT   I E

 4.   WYVQC  WVZJQ  QYZUI  UQREF  NIRHG  ORQXS  GRZAG
      H      H   P  E  E              E    M    T

 5.   IZNMG  YZEQG  PJVVI  UPWCG  GCZUI  UQREF  NZNFI
          E  I   E  H         PE  TE E

 6.   QPNYT  QALCL  PCWUO  PXWJO  GJDPF  HCXIS  GGNFT
      E      E        PE    P     THET    ETH   T

 7.   QZWEV  QBFJV  GJDKZ  IVVOG  DKXIP  BEPJW  YQJPD
      E P    E      THE       E   W TH    T S   I TH

 8.   QKRNY  YIXNE  QKREI  GKVFY  WCBIS  IIBPG  IRFPD
      E   T  I T    E      T   T  HE H     TE      TH

 9.   QKRSP  IPNPF  UQCUW  YYDAS  ABHKP  AEKUG  RDLHF
      E         T      ES  I E           THEE

10.   QQBYP  REKUM  QIEQV  QZXEK  QQGYY  WODFG  HSXJI
      E       THE   E      E T K  E B T  HEE E   T

11.   UQBUS  XJLON  YZWJW  YELJO  N
        E    LH      I P S IT
```

We have enough now to assume words from the skeletons of word exhibited. Note, this sequence at the end of the message:

```
3 4 5 1 2   3 4 5 1
W J W Y E   L J O N
P - S I T   - - - -
```



This looks like the word POSITION - , or possibly POSITIONS.

With the $J_c^4$ repeated in the correct alphabets and positions, it certainly gives good corroboration of its being $O_p$; moreover, its frequency is excellent for $O_p$. Also in lines 3 and 10, respectively, the sequences:

```
4 5 1 2 3 4 5 1       5 1 2 3 4 5 1 2
P D Q C R U M J  and  Y W C D F G H S
T H E E - E - -       T H E E - E - -
```

look like THE ENEMY. The frequency tables give excellent corroboration for the required values. Let us insert these new values in the reconstruction diagram and again apply the principles of symmetry of position and the diagram now becomes as follows:

Plain Text

```
               A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
          1.   L M O P Q R   W Y   E X H   U S   I   G   C D F J K
Cipher    2.   I   G   C D F J K L M O P Q R   W Y   E X H   U S
Alphabets 3.     G   C D F J K L M O P Q R   W Y   E X H   U S   I
          4.   E X H   U S   I   G   C D F J K L M O P Q R   W Y
          5.   S   I   G   C D F   K L M O P Q R   W Y   E X H   U
```

Nearly all the values are solved by the operation. Moreover, we note that the alphabet is a key-word alphabet because of the sequence C D F J K L M O P Q R. We could make a guess at the word upon which it is based, but it is safer to insert the new values in the message first, to see that no errors have crept in.

MESSAGE.

