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SIGNAL CORPS
Technical Information Letter

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ARMY SERVICE FORCES · OFFICE OF THE CHIEF SIGNAL OFFICER

SIGNAL CORPS

TECHNICAL INFORMATION LETTER

PURPOSE THE SIGNAL CORPS Technical Information Letter is a monthly publication designed to keep Signal Corps personnel and other military personnel using Signal Corps equipment informed on Signal Corps matters. It provides means for the dissemination and interchange of information of a widely varied nature, both technical and tactical.

SOURCE THE LETTER is compiled mainly from information available in the divisions and branches of the Office of the Chief Signal Officer. Signal Corps and other communications personnel are invited to submit, through channels, material of general interest. Information on problems encountered and overcome by combat and service communications troops is desired. Such items should reach the Chief Signal Officer (SPSAY) not later than the 15th of each month for inclusion in the letter for the following month.

DISTRIBUTION DISTRIBUTION overseas is made by The Adjutant General on the following basis:

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Within the continental limits of the United States the Letter is distributed to Signal and other Ground and Service Forces units and installations by the Chief Signal Officer (SPSAY), Washington 25, D. C. Distribution to Army Air Forces units and installations in the continental United States is made by the Commanding General, Army Air Forces (AFMPB), Gravelly Point, Virginia.

Correspondence relative to distribution overseas and to all addresses, except AAF units, in the continental United States should be directed through channels to the Chief Signal Officer (SPSAY), Washington 25, D. C. Air Force units in the continental United States should write to the Commanding General, Army Air Forces (AFMPB), Gravelly Point, Virginia, on this subject.

WARNING THIS publication is issued solely to give proper and speedy dissemination to timely, useful information concerning pertinent trends and developments. Nothing herein is to be construed as necessarily coinciding with United States Army doctrine. Changes in official doctrine, as they become necessary, will be officially published as such by the War Department.

Publication approved by Bureau of the Budget, Executive Office of the President.

CONTENTS

A Victory Message from The Chief Signal Officer:

Now that our great war for freedom has come to an end it is my desire to express my thanks to the officers and men and women, both military and civilian, of the Signal Corps for the great job they have done during the nearly four years that our country has been at war. I wish that it were physically possible for me to thank each one individually, but instead I must rely on a few words in this publication to convey my admiration and appreciation for the work you have done in the trying days since December 7, 1941.

I have not forgotten that for most of you your contribution toward Victory was made in the face of a great change—a change that called for an abrupt alteration in your mode of living and tore you from your homes, your offices, your factories, and your farms to thrust you into new and unaccustomed jobs, often in strange and distant lands. Despite this, you came through with American fortitude and adaptability to aid in the conquest of enemy armies that had been preparing for their task of attempted world domination for many years.

In a letter written after VJ-day thanking the Signal Corps for its contribution to the war effort, the Honorable Robert P. Patterson, Under Secretary of War, had the following to say:

But for the great strides made in Signal Corps equipment, particularly in radar, the war would certainly not be concluded at this early date.

I have some knowledge of the difficult problems you and your staff have solved. I am acquainted, as I wish the whole country were better acquainted, with the magnitude of your achievement.

Please allow me at this time to say thank-you for your magnificent contribution to the Victory of our Nation and our Allies.

It is my belief that my thanks extend beyond me and that I can voice the gratitude of the Army and of the American people for the way you have functioned to supply equipment and "get the message through" from that infamous Sunday at Pearl Harbor to the moment that word was flashed that peace had again come to the world. Consequently, I feel that in speaking for myself I have only put into words the feeling of the millions of Americans in and out of uniform who recognize the Signal Corps as the nerve system of our great military force.

Until a few days ago, we had a singleness of purpose; that purpose was Victory. Now that we have achieved Victory, we find that our objectives are manifold, consistent with the several military tasks that lie ahead, as well as the nation's return to its normal civilian status. Resultantly, I now wish to outline for you these objectives toward which the Army—and the Signal Corps, of course—must work.

First of all, our country must have a strong and capable Regular Army to serve as a nucleus of the postwar military establishment. This Regular Army must be constructed by the selection and retention of the best of those officers and men who have found in the Army their niche in life. The Signal Corps portion of the Regular Army must be composed of men possessing both military experience and technical qualifications, and who have chosen the Army as their life's work because they find satisfaction in it.

Our second post-VJ-day requirement is an army of occupation to stand watch over our fallen enemies and see that they never again can arise to deluge the world with blood and tears. Military necessity will govern the composition of this occupation force. In other words, if a man possesses a skill that is needed by the occupation army, then he must serve with the occupying force until someone is found to take his place. However, in general, the army of occupation will be made up of those men who desire extended active duty or whose adjusted service rating score indicates that others are more deserving of returning home.

Continued inside back cover

TANDEM RELAY FACTORS

Five Groups of AN/TRC Sets With Different Characteristics To Be Considered

THE PURPOSE of this article is to present available information on the factors that limit the number of radio relay stations that may be operated in tandem when using Radio Sets AN/TRC–1 ( ), Radio Terminal Sets AN/TRC–3( ), and Radio Relay Sets AN/TRC–4( ). These factors are: signal to noise ratio, both within and external to the radio set; audio frequency response characteristic; harmonic distortion as evidenced in noise and/or crosstalk; nonlinearity of input and output audio levels; maintenance of correct audio levels at all transmitter inputs; and cumulative practical operating limitations. The radio sets to be discussed may be consolidated into five groups having definite characteristic differences.

Group I contains only Radio Set AN/TRC–1, Radio Terminal Set AN/TRC–3, and Radio Relay Set AN/TRC–4. Approximately 200 each, radio transmitters and radio receivers, were manufactured.

Group II contains only Radio Set AN/TRC–1A, Radio Terminal Set AN/TRC–3A, and Radio Relay Set AN/TRC–4A. Approximately 2,740 each, radio transmitters and radio receivers, were manufactured.

Group III contains Radio Sets AN/TRC–1B and AN/TRC–1C, Radio Terminal Sets AN/TRC–3B and AN/TRC–3C, and Radio Relay Sets AN/TRC–4B and AN/TRC–4C. Approximately 3,500 each, radio transmitters and radio receivers, were manufactured.

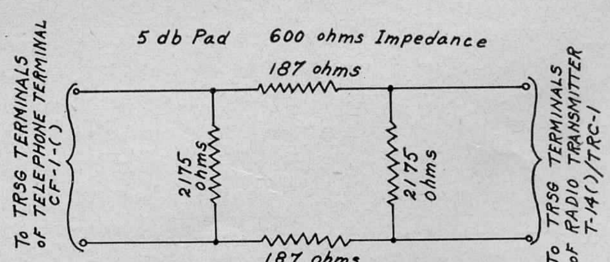
Group IV contains Radio Sets AN/TRC–1D and AN/TRC–1E, Radio Terminal Sets AN/TRC–3D and AN/TRC–3E and Radio Relay Sets AN/TRC–4D and AN/TRC–4E. Approximately 2,500 each, radio transmitters and radio receivers, were manufactured.

Group V contains Radio Sets AN/TRC–1F and AN/TRC–1G, Radio Terminal Sets AN/TRC–3F and AN/TRC–3G, and Radio Relay Sets AN/TRC–4F and AN/TRC–4G, now in production.

Group I sets use a five-conductor interconnecting cable, Cord CX–8/TRC–1, which without extensive modification prohibits their use at a relay station with any of the later models, all of which use Cord CX–104/TRC–1, a seven-conductor cable. Radio Transmitter T–14/TRC–1, a component of Group I sets, uses type 816 mercury vapor rectifier tubes. These have been replaced in all of the later models by 5R4GY high vacuum rectifier tubes. The total harmonic distortion of this model was extremely high, being for single frequency tones 25 to 30 percent at 250 cycles, 8 to 10 percent at 1000 cycles, then dropping rapidly to 2½ to 3 percent at 3000 cps.

The harmonic distortion for the sets in Groups II, III, and IV is indicated by the curves marked *before modification* on figure 1. The curves marked *after modification* on that figure represent the harmonic distortion of these same groups of equipment after being modified by the insertion of a low-pass filter (which cuts off in the vicinity of 1100 kc.) between the oscillator amplifier V2 and the phase modulator V3. This filter blocks out harmonics of the crystal frequency, which harmonics are the principal cause of the high percentage of distortion at the lower audio frequencies. (Publication of a modification work order covering addition of the filter is under consideration.) *The "after modification" curves in figure 1 are indicative of the harmonic distortion which will be present in group V sets.*

With a radio system that is lined up at the normal level as described in Technical Bulletin TB Sig 78, this reduction in level can be accomplished by inserting a 5-db pad in the line connecting the TRSG binding posts of the Telephone Terminal CF–1–( ) to the TRSG binding posts of the radio transmitter. Then, with −4-dbm test tones transmitted simultaneously on each of the four tele-



phone channels by means of the test oscillator in the CF–1–( ), adjust the audio gain control of the terminal radio receiver until the output meter on that receiver indicates −5 dbm. A 5-db pad for this use can be constructed with resistors connected as shown in the sketch. These resistors should be checked for close tolerance with an ohmmeter.

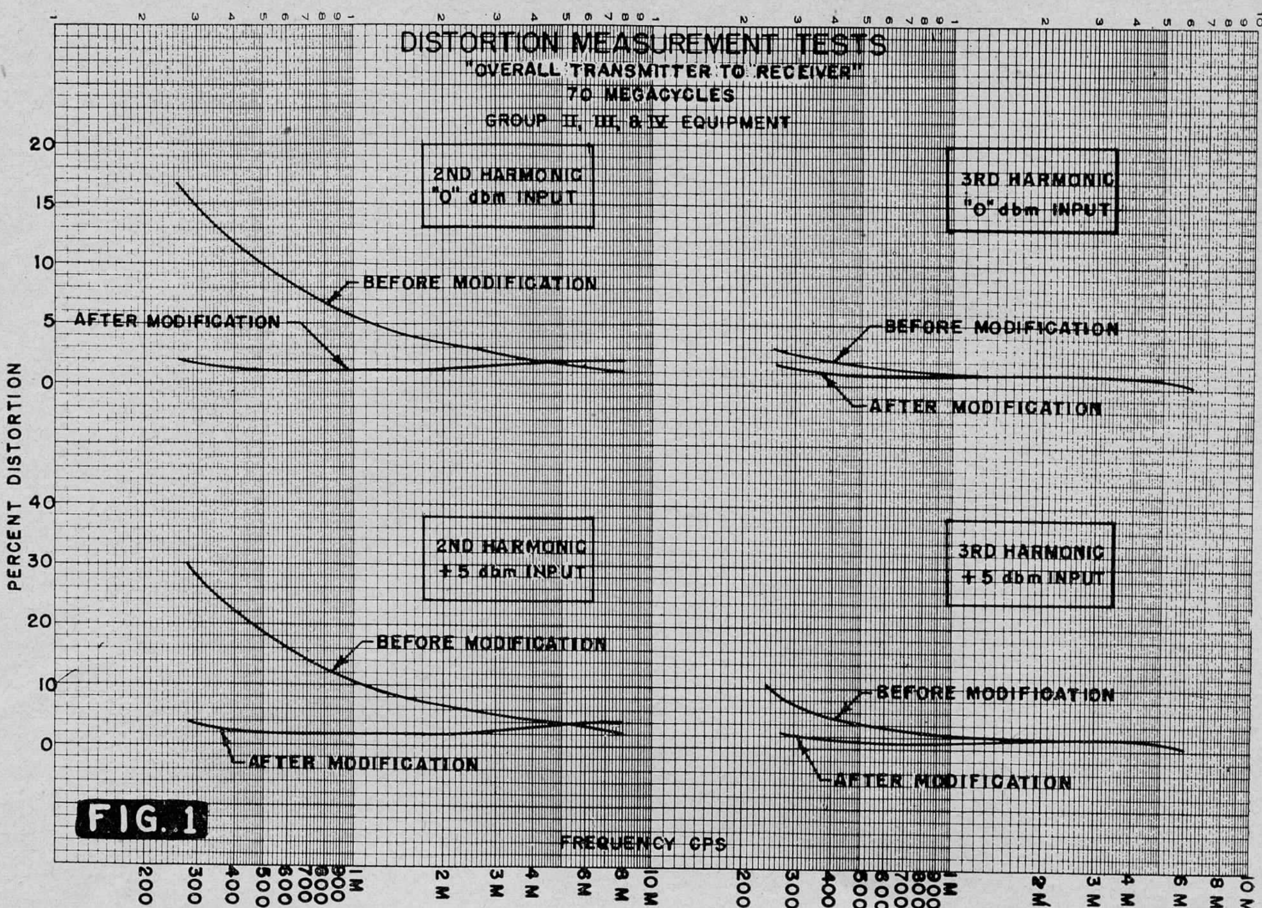


FIG. 1

This method of crosstalk reduction must be used *cautiously* since improvement in crosstalk level is obtained at the expense of the signal-to-noise ratio of that portion of the circuit over which the signal level is reduced. As this reduction in signal level results in reduced modulation of the r-f carrier, the effect of *man-made* static and similar interference will be aggravated. It is believed that this expedient may be employed to advantage in long systems where sufficient margin is available in the signal-to-noise ratios prevailing in the individual radio links.

Very weak r-f signals cause a large increase in distortion, and the receiver noise becomes very apparent at the r-f level at which distortion becomes excessive. Also, the receiver limiter is not saturated when the r-f input level is low and changes in the r-f level produce corresponding changes in the audio level. It is, therefore, very important that the radio stations be so located that they operate with an r-f input level of sufficient magnitude to produce flat limiting.

Tests indicate that with an r-f signal of about 25 db above 1 microvolt per meter, and a dipole antenna, the set noise alone measured with line weighting at the —6-db-level point would be about 30 dbRN (—60 dbm) in one relay section. This will be increased by external noise and interchannel crosstalk. It can be seen from the column in Table II, giving values of maximum tolerable noise plus crosstalk at the —6-db-level point for various system combinations, that a value of 30 dbRN (—60 dbm) in one relay section for set noise alone would exceed the allowable total noise value for five, 6-db systems in tandem, each containing three radio relay sets (four relay sections) to build up a 30-db over-all circuit.

With the addition of external noise and crosstalk, the allowable total noise value for one radio relay system containing three radio relay sets (four relay sections) with 12-db extensions at each terminal would probably be exceeded. Likewise, with the addition of external noise and crosstalk, the allowable total noise value for one radio relay system containing three radio relay sets (four relay sections) with 6-db extensions at each terminal and for five systems, each containing three radio relay sets (four relay sections) connected in tandem on a 4-wire basis to build up a 6-db over-all circuit would be closely approached.

The transmitter input impedance of sets in Groups I and II varies from 900 to 1300 ohms over the frequency range of the broadband audio channel. This fault has been corrected in the Group III sets by connecting a 650-ohm ½-watt resistor

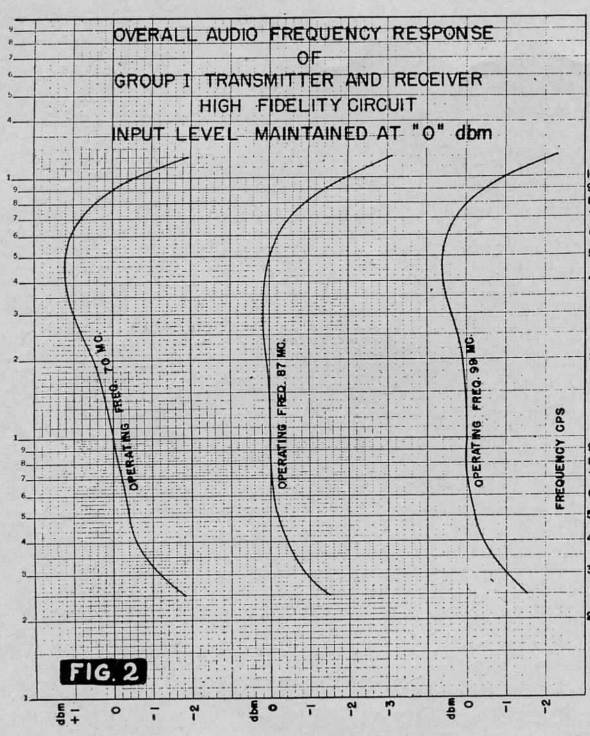


FIG. 2

across each half of the primary winding of the input transformer. As this expedient results in reduced gain, no modification work order covering this change is contemplated for Groups I and II equipments.

The broadband input transformers used in Group IV and group V equipments are a hermetically sealed type that present the proper impedance at the input terminals with little variation with frequency, as evidenced by the following table:

TABLE I.—*Input impedence*

Frequency, CPS	Cable compensator at 0 db	Cable compensator at 12 db
	Ohms	*Ohms*
300	630	550
1000	640	635
2000	660	680
4000	675	670
8000	620	570
12000	520	460

A-F RESPONSES VARY

The audio frequency response characteristics have changed with each group of models. The characteristics of Group I and IV models are shown on figures 2 and 3 respectively. These curves show that the audio frequency response varies with the r-f channel frequency. The degree of this variance has been greatly reduced in the Group V models and a modification has been devised that will give like improvement in the Group II, III, and IV models. This necessitates a modification of both the radio transmitters and receivers of those models, the details of which are shown on figures 4 and 5. The response characteristic of a seven relay (eight relay sections) system using modified Group II and III equipment is shown on figure 6. It is estimated that an equal system using Group V equipment will have a similar characteristic.

Since equalization of the a-f response of a system utilizing the subject radio equipment is accomplished only in the receiving portion of the Telephone Terminal CF–1–( ), in some cases it may be desirable to break up a long system into shorter ones by the use of additional CF–1–( ) terminals. In this connection, it is believed that the techniques described in the article entitled *Carrier Interconnection* published in SCTIL No. 34 may be advantageously employed. If it is not necessary to demodulate channels 2, 3, and 4 at the points in a system where additional equalization is required, the same improvement in the a-f response of the system as gained by use of additional Telephone Terminals CF–1–( ) can be gained by the insertion of a Repeater CF–3–A in the 4-wire connec-

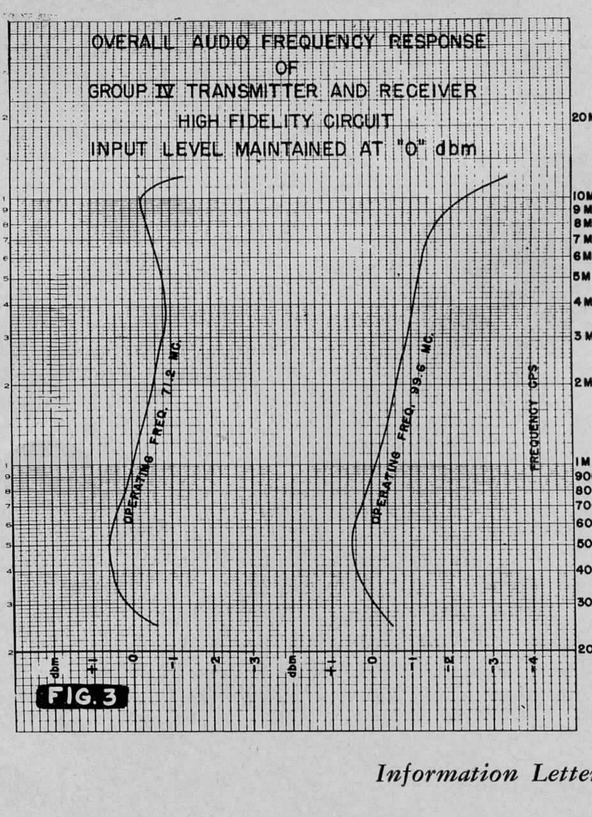


FIG. 3

tions between the radio transmitters and radio receivers of Radio Relay Sets AN/TRC–4( ) located at those points. The equalizers must be adjusted at these relay points in turn in the direction of transmission before the adjustment is made at the terminals.

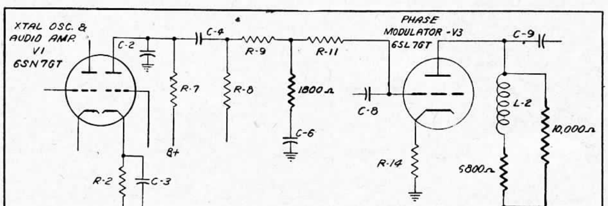
The signal-to-noise ratio, determined with an r-f signal at the radio receiver antenna terminals of 5 microvolts modulated 50 percent, is about 25 to 30 db for the Group I sets, but has been reduced in all of the later models to about 22 to 26 db. This reduction is due to a change in the squelch circuit from a differential type in the Group I sets to a type incorporating a sensitivity adjustment in the later models. As a result of this circuit change the range of squelch sensitivity control was increased from a range of 2 to 10 microvolts in the Group I sets to a range of 2 to 1000 microvolts in the later models, thus allowing the squelch relay to be made insensitive to much greater received signal strengths.

Based on the following assumptions, the maximum permissible noise per relay section for various numbers of relay sections in tandem has been calculated for various circuit conditions and tabulated in Table II. (Reference: TM 11–486, par. 1211d.)

Assumptions:

1. *Average talker.*—It is assumed that the volume from the average army talker will be —5VU. Although it is estimated that the talker volume will vary ±8VU from the average, all calculations of signal noise ratio are based on a —5VU talker.

2. For point-to-point voice service on a single channel system using Radio Sets AN/TRC–1( ) or Radio Terminal Sets AN/TRC–3( ) and Radio Relay Sets AN/TRC–4( ), where all the noise will be static or set noise, it is assumed that a 6-db signal-to-noise ratio will be the minimum tolerable.

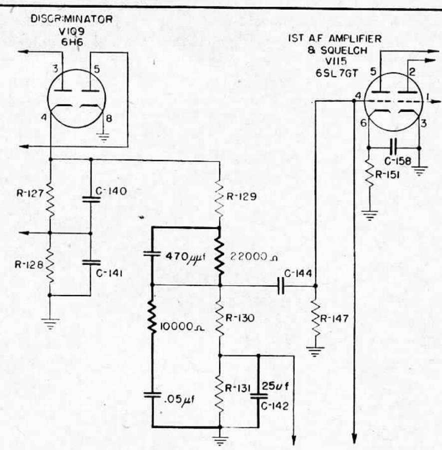


COMPONENTS ADDED TO CIRCUIT
RESISTORS
1800Ω 1 w.
6800Ω ½ w.
10000Ω ½ w.

NOTE:
HEAVY LINES INDICATE CHANGES FROM ORIGINAL CIRCUIT.

FIG. 4

RADIO TRANSMITTER T-14( )/TRC-1
PART OF RADIO SET AN/TRC-1
PROPOSED MODIFICATION FOR CORRECTION OF FREQUENCY RESPONSE



NOTE:
HEAVY LINES INDICATE CHANGES FROM ORIGINAL CIRCUIT.

COMPONENTS CHANGED IN CIRCUIT AND VALUE
CAPACITOR
C-142 CHANGED TO 25μf ±20% 50 vdcw

COMPONENTS ADDED TO CIRCUIT
CAPACITORS
.05μf ±10% 400 vdcw
470μμf ±10% 500 vdcw
RESISTORS
10000Ω ±10% ½ w
22000Ω ±10% ½ w

FIG. 5

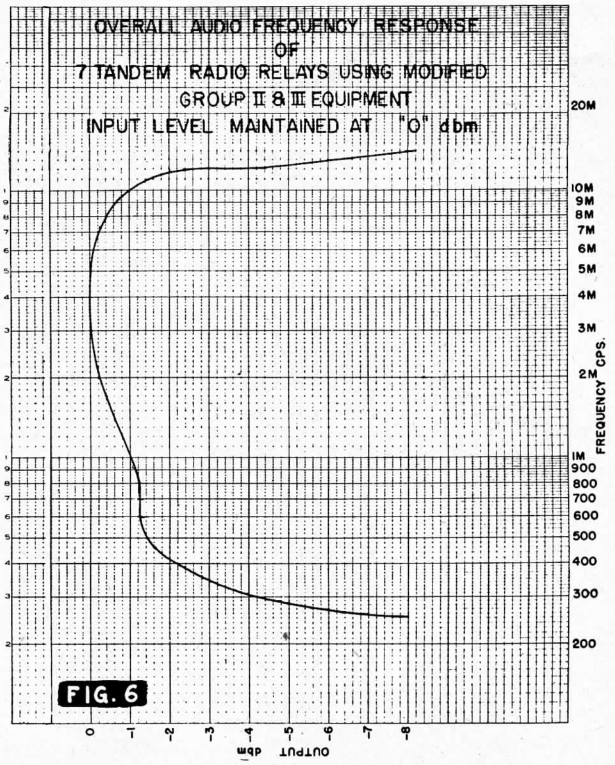
RADIO RECEIVER R-19( )/TRC-1
PART OF RADIO SET AN/TRC-1
PROPOSED MODIFICATION FOR CORRECTION OF FREQUENCY RESPONSE

3. On circuits in a 4-channel system where interchannel crosstalk is controlling, and which may be used for teletype transmission, a 3-db signal-to-noise ratio is considered the minimum tolerable.

4. In order to make the maximum possible allowance for the radio relay system when connected into terminal loops, it is assumed that two-thirds of all the noise at the telephone receiver can be permitted to arise in the radio relay system.

The input and output broadband terminals are polarized and the wiring connections in all audio circuits are identical on the Group V models. This allows accurate transposing at the odd numbered relay stations to reduce the effect of harmonic distortion. The earlier models were not so constructed, therefore, with those models reduction of harmonic distortion by this method is difficult to achieve with any degree of certainty.

When using the models of Groups I, II, and III it is very difficult to maintain the proper input level to the transmitters at relay points because of the inaccuracy of the receiver output meter. This meter varies ±2 db at 0 dbm on the Group I and II models, but was improved slightly in the Group III models by the substitution of an improved rectifier, resulting in an accuracy of ±1.5 db at 0 dbm. A calibration chart may be made for the meters on Group I, II, and III models by connecting a stand-



ard of known accuracy to the Receiver Output terminals and recording the readings of the radio receiver meter for various output levels as read on the standard. In the field, the output meter supplied with Test Set I–56 may be used as a standard with a reasonable degree of accuracy, provided a 500-ohm resistor is used as a load across which to measure. This resistor should be carefully selected for close tolerance with an ohmmeter. The frequency of the test tone at which these readings are made should be 4900 cps if made on a broadband basis or 1000 cps on CF–1–( ) channel 2. The reading for 0 dbm on the output meter is 0.707 volt. In the Group IV and V models an adjustment is provided to allow for recalibration with a standard of known accuracy. The meter can be adjusted to within ±0.25 db at 0 dbm by this means. Before the sets are shipped from the factory this adjustment is made and should hold for 3 to 4 months. The maximum error found in laboratory tests of Group IV and V models was ±1 db at 0 dbm.

TECHNICAL KINKS INCREASE

The audio level linearity, i. e. the linearity of the audio input level to a radio transmitter and the audio output level of its associated radio receiver, is good in all models and is not considered to be an important factor limiting the number of radio relay sets that may be operated in tandem for any model.

In any long system operated on a single channel basis, practical operating difficulties such as normal equipment failures, failures due to improper maintenance, and failures due to improper operating procedure, will eventually limit the number of radio relay sets that may be operated in tandem. These practical difficulties, however, will be overshadowed by technical limitations in multichannel systems and should not be factors limiting the number of radio relay sets operable in tandem.

Laboratory tests indicate that with Group I and II models, a maximum of *four* nonmarginal relay sections may be operated in tandem on a multichannel basis. Such a system will provide four voice channels, any of which will be adequate for the transmission of four v-f telegraph channels.

Actual field tests of these early models indicate that satisfactory operation can be obtained on all 4 voice channels with a maximum of 2 radio relay sets (3 relay sections) in tandem. It is estimated that channels 1, 2, and 3 only can be used satisfactorily up to 6 radio relay sets (7 relay sections) in tandem. It is also estimated that 8 channels of v-f teletype can be transmitted satisfactorily over 9 radio relay sets (10 relay sections) in tandem with Group I and II equipments operated on a single channel basis.

Further tests, using Group III and IV models under laboratory conditions, indicate that a maximum of *4* radio relay sets (5 relay sections) may be operated in tandem on a multichannel basis to obtain 4 voice frequency channels, any of which will provide satisfactory transmission of 4 v-f teletype channels. The additional relay obtained by using these models is due largely to the improved input impedance characteristic of the radio transmitters. Under similar laboratory conditions it was found that the number of radio relay sets could be increased to a maximum of 15 (16 relay sections) when using Group V equipment. This increase is due to the improved frequency response and distortion characteristics of these latest models.