```
 1.   ICBJO  AILOW  LQBUQ  ICBUN  YQJPD  QBDKL  USQUO
      E ON    AISS  AN EP  RE E   INGTH  E EPL  OYMEN

 2.   GKEJB  HXBIF  HVVMY  LQBUH  UQXIG  YQFJV  HIXNP
      TISO   MU HI  H  RT  AN EX  ONTHE  INFO   MAT O

 3.   ARFPD  QCRUM  JIRAP  REKUY  QYZEF  ARGPS  YQDAY
       OFTH  BENEM  YA  O  FTHET  ER AI   OBTA  INE T

 4.   WYVQC  WVZJQ  QYZUI  UQREF  NIRHG  ORQXS  GRZAG
      HR UG  H  OP  ER EC  ON AI   A CE  COMBA  TO

 5.   IZNMG  YZEQG  PJVVI  UPWCG  GCZUI  UQREF  NZNFI
      R  RE  I SUE  DH  C  OMPLE  TE EC  ON AI     NC

 6.   QPNYT  QALCL  PCWUO  PXWJO  GJDPF  HCXIS  GGNFT
      EM Y   E ILL  DEPEN  DUPON  THETI  METHA  TC N

 7.   QZWEV  QBFJV  GJDKZ  IVVOG  DKXIP  BEPJW  YQJPD
      E PA   E FO   THEP   R  SE  WITHO   TLOS  INGTH

 8.   QKRNY  YIXNE  QKREI  GKVFY  WCBIS  IIBPG  IRFPD
      EI  T  IAT V  EI AC  TI NT  HE HA  RA TE  ROFTH

 9.   QKRSP  IPNPF  UQCUW  YYDAS  ABHKP  AEKUG  RDLHF
      EI FO  RM TI  OMDES  IRE A    UPO   THEE  F ICI

10.   QQBYP  REKUM  QIEQV  QZXEK  QQGYY  WCDFG  HSXJI
      EN YO  FTHE   EASU   E TAK  ENBYT  HEENE  MYTOC

11.   UQBUS  XJLON  YZWJW  YELJO  N
      ON EA  LHIS   I POS  ITION
```

So far as we can see there are no inconsistencies, and many words are now possible to complete. The first word stands out as RECONNAISSANCE, and at once enables us to fill in the very next word which is PRECEDING. Further progress is very easy and the complete plain text is soon at hand. It is as follows:

MESSAGE

"Reconnaissance preceding the deployment is of much importance (x) On the information of the enemy, and of the terrain obtained through proper reconnais (s) ance combat orders are issued. How complete reconnaissance may be will depend upon the time that can be spared for the purpose without losing the initiative in action, the character of the information desired, and upon the efficiency of the measures taken by the enemy to conceal his dispositions".

The primary alphabet is found to be based upon the word EXHAUSTING:

E X H A U S T I N G B C D F J K L M O P Q R V W Y Z

Note that the key word for the message is the word LINES, appearing directly beneath the letter A in the completed diagram of alphabets.

The example above was, of course, specially prepared for the purposes of the demonstration. Usually, greater difficulty is experienced in solving such cases, but only when the message is rather short. Furthermore, in military cryptograms, such words as THE, THAT, THIS, etc. are omitted, and the opening wedge in the analysis in such cryptograms must be found in searching for other common trigraphs, and such trigraphs as ER, AN, ON, etc.

The student is urged to note well the fundamental points in the principles of symmetry of position, for they are of great assistance in the quick solution of cryptograms coming under this case. Reference is again made to the fact that the principles of symmetry of position can only be applied to the cipher alphabets when they are arranged in the form of enciphering alphabets, for symmetry, if it exists, is only shown in that form of the cipher alphabets and not in the deciphering alphabet form.

The following problem, a cryptogram of a military nature, is submitted for analysis:

QDNBA NISRD IGLAR QKIZP HJABS YXIRU

AJXGZ FVFLX LTUOM OEWMG JFFDE NCKAP

HAPFS CSNWZ VOJFB AJPSG PKPTK EGIGG

TBDEW YNVYP GWYDH ZDYGA BYQBU ANWMD

FNJLT THVHS NPPGQ ITAAZ EVQLJ DERBG

FZNMU ROHQC IBCGK GEZVD ZPKTN HJKYV

BPZON ZSGZL FAPMC VYOOS YAZZD VCFLZ

NNGIZ CVQBF WJCVR NKBEL MGTAJ OSBHD

GHEXO PMJLX RMRLG MGEGR CAAEG SCJKF

KGORJ MOKGT UNETI UHBLA BEWXK FRFEX

ZHALL ALMRI LLALM MRCYF DIADE PYNVR

MYJQE TUNGI ETMGS ECEEO DVHBA AEKUJ

SOAOI HZBAJ NIJKK ZAPFA VSSUZ BLOUZ

Y

## THE ARMY RADIO NET

The following radio stations comprise the Army and Corps radio nets in the United States proper:

| Station | Call Letter |
|---|---|
| **District of Washington** | |
| Washington, D.C. | WXY |
| Bolling Field, D.C. | WYB |
| **1st Corps Area** | |
| *Less Important Station* | |
| Ft.Ethan Allen,Vt. | |
| **2nd Corps Area** | |
| Governors Island,N.Y. | WVP |
| West Point, N.Y. | WUAH |
| Camp Vail,N.J. | WUBA |
| Mitchell Field,N.Y. | WYA |
| Ft.H.G.Wright,N.Y. | WUC |
| Ft. Totten, N.Y. | WUL |
| Ft. Hancock,N.J. | WUB |
| *Less Important Stations* | |
| Camp Dix, N.J. | |
| Raritan Arsenal,N.J. | |
| Morgan Ord.Depot,So.Amboy,NJ | |
| Ft.Hamilton, N.Y. | |
| Ft.Wadsworth,N.Y. | |
| Port Newark, N.J. | |
| **3rd Corps Area** | |
| Fort Howard, Md. | WVQ |
| Langley Field,Va. | WYC |
| Ft.Monroe,Va. | WUF |
| *Less Important Stations* | |
| Edgewood Arsenal,Md. | |
| Aberdeen Proving Gd., Md. | |
| Ft. Eustis, Va. | |
| Camp Meade, Md. | |
| **4th Corps Area** | |
| Ft. McPherson,Ga. | WVR |
| Ft.Moultrie,S.C. | WZF |
| Ft.Screven,Ga. | WZA |
| Key West Bks.,Fla. | WUEV |
| Ft.Barrancas,Fla. | WZD |
| Ft. Bragg, N.C. | WZG |
| *Less Important Stations* | |
| Ft.Benning, Ga. | |
| Ft.Oglethorpe,Ga. | |
| **5th Corps Area** | |
| Fort Hayes, Ohio | WVR |
| Ft.Benj.Harrison,Ind. | WVS |
| Fairfield,Ohio | WYD |
| Langin Field,W. Va. | WYI |
| *Less Important Stations* | |
| Camp Knox, Ky. | |



| Station | Call Letters |
|---|---|
| **6th Corps Area** | |
| Chicago, Ill. | WVT |
| Selfridge Field,Mich. | WYE |
| Chanute Field, Ill. | WYJ |
| Jefferson Bks., Mo. | WVV |
| Scott Field, Ill. | WYF |
| *Less Important Stations* | |
| Camp Custer, Mich. | |
| Rock Island Arsenal,Ill. | |
| Fort Brady, Mich. | |
| Fort Wayne, Mich. | |
| Univ. of Wis.,Madison,Wis. | |
| Univ. of Ill.,Urbana,Ill. | |
| **7th Corps Area** | |
| Fort Omaha, Nebr. | WVU |
| Ft.Leavenworth,Kan. | WUD |
| Ft.Riley,Kan. | WUI |
| *Less Important Stations* | |
| Univ. of Missouri,Columbia,Mo. | |
| **8th Corps Area** | |
| Ft. Sam Houston,Texas | WUJ |
| Nogales,Ariz. | WZL |
| Ft. Travis, Texas | WXP |
| Douglas, Ariz. | WZM |
| Ft. Bliss, Texas | WZO |
| Ft.Brown,Texas | WUZ |
| Ft. Huachuca, Ariz. | WZP |
| Ft.McIntosh,Texas | WUH |
| Ft.Ringgold,Texas | WZI |
| Kelly Field,Texas | WYG |
| Camp Marfa, Texas | WUG |
| Ft.Clark, Texas | WZB |
| **9th Corps Area** | |
| Presidio of San Francisco,Cal. | WVY |
| Ft.Douglas,Utah | WVX |
| Ft.D.A.Russell,Wyo. | WVW |
| Rockwell Field,Cal. | WYH |
| Ft.Whitman,Wash. | WZC |
| Ft.Casey,Wash. | WZJ |
| *Less Important Stations* | |
| Crissey Field, Cal. | |
| Ft. McArthur,Cal. | |
| Fitzsimmons Gen.Hosp.,Denver,Col. | |

Where no call letters are given, stations are using temporary calls assigned by Corps Signal Officers.

During the calendar year ending Dec.31,1922, the Army Net handled 62,222 official radiograms,consisting of 2,235,417 words. Had this traffic been handled over commercial land lines, it would have cost the Government $38,202. The total cost of handling this traffic by the Army Radio Net,exclusive of enlisted operating personnal,was $18,039. The total saving to the Government, therefore,amounted to $20,163.

The traffic at the present time is averaging approximately $6,000 worth of business per month.

On March 1, 1923, the War Department telegraph office was moved to the Office of the Chief Signal Officer and consolidated with the Signal Corps radio station at these headquarters, it constituting the War Department Message Center.

The new 10 k.w. tube transmitters, authorized for installation at Ft. Leavenworth, Kansas, and Fort Douglas, Utah, will very materially facilitate the handling of traffic throughout the Army Net. High speed transmitting equipment of the Kleinschmidt type has been ordered and will be placed in op- 'ion immediately at Washington and Fort Benj. Harrison. This will e- these two stations to operate at approximately one hundred words pe. minute during periods of peak traffic loads.

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DEPARTMENT OF COMMERCE
Washington

USE OF KILOCYCLES IN RADIO.

The Second National Radio Conference, which met with Secretary Hoover in March, introduced a method of designating radio waves which is somewhat new to the radio public. This is the use of frequency in kilocycles (abbreviated kc) instead of wave length in meters. The advantages of this practice have been familiar to radio engineers for some time, and it is probable that it will eventually replace the use of wave length in meters. As a matter of fact, wave length is a somewhat artificial conception in the handling of radio apparatus and is one of the difficult things for the beginner to understand. The frequency of the radio wave is the same as the frequency of the alternating current which flows in the radio transmitting or receiving set.

As often happens in technical matters, the idea of "kilocycles" is simpler than the forbidding aspect of the word suggests. "Kilo" means a thousand, and "cycle" means one complete alternation. The number of kilocycles indicates the number of thousands of times that the rapidly alternating current repeats its flow in either direction in the antenna in one second. The smaller the wave length in meters, the larger is the frequency in kilocycles.

The reason that kilocycles are coming into use and displacing meters is the necessary separation of the frequency of transmitting stations to prevent interference is the same, no matter what the frequency may be. This necessary separation is variable and quite misleading when expressed in meters. Thus the number of radio messages that can be transmitted simultaneously without interference can be correctly judged from the kilocycles but not from the meters. For example, the amateurs will in the future work in a band of wavelengths from 150 to 200 meters, but this is a frequency band from 2000 to 1500 kilocycles. This is an enormously wider band when considered from the viewpoint of kilocycles than, for example, the band having the same width in meters from 1000 to 1050 meters, which is 300 to 286 kilocycles. While it is possible to carry on fifty simultaneous radio telephone communications between 150 and 200 meters, only one could be carried on between 1000 and 1050 meters.

In accordance with the recommendation of the Second National Radio Conference, the Department of Commerce and other Government departments will hereafter follow the practice of specifying in even values of kilocycles rather than meters. The Conference recommended the practice of expressing wave frequency in kilocycles per second with wave length in meters in parentheses thereafter. The relation between the two is very simple. To obtain kilocycles, divide 300,000 by the number of meters; to obtain meters, divide 300,000 by the number of kilocycles. For example, 100 meters = approximately 3000 kilocycles, 300 meters = 1000 kilocycles, 1000 meters = 300 kilocycles, 3000 meters = 100 kilocycles. The following table may be used for rapid and accurate conversion either from kilocycles to meters or meters to kilocycles.

For highly accurate conversion the factor 299 820 should be used instead of 300 000. The table below gives accurate values of kilocycles corresponding to any number of meters and vice versa. It should be particularly noticed that the t- is entirely reversible; that is, for example, 50 kilocycles is 5996 meters a- so 50 meters is 5996 kilocycles. The range of the table is easily extended by shifting the decimal point; for example, one can not find 223 in the first column, but its equivalent is obtained by finding later in the table that 2230 kilocycles or meters is equivalent to 134.4 meters or kilocycles, from which 223 kilocycles or meters is equivalent to 1344 meters or kilocycles.

(Table omitted)



Recommendation of the "Hoover" Radio Conference, March 20-24, 1923.

It is recommended that radio stations be assigned specific wave frequencies (wave lengths) within the wave band corresponding to the service rendered as given in the following table.

Throughout this report, both wave frequency and wave length are given. Wave length in meters is 300,000 divided by wave frequency in kilocycles per second.

It is recommended that wave bands marked exclusive be used for no other type of service; those marked non-exclusive can be used for other types of radio communication, as indicated.

| Wave Frequency, Kilocycles per sec. | Wave Length Meters | Service. |
|---|---|---|
| Above 2300 | Below 130 | Reserved. (See Note 1) |
| 2300 | 130 | Government, CW, exclusive. |
| (2300<br>(2100 | 130)<br>143) | Reserved. (See Note 1) |
| 2100 | 143 | Government, CW, exclusive. |
| (2100<br>(2000 | 143)<br>150) | Reserved. (See Note 1) |
| (2000<br>(1700 | 150)<br>176) | Amateur, CW, ICW, Ph, exclusive. |
| (1700<br>(1500 | 176)<br>200) | Amateur, CW, ICW, Ph, Spk, exclusive. |
| (1500<br>(1350 | 200)<br>222) | Special amateur, and technical and training schools, CW, exclusive |