(*Continued on page 38*)

GUERRILLA COAST WATCHER

American Operated Australian Radios During Years of Resistance Duty

DURING THE Japanese occupation of the Philippines, a steady stream of information concerning enemy troop dispositions, shipping, and activities flowed back to Allied GHQ in Australia. The information was carried mainly by radio, furnished to American fighters who fled to the hills after the fall of Bataan and Corregidor. The information that follows is based on a report of one of these American soldiers who was in charge of a coast watching station that covered the Surigao Straits, which lie between Leyte and Mindanao Islands.

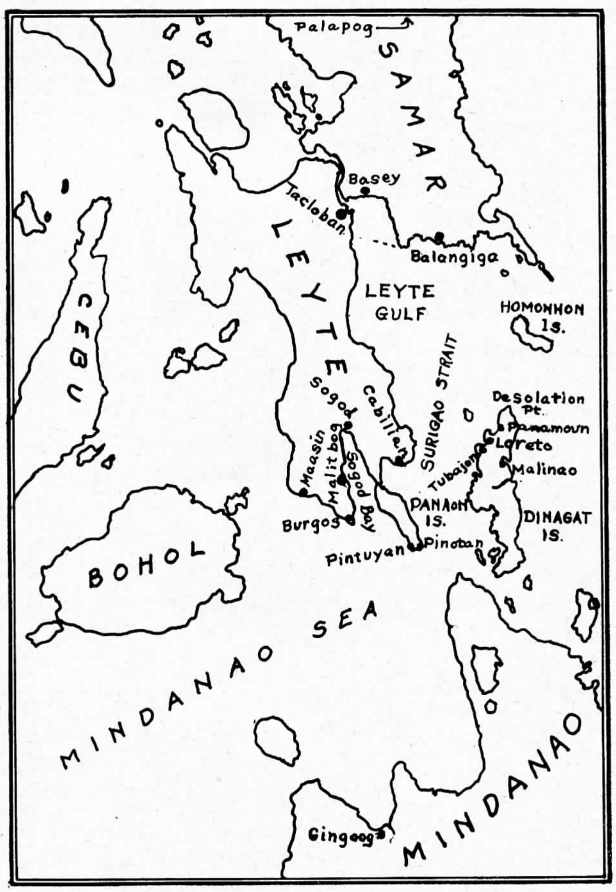
The American Guerrilla was an air photographer with the 19th Bombardment Squadron. After General Wainwright's surrender in May 1942, he and other American soldiers took to the hills of Mindanao, where the squadron was based at the time. After several months of hiding out, he contacted other groups who organized themselves into a guerrilla band. This nucleus became the 110th Military District Philippine Defense Forces with authority stemming from General MacArthur's headquarters in Australia. Their work was to keep the flame of resistance burning, to report on Jap movements and dispositions, and in general to maintain a skeleton army to prepare the way for the return of the American forces to the Philippines.

Some 6 months after the Japanese conquest of the Philippines, American submarines began bringing in supplies and equipment. Among these items were radio sets to be used for communication among the guerrilla bands and for the transmission of intelligence to GMQ. Radios for coast-watching activities were also supplied. These sets, of Australian manufacture, were low powered, voice and c-w transmitters and receivers, with ranges from 80 to 500 miles. They had been in use throughout the Australian territories for marine purposes before the war.

One of the coast-watching stations was delivered to this soldier, and he was ordered to set up on the island of Panaon, near the town of Pintuyan. Panaon is an island to the south of Leyte, lying at the southern opening of Surigao Straits. This station remained on the air from 10 April 1943 to 25 August 1943. A second station was established at Balingiga on the southern end of the Island of Samar. This station was in operation from September 1943 until mid-November of that year. The set was a rehabilitated Postal Telegraph set left on the island.

FORCED TO MOVE FREQUENTLY

During the time the American soldier, commissioned a second lieutenant and subsequently promoted to captain, was at Samar, his first set was moved to Palapag on the northwestern coast of Samar by other members of the American forces. When he reported to the Leyte commander he was given a new, improved AWA (Amalgamated Wireless of Australia Ltd.) set and a portable set and instructed to reinstall his station on Panaon. Upon returning to the island, he found that the Japs had occupied his old site at Pintuyan. Gathering 20 Filipinos, he manpacked the equip-



MAIN LOCALE OF COAST WATCHING GUERRILLAS.

GUERRILLA ODYSSEY

THE SOLDIER from Sherburne, Vt., who enlisted in the 19th Bombardment Squadron of the Air Forces in New York in December 1940 and became a coast watcher in the Philippines, spread his experiences over a number of other achievemements during the 5 years spent overseas.

After an interim spent in Hickam Field, Hawaii, as an aerial photographer, he landed in the Philippines in September 1941. Japs started bombing Clark Field, Manila, where he was stationed, on 7 December. He and others were evacuated by freight car, and by Christmas Day left Bataan for Mindanao Island to the south. They landed at Bugo on New Year's Day and spent the first part of the year near Del Monte, in the pineapple region. While he was a member of a machine-gun crew at Malabang, 10,000 Japs from both the North and South swarmed into the area, and the crew fled to the hills south of Gingoog. Six hid in a shack for 6 months during the time Corregidor and Bataan fell. Through the jungle grapevine on 26 November a group, who called themselves the *Thirteen Original Members*, organized the nucleus of the 110th Military Division. All were commissioned second lieutenants with their promotions approved by General MacArthur.

In March 1943 they sailed across Iligan Bay to visit guerrilla headquarters at Misamis, on Mindanao, and became officially recognized as the 110th Military District Philippines Defense Forces. This date also marked the beginning of the soldier's radio operations when he was asked to deliver a set to maintain watch over Surigao Straits. On 7 April the new operator sailed from Gingoog to Pinotan, where he went on the air for the first time.

On 25 August he sailed northward to Samar Island and established a station at Balangiga. In the meantime he had married the niece of the Leyte guerrilla commander at Basay. In November he returned to Leyte, with stops at Cabalian and Sogod. He received orders at Maltibog to await the arrival of a master set by submarine. His first child was born 7 December; the radio equipment arrived the next day, and on 9 December, while his baby was being christened at the church, the Japs arrived. He left by sailboat with his equipment for the Sta Francisco on Panaon Island, his wife fled in another direction with their baby, and a fellow operator functioning at the moment as godfather fled in still another. In 3 months they were reunited.

He left his station at Pinotan at midnight 15 January 1944 and sailed for Dinagat Island. Arriving at Loreto, he moved over to Panamoun to set up a station. In June the Japs set up a garrison at Loreto and *decided to take over the exact spot occupied by my station.* The coast watcher sailed around Desolation Point to Malinao. In August he moved up the river for a better view from Tubajon and again set up a station. By September he was surrounded by military activity. He notified headquarters the Japs were occupying Suluan and Homonhon Islands and he was warned to evacuate the people between Loreto and Desolation Point. On 17 October the Rangers found him. Ten days after A-Day he was ordered to turn in his equipment at Tacloban. After signing back in the Army at General MacArthur's headquarters, he sailed for the United States via Hollandia. At 158° latitude and 2° longitude his second child was born. On the bridge of the ship she was christened by the ship's captain and received into *Neptune's realm*, adding one more passenger to the list of 3,000.

The Signal Corps captain, his wife and children, arrived in New York on 2 January 1945.

ment across the island to a new site on the eastern side at Pinotan. Contact across the island during the movement was maintained with the portable set. The Japs, however, started tracking him down, so it was necessary to move again. This time, the equipment was moved across the Straits to Dinagat Island, and after a period set up at Panamoun. This was late in January 1944. In March 1944, the Japanese landed troops on that island and, the soldier stated, *decided to put up a station where mine was. I was in no position to argue.* Again the equipment was packed and the crew sailed around the northern tip of Dinigat to Malinao, where the station was again put back on the air. Transmission and reception were not too successful, and in August 1944, the station was moved to Tubajon, where the view of the Straits was superior to that at the old location. In October Allied air activity foretold the return of the Americans. On 17 October, American rangers picked him up—3 days before A-day.

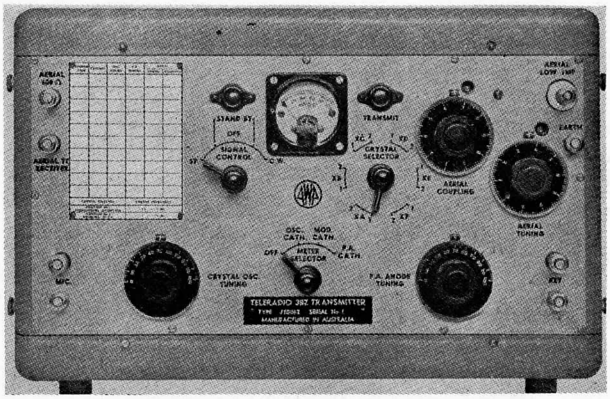
During this period, this one station reported on 150 to 200 Jap ships passing through Surigao Straits.

The crew of this coast watching station consisted of 2 operators and 4 soldiers—all Filipinos, plus the American in charge. When American forces landed on Leyte 20 October 1944, there were 50 stations in the guerrilla net. NCS was a more powerful station, hidden in the mountains of eastern Mindanao, which relayed all messages back to GHQ. Each station worked on a schedule, using a day and night frequency. The station, the story of which is recounted above, transmitted at 1000 hours and at 1600 hours, on either 4.1 mc or 6.9 mc, depending on local conditions. Special flashes were sent at any time, since the NCS maintained a 24-hour listening watch. According to reports contact was successful most of the time.

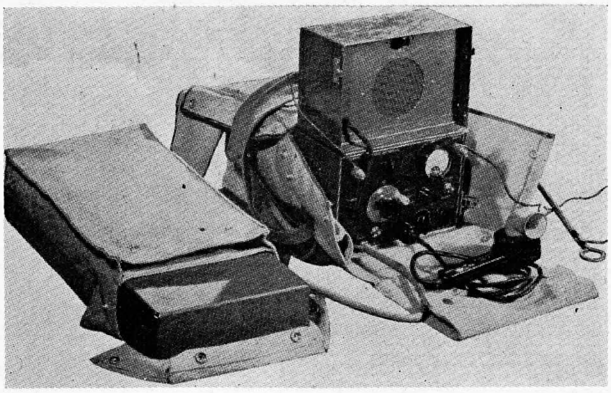
Reception was weak daily between 1400 and 1530 hours. There was QRM at night.

QUICK-DISMANTLING ANTENNA

A flat-top antenna was used, strung as high as possible in trees. The wire was lead copper. A 50-foot lead, of nickel, was also used. After the antenna had been weathered, it did not show up as badly as might be thought. A string attachment with a slipknot was improvised. When the installation had to be dismantled in a hurry, a yank



FRONT PANEL, AWA TELERADIO 3BZ TRANSMITTER.



COMPLETE EQUIPMENT, RAAF TRANSMITTER-RECEIVER ATR4A.

of the string brought down the entire antenna array.

The radio set used was an AWA Teleradio 3BZ. It consisted of a 10-watt transmitter and accompanying receiver with a range up to 500 miles depending on frequency, time of day and antenna. The transmitter was crystal controlled and covered the frequency band from 2.5 to 10 mc. Power came from a 12-volt storage battery, high voltage being provided by a vibrator power supply. The receiver was a 5-tube superheterodyne operating from a 6- or 12-volt battery. It covered 5 bands from 200 kc. to 30 mcs. Channel B (11.1 to 3.5 mc.) was mainly used in reception. Channel D (545 kc. to 1650 kc.) was used for long-wave listening. London, New York, Shanghai, Hong Kong, Singapore, India, and Australia were picked up with fair consistency and results on this channel. Antenna used was a horizontal, half-wave doublet. Battery charger was a gas-driven generator.

The transmitter weighed 44 pounds; the receiver, 38 pounds, and the speaker, 24 pounds or 7 pounds (two being furnished).

The ATR4A, also an AWA set, was a combination transmitter-receiver carried in a haversack. Transmission was voice or c-w crystal controlled in the 3.0 to 7.0 mc. band. Two crystals were furnished with each set. Receiver was a superheterodyne, functioning in the same frequency band. Aerial was a single 50-foot wire; or a half-wave single wire. Transceiver weighed 19½ pounds; dry battery (3-volt, 180-volt, −7.5-volt in one block) 19¼ pounds, and accessories, 3½ pounds.

LITTLE TROUBLE FROM RADIOS

Generally, the radio sets stood up well during the period in which they were operated. Troubles were met by slight improvisations and the spare parts furnished through the submarine transport system. However, generators furnished a continuing source of difficulty. Two 6-volt storage batteries were used with the 3BZ. Drain from the transmitter equalled eight times that of the receiver. The batteries were charged twice a week. The charger was an Amplion set (6-volt, 120 watts) that ran so quietly it could not be heard more than 200 yards away.

Fuel for the generator was everything from coconut oil to high-octane gasoline. Alcohol was also used. Coconut oil was distilled from coconut mash and functioned well. The high-octane gasoline was Japanese, washed ashore when a Jap convoy was destroyed by either American submarines or mines while sneaking through Surigao Straits one night. It was not too good.

Most ironic aspect of repairing the generator was the instruction book. *If repairs cannot be made*, it read, *call factory representative.*

The lack of test equipment was a major problem, as was also the tools with which the equipment was furnished. Hammers, screwdrivers, even soldering irons were much too large for the fine work necessary in repairing the radio equipment.

PIGEONS SERVE WATER SUPPLIERS

THE SERVICES of pigeon messengers in water supply operations are described in a report of the 405th Engineer Water Supply Battalion, which used the birds in Italy during the past 2 winters.

The idea, conceived by the commander of a water supply company, was adopted with the cooperation of the 209th Signal Pigeon Company. Its particular value is to serve distant water points from which it would be necessary to convey messages by truck or messenger over mountainous or impassable roads. Besides accomplishing the expeditious handling of operations, use of trucks and tires and the time of personnel was saved.