| (1350<br>((1300 | 222)<br>231) | Aircraft, CW, ICW, Ph., non-exclusive. |
| (1350<br>(1050 | 222)<br>286) | Class B broadcasting, Ph, non-exclusive. (See Note 2) |
| (1050<br>(1040 | 286)<br>288) | Reserved. |
| (1040<br>(1000 | 288)<br>300) | Class A broadcasting, Ph, exclusi- (See Note 3) |
| 1000 | 300 | Marine, CW, ICW, Spk, non-exclusive. (See Note 4) |
| (1000<br>( 667 | 300)<br>450) | Class A broadcasting, Ph, exclusive. (See Note 3) |
| 667 | 450 | Marine, CW, ICW, Spk, exclusive. (See Note 5) |
| ( 667<br>( 550 | 450)<br>545) | Class A broadcasting, Ph, exclusive. (See Note 3) |
| ( 550<br>( 500 | 545)<br>600) | Marine and aircraft, CW, ICW, Spk, exclusive. |

| Wave Frequency, Kilocycles per Sec. | Wave Length, Meters | Service |
|---|---|---|
| Above 500 | 600 | Marine and aircraft, CW, ICW, exclusive. See Note 4. |
| (500<br>(445 | 600)<br>674) | Marine and aircraft, CW, ICW, Spk, exclusive. |
| 446 | 674 | Government, CW, non-exclusive. |
| (445<br>(375 | 674)<br>800) | Marine and aircraft, CW, ICW, exclusive. |
| 375 | 800 | Radio compass, CW, ICW, Spk, exclusive. |
| (375<br>(315 | 800)<br>952) | Marine, Ph, exclusive. |
| 315 | 952 | Government, CW, ICW, Spk, exclusive. |
| (315<br>(300 | 952)<br>1000) | Reserved. |
| 300 | 1000 | Radio beacons, CW, ICW, Spk, exclusive. |
| (300<br>(285 | 1000)<br>1053) | Reserved. |
| (285<br>(275 | 1053<br>1091) | Marine, Ph, exclusive. |
| 275 | 1091 | Government, CW, ICW, non-exclusive. |
| (275<br>(250 | 1091)<br>1200) | Marine, Ph, exclusive. |
| 250 | 1200 | Government, CW, ICW, non-exclusive. |
| (250<br>(235 | 1200)<br>1277) | Marine, Ph, exclusive. |
| (235<br>(230 | 1277)<br>1304) | University, college, and experimental, CW, ICW, exclusive. |
| (230<br>(190 | 1304)<br>1579) | Government, CW, ICW, Spk, exclusive. |
| (190<br>(120 | 1579)<br>2500) | Marine and point-to-point, non-government, CW, ICW, Spk, exclusive. |
| (120<br>( 95 | 2500)<br>3158) | Government, CW, ICW, Spk, exclusive. |

Note -- Available for special licensing by the Department of Commerce.

Note 2. -- Not more than six CW amateur stations to be licensed to use wave frequencies above 1050 kc/s (wave lengths below 286 meters), for communication across natural barriers.



Note 3. -- A class A broadcasting station is a station of sufficient power to serve an extensive territory. Fifty territorial wave frequencies approximately 10 kc/s apart are to be assigned by the Department of Commerce to local areas throughout the United States without duplication. The ten such areas within each of five national zones are to have wave frequencies separated by approximately 50 kc/s.

Note 4. -- The 1000 and 500 kc/s (300 and 600 meter) waves are for calling and distress purposes, with a minimum of traffic.

Note 5. -- Mobile service on the 667 kc/s (450 meter) wave is to be stopped between 7 and 11 p.m. local standard time, and to be transferred in so far and as soon as practicable, to wave frequencies below 500 kc/s (wave lengths above 600 meters).

The wave bands reserved above for Government use are now the subject of study by an Interdepartmental Committee with a view to assignment of wavelengths in these bands to all Government stations in such a manner that the minimum interference will result. No steps should be taken by officers in charge of Signal Corps stations to shift from present transmitting wavelengths to the bands reserved above for Government use until definite instructions have been received from this office on this subject.

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## CONTRIBUTIONS AND EXCHANGES.

Articles under this heading must not be taken as an expression of the opinion of The Chief Signal Officer. (Names of authors will be withheld if requested.)

### THE ARMY OFFICER AND THE BOY SCOUT.

By:
Frank Moorman, Major, Signal Corps.

In publishing the following letter, attention is invited to the splendid opportunity for all army officers, especially those of the Reserve and National Guard, to do a fine bit of work for their community and country and at the same time gain contact with a source of real inspiration and personal pleasure.

Actual experience has shown that restless active boys who glory in their "toughness" and would not, for the world, admit the need of affection and good advice, find in Scouting an opportunity for that "man to man" association which carries no patronage or "sissy boy stuff." Their response is almost instantaneous and in a short time the scout leader finds himself the object of an affectionate loyalty, new alike to him and to the boys.

The training and experience of Army Officers qualifies them as teachers of what scouts are required to learn. Officers of the Signal Corps are especially fortunate in this respect and will find in America's boyhood an enthusiastic following.

The man who, today, inspires boys with a spirit of patriotism, good citizenship and service to God and neighbor is doing much to insure the future of our country. He can do it if he will. The scout uniform and the scout s[illegible]rd of living have an almost irresistable appeal for the average boy. Th[illegible] is no difficulty about getting him to come into the game but clean straight thinking men who will take time to give him what he should have, in a package so pleasing that he wants it, are harder to get. The Army, among its Regular, National Guard and Reserve Officers has nearly a hundred thousand men qualified in every way except as to willingness to spare the time. If they once experience the real pleasure of personal leadership of, and intimate association with, some dozen or more of the leaders of the future there will be no further difficulty about finding the time.

It is hoped that many Signal Corps Officers will be among those who will profit by the suggestion of the General of the Armies.

WAR DEPARTMENT
Office of the Chief of Staff
Washington

April 16, 1923.

Mr. James E. West,
Chief Scout Executive,
Boy Scouts of America,
New York City, N.Y.

My dear Mr. West:

I have received a copy of a resolution recently adopted by the Na[illegible]onal Council, Boy Scouts of America, in which the hope is expressed that Army and Navy men may take a greater interest in the organization. You ask my cooperation in bringing this to the attention of the Army with a view to encouraging active participation by a greater number of Army men.