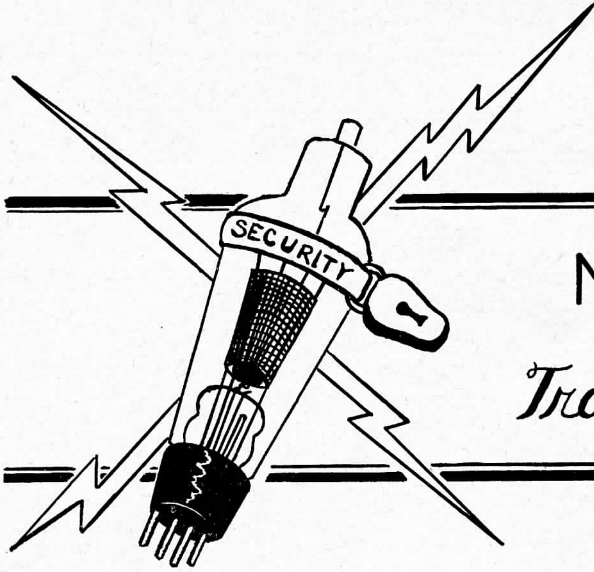
The pigeon company supplied each distant water point with four pigeons, two of which were released every morning, one with the original copy of the message and the other with the carbon copy, according to SOP for the pigeon company. Usually both birds arrived at headquarters. Pigeons were sent out by trucks hauling water to some out-of-the-way place; if the trucks broke down on the way the birds flew back to headquarters bearing requests for aid.

The pigeon messenger system was used for administrative and routine operational as well as emergency situations. Daily reports were delivered to company headquarters within an hour; weekly reports to battalion headquarters arrived the morning after the report was sent. Requests for supplies and equipment were expedited.

Use of the birds was particularly practical during the past year in Italy because of the static military situation. During the winter mud, congested highways, and transportation difficulties created a need for some courier service besides the open road. It is in a static situation that the pigeons function most successfully, according to the report which states: *In a fast moving situation, such as the swift move up the boot from the Garigliano break-through, the use of pigeons was not practical. To operate successfully the pigeon must have sufficient time to become accustomed to his new surroundings. If the pigeon is not familiar with his new location, he will invariably fly back to the location of his last loft.*

Early in their use it was necessary to train personnel regarding the proper time and conditions suitable for the best operation of the carrier service. Personnel doubted their ability to do the job and did not always understand the manner in which the birds performed their flights. The report describes such an incident:

> No member of ———— Company will ever forget the time the excited driver of a wrecked tank truck decided to make use of his pigeon. Only that morning his lieutenant had religiously instructed him that *in case of trouble, write the message, affix it to the pigeon's leg, and immediately send the pigeon back to company headquarters.* The driver followed these instructions to the letter—he wrote the message carefully, very carefully attached it to the leg of the pigeon. A passing vehicle was stopped, and the protesting pigeon, still in his cage, was loaded onto the truck and the driver was instructed to deliver it without fail to company headquarters—the pigeon was bearing vital information. It was indeed a bewildered pigeon which was delivered, cage and all, to company headquarters some hours later.



Notes on Radio *Transmission Security*

DURING THE last 4 years, military propaganda has been directed against heedless talk. Terse, colorful posters have continually reminded civilian and military personnel that *The Enemy is Listening.* The military significance of this catch phrase must not be discounted or communication security standards lowered because two enemies have been defeated and only one remains. It is particularly important to safeguard radio communications against interception by alert Japanese operators. Cryptography is one protection, but even when messages are cryptographed, maintenance of transmission security and use of prescribed procedure are necessary to defeat the cunning of efficient enemy traffic analysts.

Failure to maintain radio transmission security provides a wealth of information to the enemy. Intelligence files in every combat theater contain instances such as this:

> Early in the day a regimental commander ordered one battalion to relieve another at 2300 hours in the Salerno area. Unfortunately, the battalian being relieved spent most of the afternoon discussing the details of the move on the battalion command net.
>
> Just before 2300 hours, at the critical moment when the battalion holding the front line was due to move off and the incoming battalion was marching up from the rear to take over the position, the Germans launched a heavy attack with two assault companies brought up especially for the purpose. Since neither battalion was prepared to meet the attack, the Germans won initial successes, and it took 3 days of heavy fighting to restore the situation.
>
> Prisoners of war afterwards said that the attack was made as a result of interception of our radio traffic.

The extensive use of intercept stations and direction finders enables the enemy to record every transmission that is made and often to determine the place of origin. *It should be assumed that every time a transmitter is placed in operation, enemy interception takes place.* Recognition of this fact alone should make radio operators transmission security conscious.

SPEED VERSUS SECURITY

Speed and security do not always conflict, but it is sometimes necessary to sacrifice one in order to gain the other. The decision as to which shall yield in any instance is the responsibility of the unit commander. This does not mean that regulations and directives are to be disregarded; it does mean that commanders and signal communication personnel will be guided by the instructions set forth in each and will apply them with full appreciation of existing circumstances.

So much consideration can be given to security that speed is seriously impaired. On the other hand, in the interest of speed during tactical operations, security can be completely ignored. The disastrous results of either choice are obvious. The choice of a proper medium requires sound judgment and common sense. If the rules and the situation are known, each case can be evaluated correctly.

Security must *never* be sacrificed for speed without sound reasons. This is an example of what happened when the need for security did not receive the consideration warranted and messages were transmitted in the clear:

During the battle of Germany, Nazi intercept operators were particularly on the alert for Allied reports revealing that certain areas inside German lines were not mined. Following interception of this intelligence, those areas were mined immediately, and into these traps walked United States infantry men.

Clear-text transmission becomes a bad habit from which the enemy, besides deriving continuous information, may learn of an immediate opportunity to inflict severe punishment on our troops.

In the latter part of 1944 a United States infantry division within Germany became increasingly careless about its radio procedure. Enemy interception of transmissions containing operator *chat*, characteristic sending, and plain language had revealed the identity of all regiments within the division. Early in December 1944, the division launched a major attack. The enemy was listening as usual, and messages sent by the American division revealed the time of attack and other pertinent information. These transmissions were intercepted in time for the enemy to take effective countermeasures and arrange favorable artillery emplacements. The American attack was beaten back with heavy losses.

SECURITY VIOLATIONS

A tabulation of security violations found in c-w transmissions by analysis of monitoring logs for May 1945 showed that the most common violations were those listed below:

Use of plain language in place of applicable prosigns and/or operating signals.

Characteristic sending.

Chatting by operators; or use of improper language.

Use of personal names or nicknames.

Sending operator's sign over the air.

Off-frequency operation.

Divulging classified information.

Identification of individual belonging to an organization.

Identification of unit locations.

Compromise of call signs.

The violation, *use of plain language in place of applicable prosigns and/or operating signals*, has long been generally prevalent. In order that certain characteristics of this violation may be more thoroughly understood, the following comments are made as a result of intensive study.

Statistical research shows that a definite relationship exists between the occurrence of the violation cited above and operator *chatting*. The frequency curve of this discrepancy is closely paralleled by a similar curve, at a lower level, based on the occurrence of the violation, *chatting*. The apparent explanation of this is that the *use of plain language in place of applicable prosigns and/or operating signals* invariably lowers the guard of the operator, and unless an immediate curb is placed upon this tendency, it inevitably develops into *chatting*. The ratio between these 2 violations is usually 10 occurrences of *plain language* to 1 of *chatting;* the latter breach of security is, without exception, the greatest single potential danger to radio transmission security.

There is no substitute for strict adherence to security regulations. An operator well versed in prescribed procedure is not always a good operator, for he can endanger military operations if he has not learned the absolute necessity of observing security measures when transmitting. This recent instance of a security violation shows how quickly enemy intelligence reacts to security slips made by an operator:

In the latter phase of the Allied offensive in Europe, a reconnaissance plane spotted a concentration of enemy vehicles between two German cities. The pilot instructed his operator to transmit this intelligence to his base requesting immediate air support. Unthinkingly, the operator sent this request in the clear. Enemy interception quickly assimilated this information and acted to correct an awkward situation by rerouting the vehicles to a new location. The American attack, directed at the previous location, was fruitless.

It is not enough to point out to radio operators the urgent need for maintaining and improving transmission security. It is also necessary that officers provide close supervision where needed, and it is particularly important that they use radio facilities properly. Many violations have resulted from an officer's failure to abide by the principles of transmission security. Conversations between unit commanders have been intercepted by the enemy with great success. Official sources reveal that the Nazis received a great deal of valuable information from such conversations, relating to the strength of attacking forces and the purpose of various missions. In fact, so widespread has been this practice that an enemy intelligence service is reported to have compiled and published, for its intercept operators, a manual of code names used by our unit commanders and staff officers.

Stories recounting the aid and comfort afforded the enemy from security violations are inexhaustible. It takes only one person, regardless of rank, to violate security and allow the enemy to gain useful information endangering the lives of many others.

PROCEDURE VIOLATIONS

Radio procedure is designed for purposes of attaining uniformity, accuracy, and brevity in radio transmissions. Each radio operator should be specifically instructed not to substitute commercial or amateur procedure, vary his transmissions with individual characteristics, or take short cuts by omitting procedure. He should follow prescribed procedure, not because of fear of disciplinary action, but because of personal pride in the importance of his job.

Occasional procedure violations are unavoidable and do not materially hinder efficient operation or affect security. However, as the volume of procedure violations increases, the number of messages cleared decreases, and the operational efficiency of the net is lowered. Viewed cumulatively, errors in procedure will invariably undermine circuit discipline and, inevitably, security.

The most common procedure violations in c-w transmissions are given below:

Unnecessary transmissions.

Omission of K or $\overline{\text{AR}}$.

Use of incorrect procedure in requesting repetition when breaking into a transmission.

Use of less than eight E's in error sign.

Use of unauthorized procedure.

Failure to repeat last word transmitted correctly, or improper reply when repetition is requested.

Use of repeat sign, $\overline{\text{IMI}}$, to cover an error, or in place of $\overline{\text{INT}}$.

The above deviations from prescribed procedure comprise approximately 70 percent of the total. The remaining 30 percent includes 40 types of less common errors. The 7 violations listed above have been the most common violations month after month, and require the concentrated efforts of all communication personnel to reduce their occurrence to a minimum.

The majority of procedure discrepancies can be traced to superfluous transmissions and unauthorized short cuts. Listed below are examples of transmissions showing common errors in procedure. Deviations from prescribed procedure are given under the heading *INCORRECT*. Examples under the heading *CORRECT* illustrate the prescribed procedure. Call signs are fictitious. The transmitting station is shown in parentheses.

Incorrect	Correct
Unnecessary Transmissions. (Ref. TM 11–454, p. 11, par. 20c.)	
VE WABC V WDEF WABC V WDEF VE VE WABC V WDEF QRU K	WABC V WDEF QRU K
Omission of K or $\overline{\text{AR}}$. (Ref. FM 24–10, p. 31, par. 89.)	
QJS 2 K (WABC) $\overline{\text{INT}}$ 2 (WDEF) C (WABC)	QJS 2 K (WABC) $\overline{\text{INT}}$ 2 K (WDEF) C K (WABC)
Use of incorrect procedure in requesting repetition when breaking into a transmission. (Ref. TM 11–454, p. 45, par. 72.)	
WKYWA JTFY (WABC) J (WDEF) JTFYH AYAZZ (WABC)	WKYWA JTFY (WABC) TTT WKYWA K (WDEF) WKYWA JTFYH AYAZZ (WABC)
Use of less than eight E's in error sign. (Ref. FM 24–10, p. 10, par. 31.)	
TLMAS UGH EEEE TLMA UMHXF	TLMAS UGH EEEEEEEE TLMAS UMHXF
Use of unauthorized procedure. (Ref. FM 24–10, p. 10, par. 31.)	
WABC V WDEF NR4 1313EEEEEEEE $\overline{\text{AR}}$ (WDEF) WABC V WDEF NR4–A–WDEF 13133OQ WABC etc. (WDEF)	WABC V WDEF NR4 1313EEEEEEEE NR4 – A – WDEF 13133OQ WABC etc. (WDEF)
Failure to repeat last word transmitted correctly or improper reply when repetition is requested. (Ref. TM 11–454, p. 45, par. 72b.)	
PREUD EUPLM (WABC) TTTT EUPLM (WDEF) $\overline{\text{IMI}}$ EUPLM RLWCJ (WABC)	PREUD EUPLM (WABC) TTTT EUPLM K (WDEF) EUPLM RLWCJ (WABC)
Use of repeat sign, $\overline{\text{IMI}}$, to cover an error, or in place of $\overline{\text{INT}}$. (Ref. FM 24–10, p. 10, par. 31.)	
DROFV IVTO $\overline{\text{IMI}}$ IVTWQ	DROFV IVTO EEEEEEEE DROFV IVTWQ

Comments on prevalent procedure violations are presented in the following paragraphs:

1. **Unnecessary transmissions.** Of all the breaches of radio discipline, the most prevalent

are unnecessary transmissions. Extensive monitoring has shown that a large portion of all radio transmissions are superfluous. Operators should constantly bear in mind the fact that unnecessary transmissions greatly impair efficiency of communications and delay the handling of important traffic.

2. **Omission of K or $\overline{\text{AR}}$.** Every transmission, regardless of length, must end with either K or $\overline{\text{AR}}$. Omission of K or $\overline{\text{AR}}$ leaves the receiving operator in doubt, frequently leads to simultaneous transmissions, and wastes valuable time.

3. **Correcting errors.** An excerpt from a report of the experiences of a mobile radio team in France states that one of the chief causes of delay in transmission of messages was the use of improper procedure in correcting errors. The prescribed method of correcting errors in transmission is to send not less than 8, nor more than 10 E's immediately following the error, repeat the last word, group, prosign, or operating signal correctly sent, and continue with the transmission. The prosign $\overline{\text{IMI}}$ is never used to correct an error in transmission.

4. **Break-in procedure.** When only one station is receiving a message, break-in procedure may be used to obtain repetitions. The receiving station transmits a succession of dashes, and repeats the last word or group correctly received, followed by the prosign K. The transmitting station then continues, commencing with the word indicated by the station breaking in.

(In a later installment of *Notes on Radio Transmission Security,* the mechanics of achieving security will be discussed).

VALUE OF MONITORING

During the present operation enemy documents were captured which proved that the preventative measures taken by this headquarters for radio security were sound. These preventative measures include the suppression of: clear text transmissions, telephone directory names and names of individuals in the clear, unauthorized call signs, unauthorized codes and unusual operating characteristics. The enemy gained most of his information through violations of these regulations.

The above stated facts demonstrate the need for constant monitoring of friendly radio nets to insure that such violations are not made and, if made, to enable strong corrective action to be taken to prevent recurrence of such violations.

—From a Fifth Army (Italy) Report.

1,600-FOOT OPEN WIRE SPAN

Harry C. Ingles Line Across Rhine Required Ingenuity and Improvisation

WITH THE completion of a 1,600-foot open wire span over the Rhine, the 36th Signal Heavy Construction Battalion reported one of its most difficult missions successfully carried out. This river crossing, considered one of the longest single spans of open wire anywhere, was named by the men who built it in honor of Maj. Gen. Harry C. Ingles, Chief Signal Officer of the United States Army. Located between the towns of Urmitz and Engers, on opposite banks of the Rhine, it formed a part of the Cologne-Frankfurt double-arm lead.

When the speedy establishment of permanent communication across the Rhine was assigned to the battalion, the first problem faced was to find material for a span of such size. Improvisation and a number of ingenious substitutions saved the day. A light loading, noncatenary type of long span construction was decided on, and for this purpose three 65-foot poles were needed for the west bank fixture and three 70-foot poles for the east bank, 5 feet lower at the crossing point. Uncut timber found in a sawmill approximated class 2 poles of these heights. Channel iron suitable for crossarms was also found, cut into proper lengths, and drilled. Dead end and suspension fixtures were devised from power insulators and clamps from a German trolley line. A German steel wire about the weight of our No. 165 wire was used.

The Ingles span was the first job of its kind attempted by the battalion, but after careful organization and preparation, the work went forward with speed, precision, and *no foul-ups.* The 80 men engaged in the operation in the first 2 days placed 3 dead end poles and 3 suspension poles on each bank of the river. For dead ending, 30-foot poles were set 150 feet behind the suspension fixtures on the west bank, and 172 feet back on more irregular terrain of the east bank. Thus, the total distance from dead end to dead end was 1,922 feet. In erecting the 3-pole suspension fixtures, a gin

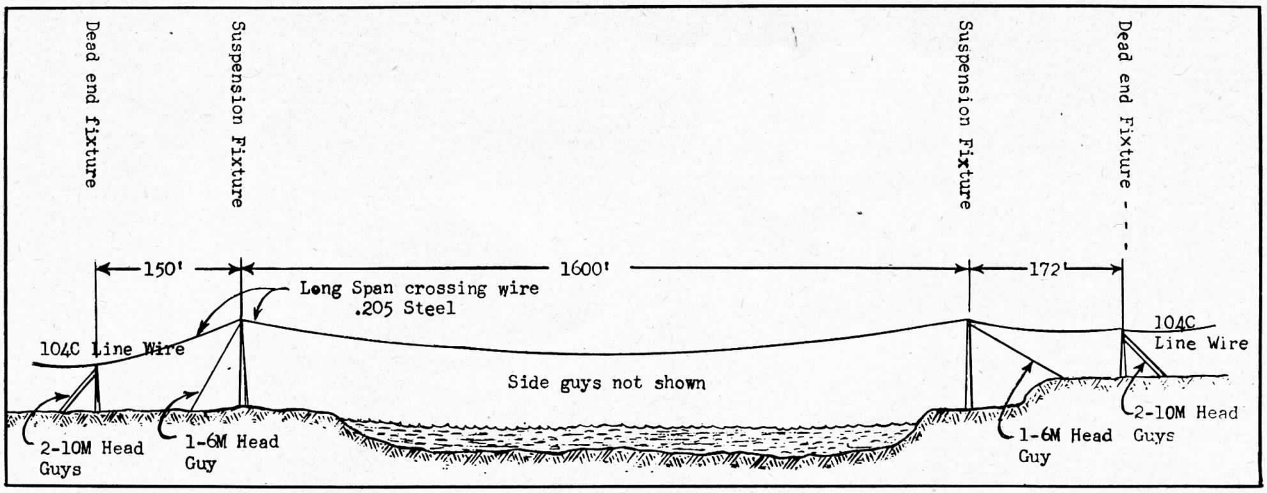
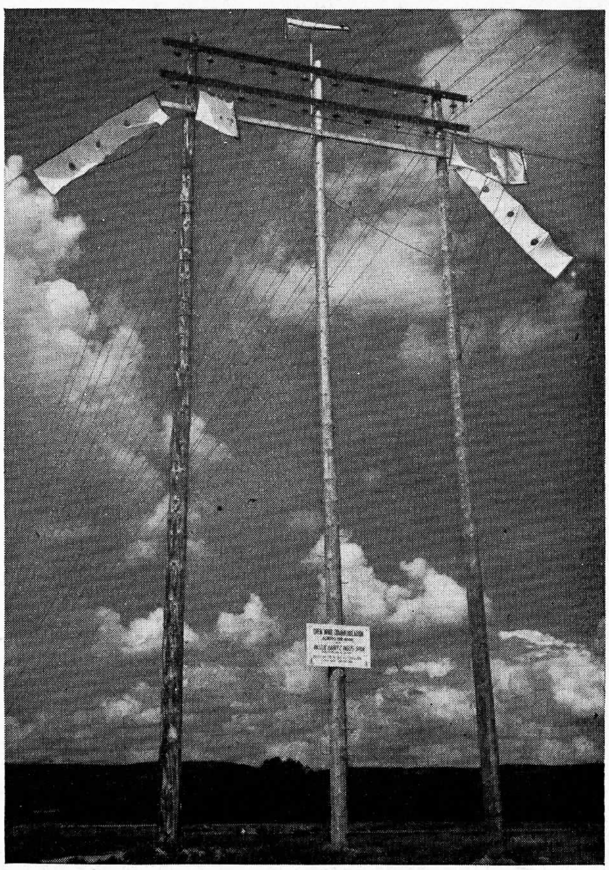


DIAGRAM OF THE HARRY C. INGLES SPAN.

pole was used on the west bank, while a dock crane was available on the east bank. The 2½ by 6 inch channel irons were raised with the winch lines of K–43 trucks. Six 10M guys attached to a log anchor took the load at each dead end.



VIEW OF SUSPENSION POLES AND WARNING PANELS ATTACHED ON WEST BANK OF RHINE.

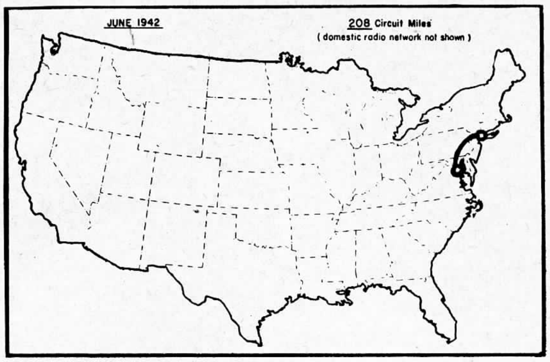
BOATS HAUL WIRE ACROSS

Next came the most difficult step in construction: pulling the wire across the river. First an attempt was made with a barrage balloon cable used as a fish line. K–43 power take-offs were set up on opposite banks to wind the line, but it was found impossible to synchronize the reels and the cable snapped. Then four assault boats were lashed together and, with outboard motors, proved powerful enough to pull one strand of wire at a time against the strong current.

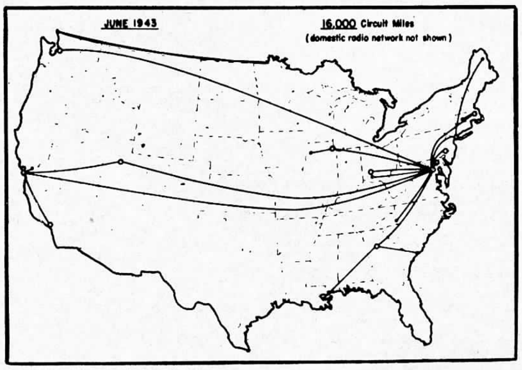
Six days after the work had begun, the top 10 wires were across. The next day rain and high wind made the river unsafe, but on the following day the top arm was sagged and dead ended. Two days later the second arm was complete. The wires were given a 30-foot sag, bringing them 7 meters above the mean level of the river. A spacing of 30 inches between wires was made to prevent swinging shorts and to reduce induction, since no transpositions were possible in the span. As a safety measure a third wooden arm was attached to each suspension fixture so that no wire could fall from its clamp into the river, and a length of strand was run from the ends of the top arm to this third arm. Thus the wires were completely enclosed. Final tests were made and the wires bridged through 11 days after the project was begun.

Every man on the job was impressed with the principle that safety first must be given equal priority with speed. As a result, the battalion medics had not even a minor casualty with which to deal.

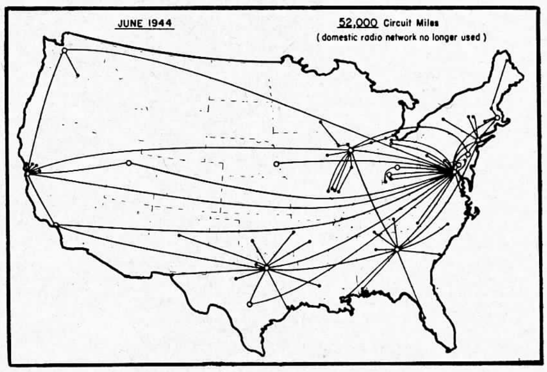
1. In ***June 1942*** the Army Command and Administrative Network Domestic Teletypewriter System started with this ➡



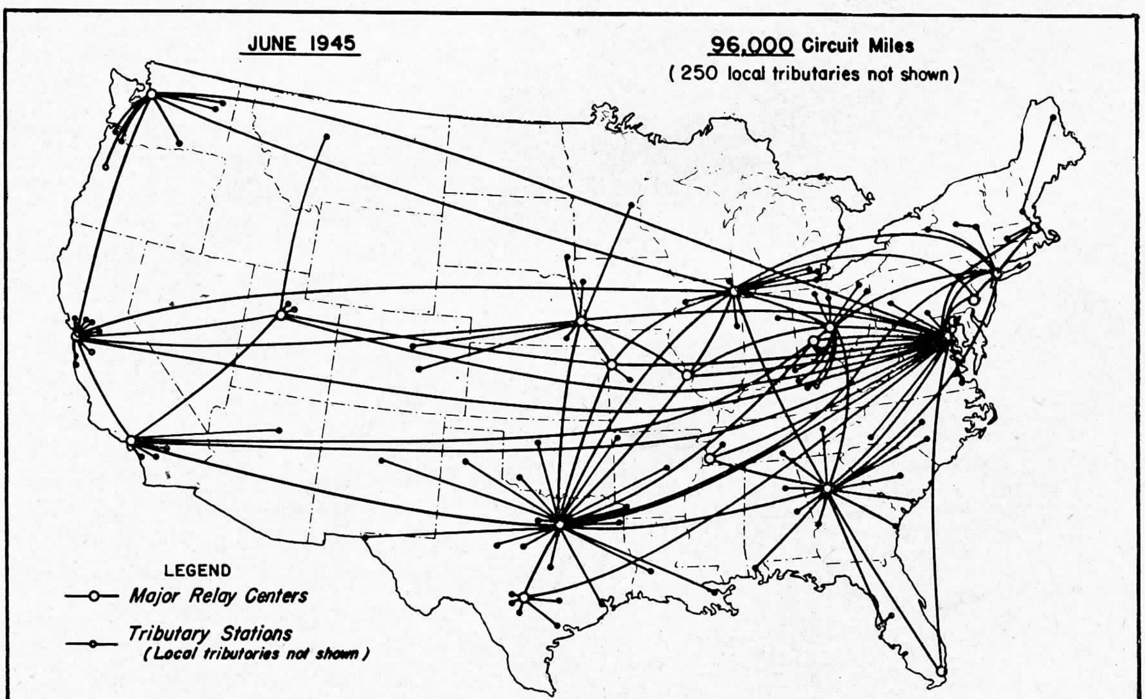
2. By ***June 1943*** it had grown to this ⬇



3. By ***June 1944*** the net had grown to this ⬇



4. ***Today*** it looks something like this ⬇



ARMY TELETYPEWRITER NET

Streamlined Domestic System Now Handles 20 Million Words Every 24 Hours

THE WAR that struck on 7 December 1941 opened the flood gates to a torrent of messages—messages from headquarters to overseas theaters, from arsenals to ports of embarkation, from depots to training camps, messages from Army installations all over the United States, all over the world, messages containing instructions, requisitions, inquiries, directives, and reports. The commercial networks and the limited Army communications facilities were strained to their utmost. The preparation of men and matériel for an all-out global war called for peremptory action. The messages had to get through.

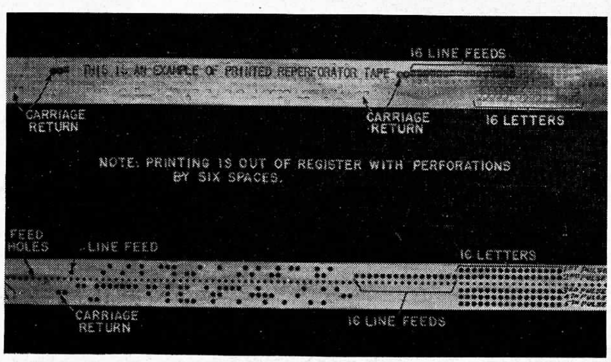
The answer had to be found—and put to work—fast. It was.

The answer was a world-encircling network.

From Washington to a headquarters in France, from San Francisco to an island in the Pacific, from Maine to Iceland, from New York to Dallas, from Cairo to Teheran, from Brisbane to Manila, from Chicago to Seattle, from New Delhi to Chungking, the global network created by Army Communications Service has provided the Army with the nerve system vital to victory.

The hub of this network is in the United States—in the War Department Signal Center—at WAR. Around that hub—like spokes of an inner wheel—the Nation is itself interlaced with the domestic section of this system.

Stemming out of the War Department Signal Center, the domestic Nation-wide teletypewriter system, engineered by Army Communications Service, has grown from one circuit in the early summer of 1942 to almost 100 trunk and 400 tributary private line circuits today The 208 circuit miles of 1942 have spread to 96,000 circuit miles in 1945. Over these lines in this country alone more than 20 million words are transmitted every 24 hours. *If those words were all printed on one continuous tape, that tape would stretch out over a distance of 190 miles every day.*



20 MILLION WORDS ARE TRANSMITTED EVERY DAY ON 190 MILES OF PRINTED PERFORATED TAPE SUCH AS THIS.

MANUAL RADIO INADEQUATE

Manual radio—the means used till Pearl Harbor—could not adequately meet the increased domestic needs. The innumerable frequencies required were not available. Manual radio involved repeated sending of every message by hand every time it had to be relayed, the possibilities of error in retransmission, a great increase in service messages, and delays. Atmospheric conditions precluded the full 24-hour service so imperatively needed. Security, too, was endangered. Radio operation called for highly skilled personnel—and with overseas needs pressing for these operators, there were not enough operators to go around. Mechanical means had to replace human skill. Whether the equipment was Boehme, high-speed IBM radiotype or ordinary manual, radio could not meet the domestic need. Land-line teletype, however, could.