The Scout program being non-military in character, it is true, as suggested in the resolution, that some Army officers have hesitated to take active part in scouting, fearing it might create misunderstanding, but I am sure, from the information you have presented to me, that making known this resolution, expressing the earnest desire of the leaders of the Boy Scout Movement for a greater degree of cooperation, will serve to remove this misunderstanding.

After carefully reviewing the activities of the Boy Scouts of America, their program, objectives, leadership and actual accomplishments, I do not hestitate to say that I should be very glad to see members of the Army everywhere take such active part in scouting as official duties and local conditions permit.

That the Boy Scout Movement has already recruited a group of over 130,000 men giving volunteer service in character building and citizenship training, and that over 2,000,000 boys of America have been helped by this program is a remarkable accomplishment. I feel that the work is one with which any soldier should be proud to be associated.

Such association would be of benefit in many ways. The leadership of boys develops qualities which aid in the leadership of men, and active scout service would give valuable experience to many of our officers which they might not otherwise get in time of peace. Moreover, the responsibility of setting an example to boys who have adopted a standard as high as that expressed in the Scout oath and law must react on the leader in a manner entirely to his benefit and to that of those with whom he associates.

Having kept in close touch with the work of the Boy Scouts, I thoroughly approve of its object for the good it does the boy, and further, I approve of it as a soldier for the good it does to those who may be called upon to serve as our future defenders, and finally, as an American citizen I approve of it for the training it gives in preparing the boy to be a worthy citizen of his country.

I feel that it is a distinct recognition of the high qualifications of Army men to be asked to participate in a movement which has accomplished so much for the youth of the land and which has so much of promise for the future.

The Secretary of War, with whom I have discussed the matter, joins me in hoping you may find many Army men who will appreciate and take advantage of this opportunity to become useful workers in a great undertaking.

Very sincerely yours,

(signed) John J. Pershing.

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# THE SIGNAL CORPS R.O.T.C. UNIT AT THE UNIVERSITY OF MINNESOTA.

by:
Captain James T. Watson, Signal Corps (DOL)
Officer in Charge.

University of Minnesota, a state institution, is located in the city of Minneapolis, and close to the city limits of St. Paul; so while not far from the business center of the former city, it can be easily reached from any part of either metropolis. The Twin Cities, having a combined population of about 700,000, are two closely associated live western business centers which are the main distributing points for the northwest.

The University still lacks over fifteen years of reaching the three quarters of a century mark. Its present enrollment, excluding summer and night schools and extension courses, is 4665 men and 2517 women students. It is composed of some 12 colleges (Colleges of Engineering, and Architecture, Science, Literature and Arts, Dentistry, Pharmacy and Education; Schools of Law, Medicine, Mines, Chemistry, Business and Graduate School and Department of Agriculture,) all of which are co-educational. With the exception of one girls' dormitory and several small club-houses, the University makes no provision for the housing of the students who find scattered accomodations all over the Twin Cities.

A land-grant institution is one to which the government gives financial aid, and the institution provides military instruction, including two years of compulsory military training for all physically fit male students who are American citizens, and additional advanced military training as well. The University of Minnesota is such an institution. This compulsory military training covers a period of three hours per week for students of the first two years (Freshmen and Sophomores), arranged in one hour periods on Mondays, Wednesdays and Fridays for two thirds of the school year and in three hour periods for the remaining third. The one hour periods are used principally for indoor theoretical instruction such as lectures on Infantry Weapons and Message Centers, and the three hour periods are used primarily for outdoor instruction of a practical nature; for example, Map-making and Infantry Drill. Only students who have satisfactorily completed the first two years of compulsory training are eligible to take the Advanced Military Training. This Advanced Course calls for at least five hours per week instruction for the student. Upon satisfactory completion of the Advanced Course which includes one summer camp of some six weeks, the student may be commissioned in the O. R. C. The student taking the Advanced Course receives commutation of rations during the school year, mileage or transportation to camp and pay of the 7th grade while at Camp.

There are five Units of the R.O.T.C. established here, Infantry, Coast Artillery, Signal Corps, Dental and Medical. The Infantry Unit takes men from all colleges; the Artillery Unit from all engineering schools, the Medical and Dental Units from the Medical and Dental colleges respectively; and the Signal Corps Unit from the Electrical Engineering Department of the College of Engineering. Enrollment in the above Units is as follows:

| Unit | Basic Course | Advanced Course | Total |
|---|---|---|---|
| Infantry | 723 | 35 | 768 |
| Coast Artillery | 161 | 32 | 193 |
| Medical | 12 | 47 | 59 |
| Dental | 100 | 54 | 154 |
| Signal Corps | 95 | 27 | 122 |

On duty with these Units are six Infantry, two Coast Artillery, One Medical, one Dental and one Signal Corps officers, seven Infantry, two Coast Artillery, two Signal Corps noncommissioned officers. These five units,