On 27 June 1942, the first teletypewriter circuit on the Army Command and Administrative Network opened between WAR and New York—known, appropriately enough, as *GI* (which actually, however, stands for *Governor's Island*). One month later another signal center was converted to wire operation at Boston, then came another at Atlanta, quickly followed by Baltimore and Philadelphia, then Chicago and San Francisco, Seattle, Omaha, Dallas, and many others.

Trunk lines were thrown across the continent from coast to coast, from border to border, with tributary spokes out of each relay center, crisscrossing the Nation, connecting every important military installation in the United States. The need was to haul tremendous volumes of traffic, whether over long or short distances, with security, accuracy, and speed, and with a minimum of critical facilities.

661206—45——3

SEMIAUTOMATIC TRANSMITTER—1 OPERATOR HANDLES 12 CIRCUITS.

Obviously, direct private lines could not be set up between every originating station and every one of its addresses. An engineering study indicated 21 major areas of concentrated message traffic. These points were connected by intercity or transcontinental truck circuits to get the traffic out of one area and into another without wasting facilities or equipment and at the same time satisfying the urgent service requirements.

RELAY CENTERS ESTABLISHED

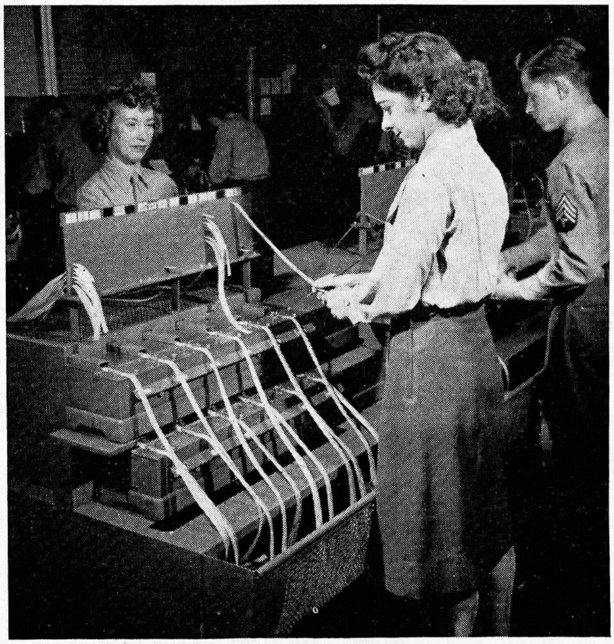
In the heart of each of these areas there was set up a major relay center, connecting with other major centers for which it had concentrated loads. Then out of each of those centers branched numerous tributaries, in turn often acting themselves as relay points for other local stations. Besides these, numerous installations have TWX connections into or out of the network.

Through this set-up, a depot in Richmond, Va., for example, wanting to send a message to the San Francisco Port of Embarkation, transmits the teletype message over its tributary circuit to its relay center, which in this case is WAR in Washington. WAR immediately relays it over a transcontinental trunk to San Francisco Signal Center. The latter then makes the final relay over its local tributary circuit to the POE.

During the early stages of the system, the prewar radio network intermingled with the land-line teletype net. This meant that certain messages originating at a local radio station would be transmitted by radio to its relay center, to be retyped and sent over the land-line to another relay center, which might in turn have to retype the message for transmission by either TWX or radio to the ultimate addressee.

This was clearly not enough to meet the need. This retyping every time the message was relayed at each point on its long cross-country journey meant loss of speed, greater risk of error. The relay system itself had to be streamlined. Tape-relay provided the streamlining, enabling savings in transmission time, in personnel, in equipment, and in money.

How does tape-relay work? Go back to the example. The depot in Richmond desires to wire the San Francisco port a long and complicated list of urgently needed items, giving requisition numbers, stock numbers, code markings, arrival dates. *Under the tape-relay system, that message, no matter how many relay stations it may pass through, is actually typed manually only once*, at its point of origin, which is when the operator at the Richmond depot places the message on the wire. The message comes into WAR (its first relay point) not on a printer as a page-form telegram but on a typing reperforator as a narrow perforated tape. The perforations correspond to the characters or symbols transmitted. This tape—with its typed directional call signs plainly indicating its destination—is within a few moments of its receipt placed in another transmitter at WAR to be sent over one of the transcontinental trunks—at a speed



SEMIAUTOMATIC RECEIVING CABINET—ONE OPERATOR HANDLES EIGHT CIRCUITS.

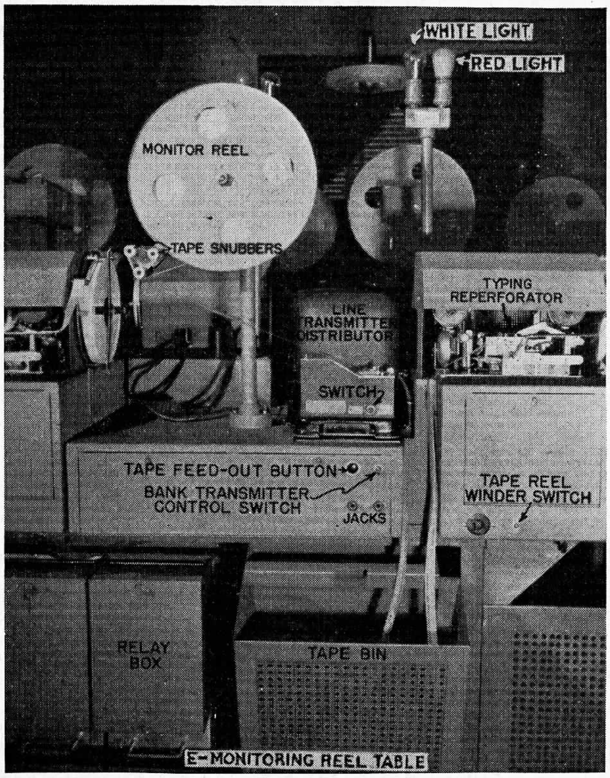
of 100 words per minute—to the San Francisco Signal Center. There it again emerges as a perforated tape which is likewise immediately retransmitted, again without retyping, over the local tributary circuit to the port. This time, however, it comes out at the port not on a reperforator as a perforated tape but on a printer as a page-form message. Thus is the possibility of error reduced to the minimum, speed raised immeasurably.

TAPE SPEEDS RELAYING

The originating teletypewriter may be a No. 15 KSR, which is a keyboard sending and receiving machine, transmitting on the line directly from the keyboard and receiving page-copy on the printer, It may be a No. 19 ASR, which is an automatic sending and receiving machine, permitting the operator to prepare a perforated tape at a speed up to 75 words per minute (for later transmission over an automatic transmitter-distributor) while at the same time receiving a message on the page-printer. This type of machine can handle a much greater volume of traffic than a No. 15 KSR. In either case, however, the message is received at the relay center on a typing reperforator, producing a perforated tape which can then be relayed through another automatic transmitter-distributor to the next point on the message's journey.

Relay center equipment has undergone drastic changes since the network's early days. The "Q" 102 Assembly, for example, consisted of a typing reperforator and a TD (automatic transmitter-distributor). Tape being received from a tributary would come into the relay center's "Q" 102, have an identifying channel number manually spliced into its head, then the two would be manually spliced into the tail of the last message sent over the circuit for which it was destined (in order to provide a continuous tape) and then started on its next step through the TD. This process would be repeated at each relay point. Requests from distant points for correction or information concerning messages already relayed would require fishing out endless tape from bins till the one sought was found.

The manual splicing and storage of sent tapes involved in the "Q" 102 method could not long continue. As quickly as critical material shortages made replacement possible, semiautomatic equipment was thrown into the breach.* The benefits



SEMIAUTOMATIC MONITOR REEL WHICH KEEPS RECORD COPY OF ALL MESSAGES.

were obvious and instant. Tape-splicing was eliminated: messages now are simply inserted into the proper transmitting bank, automatically numbered, and sent forward with a simple push of a lever. Local record copy is automatic, too, a separate monitor reel keeping an accurate and chronological record of every message sent over every channel. Speed of service has again shot upward. Valuable space and personnel are conserved. In WAR Signal Center alone, for instance, although the traffic increases over the last 2 years would have required, on the old basis, many times the personnel and equipment that it had in 1943 (even assuming that they were available—which they were not), *the introduction of semiautomatic equipment has enabled WAR to handle a 900 percent increase in traffic work load with an increase of only 28 percent in its authorized personnel and without the increases in equipment that would otherwise have been necessary.* The progressive installation of semiautomatic equipment throughout the country has also enabled the network to prepare in advance for fu-

*TB SIG 198, *Description of Operation Tape Relay Semiautomatic Fixed Station Equipment,* was issued 1 August 1945.

ture loads and to maintain continuously its standard quality of service despite the vastly increased traffic.

At the same time the taxing of facilities to capacity necessitated research into the possibility of increasing circuit message-carrying capacity in lieu of constructing additional lines. Persistent experimentation resulted in raising the 60-words-a-minute capacity up to 75 and now to 100-words-a-minute—with further increases in prospect.

Signal center message-handling has received similar attention. Speed of service has improved almost incredibly. *At WAR Signal Center, for illustration, a message received over-the-counter for wire transmission which would have required 40 minutes to be prepared and to clear the center in 1942, is out on the network today within 9 minutes.*

Today 20 major relay centers and more than 335 private-line tributary stations dot the Nation's map. Some tributaries, as in the spreading plains of Texas, are 600 miles from their relay center, many others are located in the immediate vicinity of their relay center. The local tributaries out of WAR alone, for example, total 46. New York City has more than 30, Atlanta 29, San Francisco 28, Seattle 26, Dallas 25. Many others are similarly situated. And, in addition to all these, more than 1,000 TWX stations can be reached through the network's facilities.

Tape-relay makes possible the instant and constant interlocking of the domestic network with the overseas system. *The use of the standard five-unit perforating code makes the same tape completely interchangeable between land-line, radio-teletype and cable facilities.* From New York a message can be tape-relayed by land-line to Seattle, sped on its way to Anchorage by cable, then radio-teletyped to an island in the Aleutians, all without the slightest change in the appearance or character of the tape. This relay system makes possible the sending of messages from authorized domestic stations over radio-teletype facilities to any of our overseas theaters in precisely the same manner and with the same speed as if they were being relayed to an adjacent service command. It has made possible the sending of a message from WAR by tape-relay through Asmara on to New Delhi and Brisbane and then to San Francisco for final relay back to WAR in the 'round-the-world record time of 3½ minutes!

The domestic Army Command and Administrative Network is thus completely integrated in a world-wide system, interlocking the zone of the interior with every overseas theater of operations.

SPEAKING OF WIRE TROUBLE

THE FOLLOWING remarks extracted from a report submitted by a Field Artillery captain dealing with wire communication during one of the island campaigns in the Pacific indicate that Signal Corps personnel are not the only victims of interruptions to communication resulting from other than enemy action.

Line failures occurred on an average of considerably more than one per day per circuit. Some lines averaged three and four interruptions per day.

Wire was strung from trees along the road. Trees were knocked down by bulldozers widening the road, by oversize equipment, such as power shovels and Air Corps trailers. Wire was shot out by AA fire and damaged by blasting during road building and quarrying operations. During the early phases of the campaign wire strung from palm trees along the beach was shot out nightly by AA machine guns.

Wire laid on the ground was torn out by bulldozers, tanks and other vehicles, particularly tracked ones. Cooking fires were built over the wires and in some instances, lengths of wire were cut out for use as trip wires for local alarm systems or for clothes lines.

Wire laid in the water parallel to the coast line was torn out by amphibious vehicles and land vehicles coming ashore or, if laid farther out from the shore, became entangled in the screws of landing craft. At some points the wires were elevated to poles set in the water. The poles were knocked down by drifting logs.

On one occasion division artillery was given the use of a section of pole line constructed by Signal Corps troops. This line was singularly free from interruption since the right-of-way had been cleared to such a distance that falling trees could not touch the line, and since bulldozer and other vehicle operators took more care in avoiding the telephone poles than they did the trees from which wires were strung along other routes.

Because of the interruptions enumerated above it was necessary, to insure continuous wire communication, to lay three circuits from division artillery to each battalion and to require two laterals between adjacent battalions. This was usually sufficient.

SIGNAL ASSAULT PLANNING

Simplicity and Flexibility Marked First Army Signal Service Preparations for D-day

THIS REPORT covers items of interest during the training, preparation for operations prior to the invasion of Europe, and subsequent operations from D-day, 6 June 1944, to D-plus-56, 1 August 1944.

Training in communications for assault operations stressed the fact that *simplicity and extreme flexibility* were of primary importance. Thorough instruction of communication personnel in the waterproofing of equipment and the set-up and operation of communications necessary to support the fighting arms was carried out at the Assault Training Center in the United Kingdom. In addition to training in signal operations, personnel attending the various courses were also oriented in the general mission of an assault force.