under the direction of the Professor of Military Science and Tactics cooperate to a large extent especially with the Signal Corps unit. For example, instruction in First Aid and Hygiene is given by a Medical Officer, lectures on Military History are given to Advanced Course students by an Infantry officer who has made a special study of this subject, etc. The Infantry Unit, the largest unit of the five, also takes care of the administration of the unit as a whole, the Professor of Military Science and Tactics and his adjutant being Infantry officers.

Although there are some twelve colleges, that go to make up the University, the Signal Corps Unit has but one Department of the Engineering College from which to recruit students for the advanced course. Practically speaking, only students who take the Electrical Engineering course are eligible for this unit, though it is possible for a student majoring in electrical physics to become a member. The enrollment in the Electrical Engineering Department is as follows:-

Freshmen 150 *
Sophomores 113
Juniors 66
Seniors 60

Less than half of the men in the junior class have been eligible to take the advanced course, not having had two full years of R.O.T.C. training. Some have had military service in lieu of R.O.T.C.; others have had work at other schools not requiring military training, others are physically unfit or have gone out for athletics one or more quarters and so are not eligible to take the advanced course of instruction.

The fact that a student must have completed two years of R.O.T.C. training has worked an injustice to a great many ex-service men who desired to take the advanced course but were not eligible. Although this department is relatively small, the Signal Corps, with the solid backing of the faculty of this department and the active support of its head, has been able to make a good showing.

Courses covering the fundamental theoretical principles, and accompanied by closely related experimental work in the laboratories, are conducted by Professor George D. Shepardson, head of the department of electrical engineering, by Assistant Professor C. Moreau Jansky, Jr., in charge of radio work, and by Instructor George M. Swenson, in charge of the telegraph and telephone laboratory. Each of these men is well known for research work in the field of electrical communication, the two latter holding commissions in the Signal Officers' Reserve Corps.

As preparation for the theoretical work of the Advanced R.O.T.C. courses, the students have had two years of college mathematics, including higher algebra, trigonometry, analytical and descriptive geometry, differential and integral calculus; and simultaneously with the course in electrical communication, they continue with theoretical mechanics, hydraulics and strength of materials. They have also had a year of college physics and a year of elements of electrical engineering before beginning the communication courses, and they continue with a year 's course in dynamo electric machinery and a year in alternating current theory and practice, each of these courses including class and laboratory work.

The communication courses really begin with practical work in connection with the basic courses of the freshman and sophomore years. The advanced courses begin with theoretical and laboratory work on wire-conducted telegraphy. Hausmann 's "Telegraph Engineering" is used as a textbook, being supplemented by lectures and by laboratory work. The second quarter takes up the fundamentals of telephony, using as a textbook,

*Freshman in Electrical Engineering Department estimated as all freshman in Engineering College take same work.

Shepardson's "Telephone Apparatus" supplemented by "Signal Corps Manual No. 3" and by Bureau of Standards Circular No. 112, "Telephone Service" and by laboratory work. During the third quarter of junior and senior years, the work is administered exclusively by the military department, except that students may elect additional work in the electrical department.

The laboratory work in connection with wire-conducted telegraphy and telephony is designed to give the students first-hand knowledge of magnetic circuits as used in communication, experience in setting up and operating the more fundamental circuits, practice in adjusting instruments, studying limits of current or voltage values for reliable operation. On account of the smallness of the currents used, especially in telephony, difficulty has been experienced in developing quantitative experiments; but these are being worked out satisfactorily. The accompanying lists of experiments (which are being prepared for publication) indicate something of what is being done:

Exhibit I. (Experiments for Telephone)

1. Preliminary study of a telephone receiver.
2. Study of an elementary microphone.
3. Study of telephone transmitters.
4. Study of a magneto generator.
5. Study of telephone ringers.
6. Study of subscribers set.
7. Study of magneto exchange (board).
7a. Study of magneto exchange (regular).
8. Study of central energy exchange circuits.
9. Study of automatic exchange.
10. Study of phantomed circuits.
11. S tudy of Signal Corps field buzzer set.
12. Study of line disturbances and transpositions.
13. Study of polechanger.
14. Location of faults in line, Murray and Varley loops.
15. Measurement of capacity; location of break in line.
16. Measurement of self-induction.
17. Study of composite circuits.

Exhibit II. (Experiments for Telegraph)

1. Preliminary study of telegraph sounder and relay.
2. Study of inking recorder and fire alarm records and stations.
3. Study of electric clocks.
4. Study of various types of annunciators.
5. Quantitative study of vibrating contact bell or buzzer.
6. Magnetization cycle in a permanent magnet. (Traction method)
7. Magnetization curve of a magneto generator.
8. Distribution of flux from a permanent magnet.
9. Comparison of pull by electro-magnets and permanent magnets, using various pole tips.
10. Study of simplex Morse circuit.
11. Study of open circuit telegraph and repeater.
12. Study of Ghegan repeater.
13. Study of a polar relay.
14a. Study of a differential duplex circuit.
14b. Study of a polar duplex circuit.
14c. Study of a Western Union bridge duplex circuit.