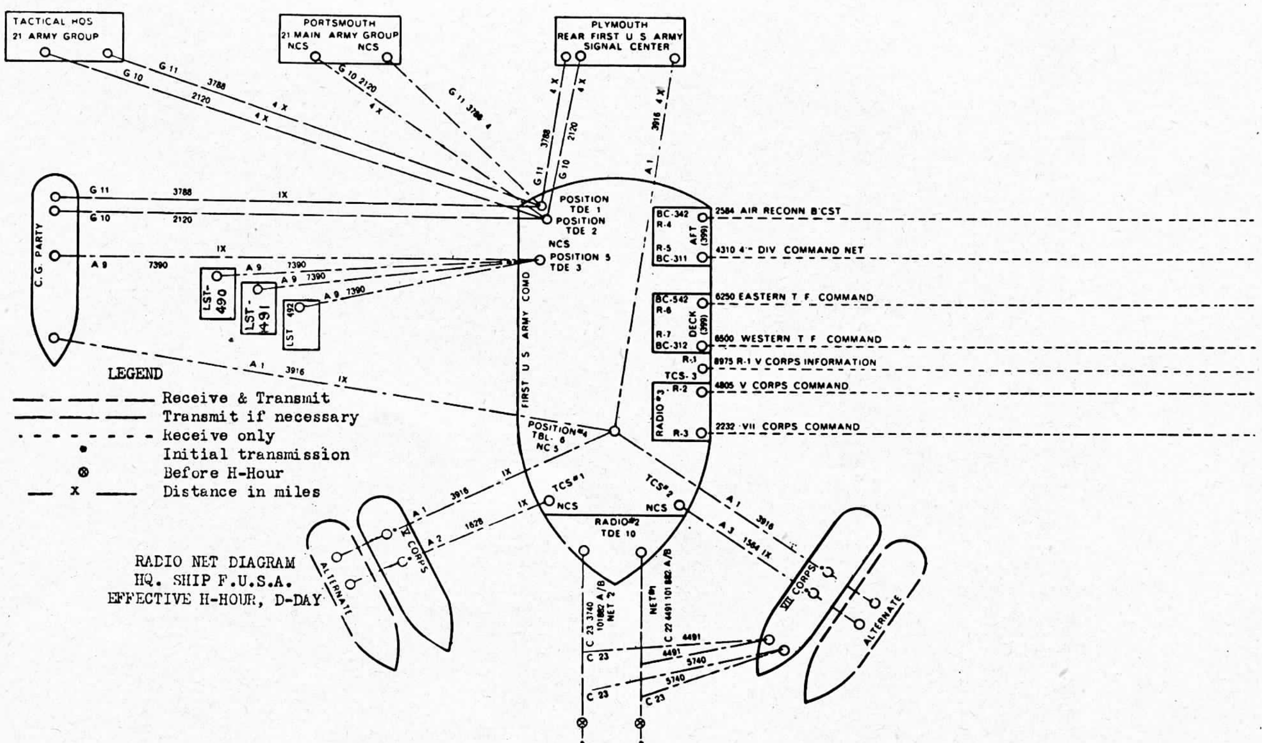
Normal Signal Corps specialist training was conducted on wire, radio and message center subjects including enemy radio equipment, waterproofing (signal equipment and vehicles), Royal Signals NCO Course No. 14, British multi air line construction (team instruction) and bomb disposal.

In addition to the specialized training, Signal Corps personnel received training in aircraft recognition, defense against chemical attack, rapid fire of weapons used, map reading, mine detection, close order drill, and lessons in foreign languages (French and German).

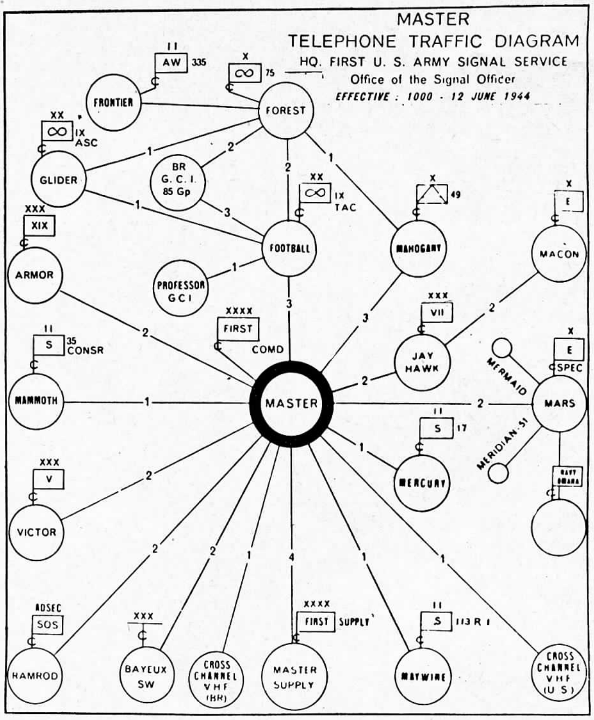
A plan was evolved in the latter part of January 1944 for the training of Army radio operators and cryptographic clerks. At the same time provision was made for training of the radio intelligence unit eventually to be assigned to First Army. By design, radio traffic was increased to attain a total of 10,000 groups daily. Logs resulting from monitoring were studied, and where necessary, corrective action was taken to insure that violations were not repeated.

All radio equipment should be thoroughly tested and tuned by the using personnel immediately prior to embarkation, and locked on frequency.

Signal operation instructions should be kept to an absolute minimum in an operation of this type and should contain only essential items (items which are SOP should be deleted).



RADIO NET DIAGRAM
HQ. SHIP F.U.S.A.
EFFECTIVE H-HOUR, D-DAY



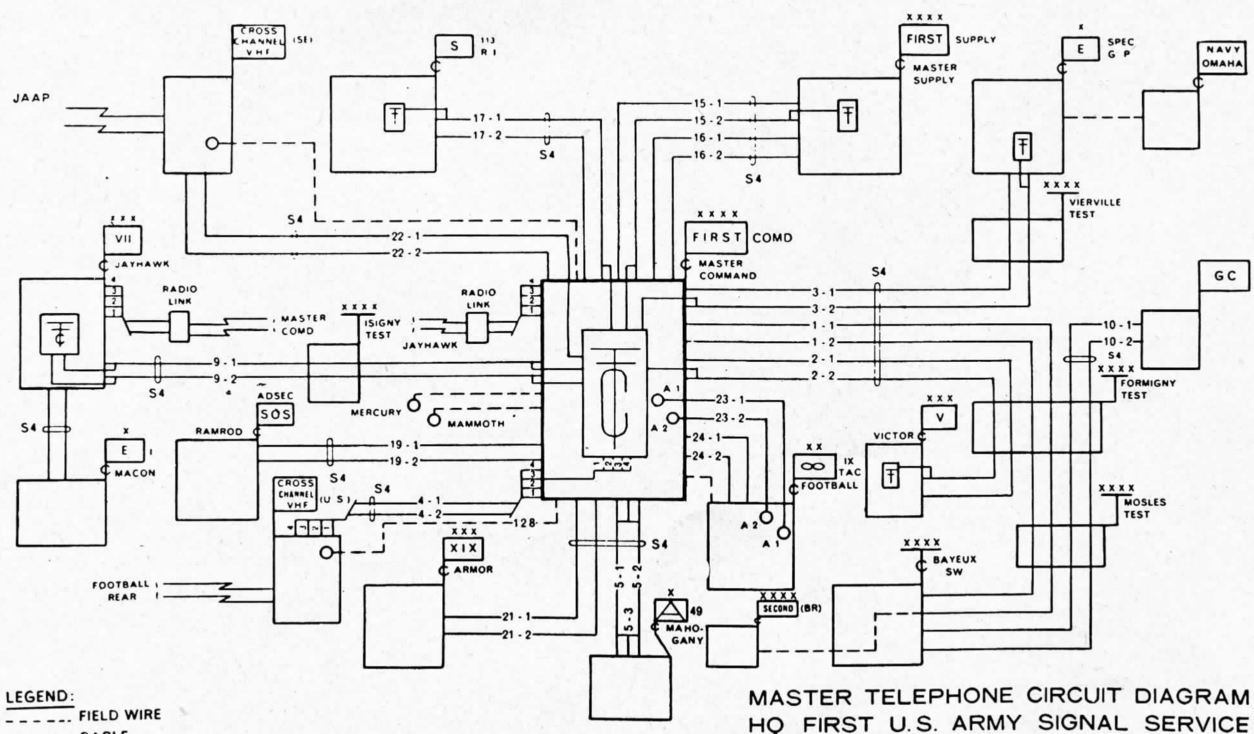
The *signal communications plan* covered the provision of signal communications for the First U. S. Army, a force occupying a sector of the Northern Coast of France as a base for future operations on the continent of Europe.

The *assault operation* included the establishment of communications during mounting in the United Kingdom, while afloat, during the assault phase and the subsequent phases which included the establishment of communications across the Vire Estuary from a point north of Isigny to the Contentin Peninsula.

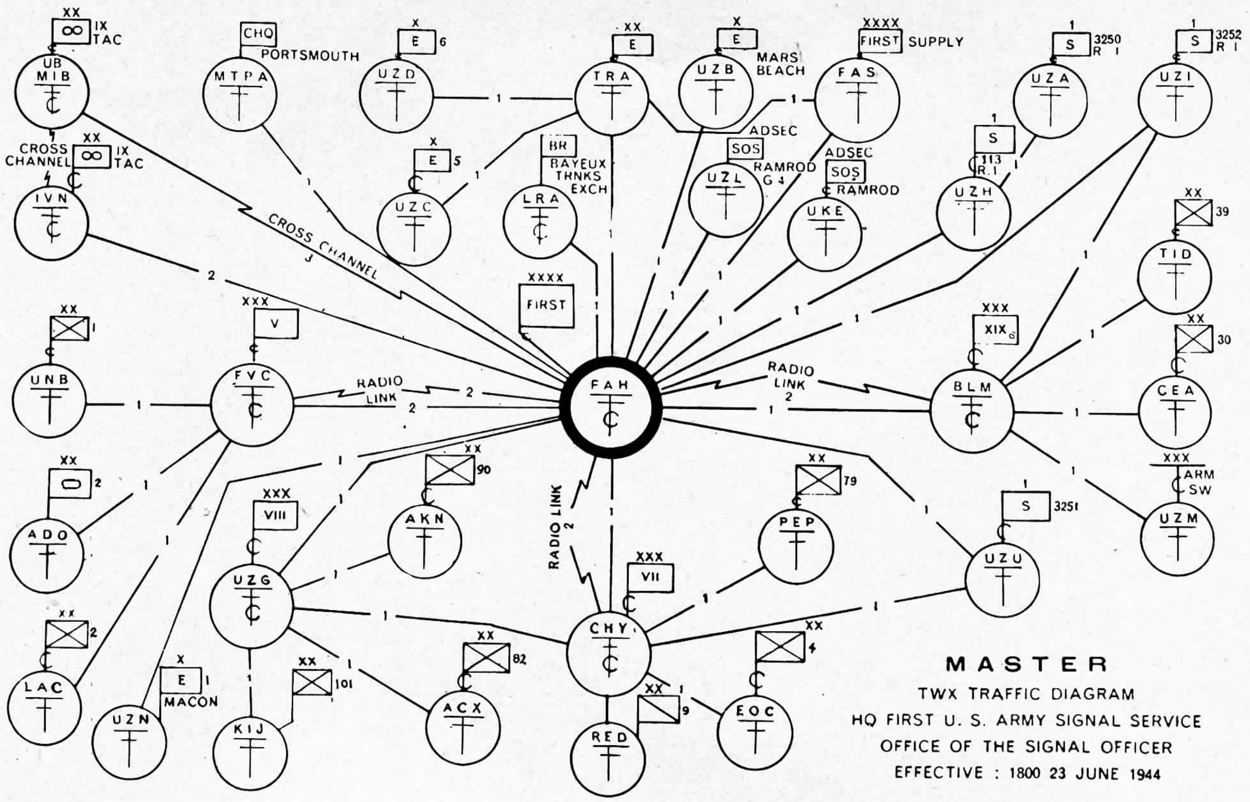
The *signal mission* was to provide communications for the First U. S. Army during the assault on the Continent, the capture of Cherbourg, and the movement inland.

OPERATIONS 15 MAY TO 1 AUGUST 1944

Signal communications for the ship phase of the operation consisted of radio nets supplemented by visual channels between ships furnished by the U. S. Navy. These nets furnished communication between echelons of the First U. S. Army Headquarters, both afloat and ashore for the Commanding General, his deputy, and higher; adjacent and subordinate headquarters. Contact between all echelons was continuous. Two radio nets were particularly valuable, i. e., the V Corps information net which operated from Omaha Beach and the 4th Infantry Division command net, operating from VII Corps or Utah Beach. These nets furnished both the Commanding General and Deputy Commander with information of condi-



MASTER TELEPHONE CIRCUIT DIAGRAM
HQ FIRST U.S. ARMY SIGNAL SERVICE
Office of the Signal Officer
EFFECTIVE: 0001-13 JUNE 1944



MASTER

TWX TRAFFIC DIAGRAM

HQ FIRST U. S. ARMY SIGNAL SERVICE

OFFICE OF THE SIGNAL OFFICER

EFFECTIVE : 1800 23 JUNE 1944

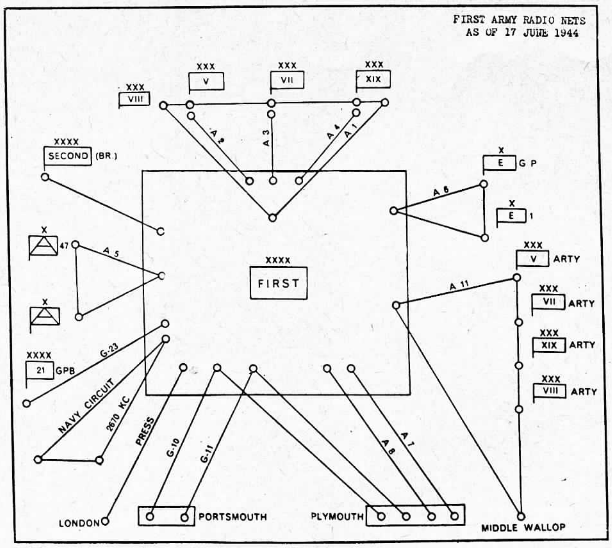
tions on each beach. The Tactical Reconnaissance broadcast channel was also of value. Some difficulty was experienced during this phase with overclassification of messages and long, poorly worded and carelessly encrypted messages. This situation taxed the code personnel to the limit. Navy personnel cooperated fully during this phase and were of great help in clearing Army messages between ships.

The joint assault signal companies of the Engineer special brigades landed in accordance with plans and set up radio channels. The 293d Joint Assault Signal Company which followed the 294th Joint Assault Signal Company ashore at Omaha Beach lost approximately one-third of its vehicles and half of its radio equipment. In addition, it suffered personnel casualties. The 286th Joint Assault Signal Company at Utah Beach lost some radio equipment but shortly after landing had wire communications functioning satisfactorily.