All Signal Corps R.O.T.C. students take the course in Radio Communication given in the Electrical Engineering Department. This course consists of two hours per week combined lecture and quiz work and three hours per week laboratory work. The senior courses in radio communication are conducted by Professor Jansky through lectures and laboratory work. The work in laboratory includes theory of damped and undamped wave,



appa ratus and circuits, theory of electron tubes and electron tube circuits, and other material dealing with high frequency. As the students taking this course have had three years of electrical engineering, it is expected that they are adequately prepared to take a thorough course in radio engineering, including the necessary mathematical and physical treatment. Consequently, the course in radio communication is a thorough fundamental course. The laboratory work includes experiments on resonance measurements of inductance, capacity and wave lengths, measurement of high frequency. As the students taking this course have had three years of electrical engineering, it is expected that they are adequately prepared to take a thorough course in radio engineering, including the necessary mathematical and physical treatment. Consequently, the course in radio communication is a thorough fundamental course. The laboratory work includes experiments on resonance measurements of inductance, capacity and wave length, measurement of high frequency resistance, measurement of electron tube constants, and other experiments designed to familiarize the student with high frequency equipment. Extensive use is made of apparatus and sets such as are in use in the Signal Corps.

In addition to the course in Radio Communication, the Electrical Department operates an experimental radio station. The operating staff of this station consists of from four to six electrical students who have had operating experience and who possess the necessary licenses. These operators take turns in maintaining nightly schedules, during which communication is carried on with other university and experimental stations. This communication work furnishes the means of testing and developing transmitting and receiving apparatus and of studying transmitting and receiving conditions. The value of operating such an experimental radio station in connection with research work and the teaching of radio communication cannot be overestimated. It makes possible the connecting up of the students' work with actual communication conditions.

It is to be hoped that more and more Signal Corps men can take an active part in the work of the experimental station. Such work will make Signal Corps officers much better able to direct radio communication projects and to design or pass judgment upon radio apparatus, as it is only by contact with actual operating conditions that an adequate knowledge of the possibilities or limitations of radio communication can be obtained.

In addition to the two courses mentioned above, considerable research work is being done along high frequency lines. Two years ago a high efficiency undamped wave transmitter using four VT-2 tubes and radiating over 100 watts was developed and tested in our experimental station. The specifications for this set have been followed by a number of other Signal Corps R.O.T.C. units, in building their stations.

The experimental station has also tested receiving equipment for the Bureau of Standards and has made studies of the effect of atmospheric conditions on operating conditions. It is to be hoped that the day is not far distant when all R.O.T.C. units will either build up or secure sufficiently efficient transmitting and receiving equipment and adequately trained operating staffs to enable the establishment of an inter-unit network. The possibility of tying such a network into the regular Signal Corps net or of establishing future Signal Corps stations at R.O.T.C. units should be thoroughly considered.

The Signal Corps Unit is doubly handicapped at present by inadequate housing facilities. This unit, like the other two line military units, is housed in a building that was built a number of years ago to serve both as University Armory and University Gymnasium, when the number of students was about one fourth the present attendance. The congestion, especially in inclement weather when outside drill is impracticable. is more comfortable to contemplate than to experience. The Signal Corps apparatus is unavoidably stored in the basement of the Armory, where it is difficult to reach, and where experimental work is out of the question. Likewise, the Electrical Building, where much of the theoretical and laboratory work is conducted, is greatly congested by more than four times the number of students for which the building was planned.

Better housing facilities, however, are in preparation, and should ready for service in September, 1924. Bids are being invited, and the contracts will probably be let in May or June, 1923. In the new Electrical Building, which with its equipment will cost approximately $400,000, an entire floor of the laboratory wing, 63 by 153 feet, is assigned to the specific work of the Signal Corps. For the more theoretical laboratory work, there will be available a telephone and telegraph laboratory 40 by 22 feet, a radio laboratory, 40 by 22 feet, high-frequency laboratory 15 by 22 feet. Close by will be the radio station with its studio and ante-room, while several small rooms adjacent will be available for research studies. The other laboratories for the more general electrical work are within easy reach on the floors below. All the laboratories and offices are amply provided with circuits connecting with switchboards where connections may be made for any kind of electric power. A suite of three rooms is assigned to the specific work of the Signal Corps, including an office 11 by 22 feet, a squad practice room 23 by 22 feet, and an equipment room 16 by 22 feet. Adequate classrooms will be available for practice work.

Military instruction for all students of the first two years, whenever practical is conducted on the small group system. With one officer and two experienced noncommissioned officers available, the classes are usually split into three groups. With this system students receive considerable individual attention. A typical example is as follows: Sophomore class of 50 men divided into three groups, one receiving instruction in wire splicing, the second in ties and the third in pole climbing, all classes being practical, each group spending one hour on each particular subject, taking three hours to complete instruction. Another example would be a radio class of three hours, class ded into three groups as before, one the S.C.R.67 set, another, on the Cavalry pack set and another working on the SCR-79 set, a change in classes being made at the end of each hour until all three groups have spent an hour on each set. This system of dividing the class is not applied to the advanced units, as the classes are considerably smaller, the instruction in this case being about half practical and half theoretical.

Last summer the Signal Corps took some twenty two men to the summer camp at Camp Custer, Michigan. After a successful camp, practically all the Signal Corps students from here made an inspection trip on their return to Minneapolis, conducted by the officer-in-charge of this unit. The following plants were inspected: The Ford Plant at Highland Park, the Detroit Edison Conner's Creek Plant, The Detroit News Radio Station and the telephone central at Detroit, Michigan, the Steel Plant at Gary, Indiana, the Cement plant at Buffington, Indiana, The Western Electric Hawthorne factory and The Belden Wire Plants at Chicago, Illinois, and the Cutler-Hammer and Allis Chalmers plants at Milwaukee, Wisconsin. The Electrical Engineering Department gave a one hour credit to all students submitting satisfactory written reports on the trip. This trip proved to be very popular with the students and has helped to secure men for the summer camp, and has made the Advanced Course more attractive.

The writer is very enthusiastic regarding the type of man the Signal Corps Reserve is securing through the R.O.T.C. The present members of the Senior Unit at the University of Minnesota are a fine group of men and will be particularly desirable addition to the Officers' Reserve Corps. Be[illegible] these men, who complete the four years of training, are the men who take out the first two or less. These latter students have received training that will stand them in good stead in the Signal Corps in case of emergency. Too much cannot be said in favor of the training of officers in educational institutions in this manner.



SCHEDULE OF INSTRUCTION, SIGNAL CORPS R.O.T.C. UNIT.

(only instruction given by Military Dept.)

1st Year Basic (Freshmen)

| | |
|---|---|
| Organization - - - - - - - - - | 3 hrs. |
| Military Courtesy - - - - - - | 2 hrs. |
| Physical Training - - - - - - | 7 hrs. |
| Infantry Drill - - - - - - - | 33 hrs. |
| Ceremonies - - - - - - - - - | 6 hrs. |
| Marching - - - - - - - - - - | 3 hrs. |
| Military Telegraphy - - - - - | 7 hrs. |
| Military Telephony - - - - - | 6 hrs. |
| Radio Sets - - - - - - - - | 6 hrs. |
| Rifle Marksmanship - - - - - - | 9 hrs. |
| Pistol - - - - - - - - - - - | 3 hrs. |

2nd Year Basic (Sophomores)

| | |
|---|---|
| Organization - - - - - - - - | 3 hrs. |
| Organization-Signal Troops - - | 3 hrs. |
| Topography - - - - - - - - | 15 hrs. |
| Infantry Drill - - - - - - - - | 4 hrs. |
| Physical Training - - - - - - - | 2 hrs. |
| Marching - - - - - - - - | 3 hrs. |
| Military Telegraphy - - - - - | 27 hrs. |
| Military Telephony - - - - - | 15 hrs. |
| Radio Sets - - - - - - - - | 10 hrs. |

1st Year Advanced (Juniors)

| | |
|---|---|
| Field Engineering - - - - - - - - - - - | 11 hrs. |
| Tactics All Arms - - - - - - - - - - - | 6 hrs. |
| Minor Tactics - - - - - - - - - - - | 15 hrs. |
| Military History - - - - - - - - - - - | 5 hrs. |
| Military Law - - - - - - - - - - - | 5 hrs. |
| Administration - - - - - - - - - - - | 5 hrs. |
| Hippology. - - - - - - - - - - - - | 3 hrs. |
| Staff Duties - - - - - - - - - - - - | 4 hrs. |
| Message Centers - - - - - - - - - - - | 3 hrs. |
| Codes and Ciphers - - - - - - - - - - | 2 hrs. |
| Telegraph Net Construction - - - - - - | 5 hrs. |

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Extract from General Orders No. 13, War Department, dated March 31, 1923.

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VIII. Commendations for heroic conduct.- The following named enlisted men are commended for heroic conduct, but such conduct, not having occurred in action, is not within the provisions of law authorizing decorations:

Allister D. Glenn (Army serial No. 6503327), private, first class, Service Company No. 8, Signal Corps, United States Army. For gallantry and devotion to duty at Benicia Arsenal, Calif., August 12, 1922. The arsenal being threatened with destruction by fire, Private Glenn remained on duty for more than eight hours, and without regard to his personal safety rendered valuable assistance in keeping in service the telephone system and in cutting out high-tension power lines which endangered the lives of the fire fighters; this duty performed despite the constant danger of exposure to exploding shrapnel and high-explosive shell. Residence at enlistment: 3718 North Third Street, Tacoma, Wash.

John A. Hewson (Army serial No. 650[illegible]5[illegible]), private, Service Company No. 8, Signal Corps, United States Army. For gallantry while on duty at Benicia Arsenal, Calif., August 12, 1922. The arsenal in danger of destruction by fire, Private Hewson remained at his post, exposing himself to the constant danger of exploding shrapnel and high-explosive shell, and by his efficient and prompt handling of all calls during the emergency [illegible] valuable assistance in requesting help from civilian fire departments in near-by towns. Residence at enlistment: 32 Richmond Street, Elizabeth, N. J.

George A. Reeves (Army serial No. 6516339), private, Service Company No. 8, Signal Corps, United States Army. For gallantry at Benicia Arsenal, Calif., August 12, 1922. During the threatened destruction by fire of the arsenal, Private Reeves while sick in the post hospital volunteered his services to assist the post surgeon in fighting the fire which threatened the hospital and exposed himself to exploding shrapnel and high-explosive shell. Residence at enlistment: 735 Geary Street, San Francisco, Calif.

(A. G. 220.5[illegible])

By order of the Secretary of War:

JOHN J. PERSHING,
General of the Armies,
Chief of Staff.

Official:
Robert C. Davis,
The Adjutant General.

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