The Army command post was selected on D plus 2 and advance command post personnel unloaded the following night, D plus 3, and spiral-four wire communication was established to V Corps and the Engineer special brigade group early on 10 June 1944. On 11 June, a v-h-f radio link with carrier was established to the United Kingdom. The successful establishment of this link high lighted the communication achievements during the early phase of landing. *Although this system was used in previous campaigns on a trial basis, it marked the first time radio link equipment with carrier was actually used as a dependable means of communications in the field.* There were six channels used on this set-up: One telephone, four teletypewriters, and one facsimile.

By 12 June (D plus 6), in addition to normal means of communication, a radio relay was in operation from First Army to V Corps, VII Corps, and XIX Corps. Each link provided three speech circuits and one teletype circuit. Radio relay communication was also available to Ninth Air Force Rear, which connected direct through commercial telephone to all parts of the United Kingdom.

During the period 26 June to 24 July, the need for a central control of communciation facilities became apparent and as a result a communications



control office was established and put into operation. This office was manned by the S–3 of the 17th Signal Operation Battalion and the S–3's of the 32d and 35th Signal Construction Battalions. It was the duty of these three officers to keep in constant touch with all phases of operation, maintenance and construction which was handled by their respective units and these officers had the authority to order rerouting of circuits, patching out of defective facilities and transfer of personnel when necessary to maintain communications.

During this period, communication requirements had grown to such an extent that it was necessary to increase the number of trunks between Army command and supply echelons to 12 one-way circuits from the command to the supply echelon, and 10 one-way circuits from the supply to the command echelon.

From 25 July to 1 August the greatest damage to army wire facilities by enemy activity was inflicted, with over 60 trunk line circuits having been put out of service on the night of 28–29 July. Damage was caused by bombing and shelling and in one case by an enemy plane crashing through open wire lines. The radio traffic during this period was almost halved, with a daily average of approximately 10,000 groups being transmitted.

STUDY OF TERRAIN NECESSARY

A detailed map study of the terrain is necessary prior to the establishment of a radio relay circuit in order to utilize the best possible location for terminal and relay sites. Ample notice of all moves and changes in CP locations is necessary for the proper establishment of such circuits, especially when relay stations are involved. A hasty selection of a relay site may easily result in a lack of communications for an extended period because of the difficulty of moving the isolated relay station to a better site.

FREQUENCY LIST SYSTEM

The frequency list system developed by the British has shown through actual use in combat to be a good, workable solution to the frequency problem. Briefly, it consists of breaking down the total available frequencies into basic lists. A similar system was developed for FM frequencies. The 120 channels of the SCR–600 series sets were broken down on the basis of 3 channels per artillery battalion and 5 per tank destroyer battalion. Three groups of 13 frequencies each were set up for infantry divisions; 1 group of 56 frequencies for corps artillery and tank destroyer battalions and 25 frequencies for army artillery. For the SCR–500 series sets, all 80 channels were assigned to each armored division.

LOCATOR SECTION FORMED

Shortly after the arrival of the First Army in France a major problem developed in the distribution of dispatches to subordinate units by message center. Due to the rapid movement of command posts a *Locator Section* was originated, so that the message center could post daily the changes in location of army and other units. Each day the various army staff sections reported new arrivals in France and CP changes which had occurred in each 24-hour period. A similar report was received from each corps, and all information was compiled so that the message center knew the exact location of every unit under army control. Since First Army could not possibly furnish each army unit with direct messenger service, there were established five pick-up points in the American sector for subordinate units to make a daily pick-up of dispatches. All units made two pick-ups a day and the geographical location of each unit determined which pick-up point woul be used.

UNDERGROUND CABLE SAVED

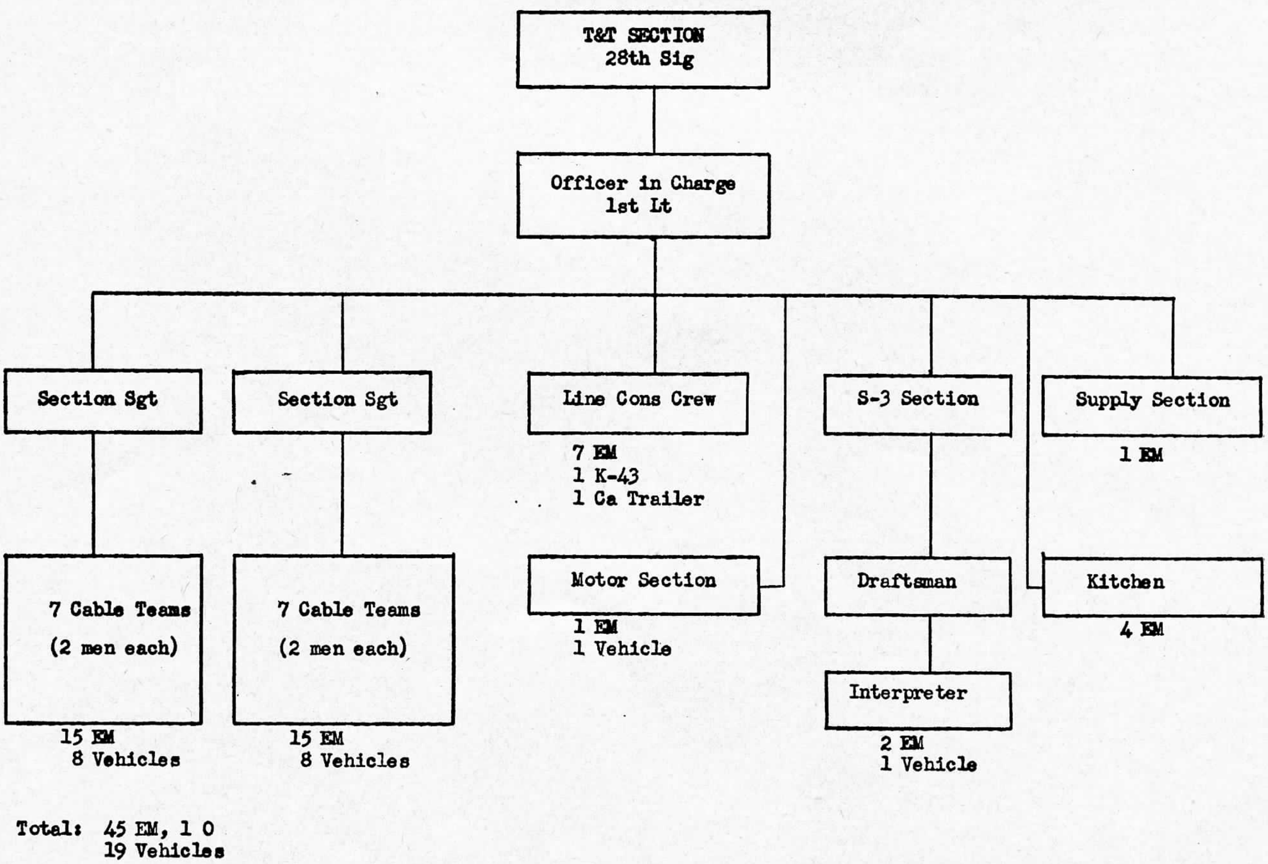
System Rehabilitated by Special Cable Team Furnished Quick Service to Army

THE RAPID movement of Army troops over long distances made it impractical to construct open wire or spiral-four cable leads to furnish the Seventh Army with its desired maximum number of circuits. In addition, the number of signal units assigned to Seventh Army was inadequate to meet the steadily increasing demands for circuits, and there was a definite need for some type of relief or rest for these overworked, overfatigued signal units. In order to alleviate these situations, it was decided to utilize existing German underground cable.

This decision necessitated the grouping of all splicers in Seventh Army signal units into a cable team. The organization and supervision of this team became the responsibility of the 28th Signal Heavy Construction Battalion.

The importance of this operation was tremendous, since the Army would save tons of open wire, field wire, and spiral-four cable. Also, thousands of man-hours would be saved, and, most important, increased lines of communication for Seventh Army units would be available.

This new cable splicing team was composed of crews from all signal units assigned to provide for Seventh Army communications. These crews had been previously assigned to the Sixth Army Group splicing team in rear of Army. It was obvious that there was a need for reorganizing the team in order to acquaint it with the policies and procedures established by the 28th Signal Heavy Construction Battalion. Hence the team was oriented as to its objectives, procedures, and new organization, and the accompanying chart was established to indicate more clearly the over-all picture.



ORGANIZATION OF SPECIAL SEVENTH ARMY CABLE REHABILITATION TEAM.

ALLOCATION OF DUTIES

The duties and functions of the various sections were set up in the following manner. The officer in charge, with a general knowledge of the Seventh Army axis, located the existing German underground cable with the aid of the interpreter. This meant searching for existing cable charts and questioning various German cable technicians. When the OIC had an accurate picture of the cable routes, he assigned his section sergeants specific areas for which they were responsible. At this point, the crews were distributed along the cable route and work was begun to get the cable in good operating order, by repairing all breaks. Progress made by each crew was reported to the section sergeant, who in turn consolidated all reports and handed them in to S–3, which grouped the section reports into final form for the T & T Section of the battalion.

This system of reporting on breaks, need for additional cable, location of repeaters and terminals, working cable pairs, and cable counts made it possible for the battalion to keep an up-to-the-minute check on all progress made, and to organize and plan future work in accordance with the work accomplished. (See cable chart.) It also made for an organization center that would eliminate duplication of work and lost time.

The construction crew's mission was to take care of heavy work, involved in river crossings, to aid in placing cable across partly destroyed bridges, and to take care of all miscellaneous work which cable teams were unable to handle.

The Supply Section's most important objective was the locating of any loose cable that could be used for repairs and maintaining a supply of cable tools and equipment. The Motor Section was established as a roving maintenance and repair section to take care of all vehicles assigned to the team.

ACCURATE RECORDS KEPT

The primary mission of the Seventh Army Cable Splicing Team was to provide cable communications within the Seventh Army axis. This mission necessarily involved the maintaining of accurate records on all cables, terminals, and repeater stations.

It also meant that the team must be ever moving forward, trying to locate underground cables, testing their workability, and keeping Army informed continuously of cable possibilities and conditions within its area.

In addition, it was fundamental that a careful analysis and spotting of all underground cable be considered in order to establish potential routes in case certain cable lines were too badly damaged to warrant the time and equipment essential to repair.

Completion reports show that 2,741 man-hours were consumed (this includes all overhead) to rehabilitate one section of cable which provided an average of 100 circuits. It is estimated from figures available on the placing of two spiral-four cables, stranded, over a comparable distance, that it would require 4,720 man-hours to provide the necessary circuits from Army CP to Army Rear. In addition, the amount of material involved in the operation would be great and must be considered as a factor in the comparison.

In general it is felt that this new venture into the possibilities of existing underground cable has paid off in large dividends. The tons of material and the man-hours saved together with the rapid establishment of innumerable circuits are a testimonial to the importance and success of this project. More than 361 miles of cable (sheath miles) were rehabilitated from 15 March to 1 May 1945 by the cable splicing team.

By keeping cable spotters up with actual combat troops in order to learn more quickly the condition of terminals and repeaters, by exploring all possible cable routes, and by ever looking forward to potential Army moves, the team not only was able to aid in *getting the message through* but also has been able to provide immediately almost unlimited circuits for units greatly in need for wire communication facilities.

RADIO PROPAGATION FORECASTING

Results of Tests Based on New Ionospheric Hypotheses May Triple World Coverage

THE IONOSPHERE in its broad characteristics has many features in common with weather. To form a true picture of the state of weather over the earth's surface at a particular time, an enormous number of weather stations all making observations at the same time is required. These observations are never complete; there is no such thing as a complete and uniform coverage of the world by meteorological observing stations.

For regions for which there exists no direct observation, analogies frequently exist with regions which are well known. The meteorologist naturally applies the known information to the unknown region which he has reason to believe is similar. Such studies are frequently discussed under the heading of climate.

The meteorologist has many problems with which to deal. In forecasting weather he is generally asked not what the weather is now, but what the weather will be at a particular point tomorrow, next week, or next year. He has learned from experience and through study of the accumulated data to make short-term forecasts with some degree of skill. The problem is intricate and while many features of it have received general attention, much in the way of special forecasting skill depends upon special knowledge. If asked to predict the weather for next week the meteorologist becomes much less certain of his ground. Weather forecasting contains so many variables and so many imponderables that long-term weather forecasting is at present in a rudimentary state.

The problems of ionospheric forecasting are remarkably similar to some of the problems faced by the meteorologist. For instance the ionospheric scientist can draw a map representing the normal propagation characteristics of the ionized regions of the upper atmosphere as observed at a particular instant of time by a scattered group of ionosphere stations. Such a map, like its corresponding weather map, is of limited importance. It permits understanding of certain radio phenomena which took place at the time the observations were made. It does not help in understanding transmissions which may have taken place before or after the actual time of the observations mapped. Hence the ionospheric scientist is faced with problems the solution of which involves the ability to forecast conditions in the ionosphere for times in the immediate and more distant future.

Study over many years has clearly demonstrated such facts as the normal range of variation of an ionospheric characteristic from day to day and hour to hour. This variation insofar as practical ionospheric forecasting is concerned is considerably smaller than the variation of many meterological characteristics of the lower atmosphere.

The accumulation of information from long established ionosphere stations showing the diurnal variation of ionospheric characteristics from month to month, season to season, and over a sufficient period of years to represent the variation in the activity of the sun, has made it possible to make ionospheric forecasts for the station concerned many months in advance.

In recent years the metorologist has found it necessary due principally to the growth of world aviation to extend his forecasts to as much of the earth's surface as it is possible to cover by observation and analogy. The setting up of many new meteorological observing stations has yielded rich dividends in the saving of lives and aircraft, and in advancing not only long distance aviation but also the science of meteorology. The ionospheric scientists have similarly been called upon recently to make forecasts of radio transmission conditions over long routes as well as short ones, in regions of the world for which there has been no direct observational data about the ionosphere. Like the meteorologist the ionosphere forecaster has sought to make use of analogy by the application of known ionospheric data from the limited number of ionosphere stations.

Latitude Equivalence Hypothesis—Ionospheric Forecasting Before 1943

At a particular region of the earth's surface, the characteristics of the ionosphere vary in a noticeable manner from day to night, season to season, and more slowly with sunspot cycle. To predict the useful characteristics of a radio transmission link it is necessary to prepare maps or charts showing the predicted characteristics of the ionosphere. The first and most obvious assumption to adopt in preparing such charts is the *statistical equivalence* of the propagational characteristics of the ionosphere above all points having the same latitude for the same local time. For instance, it would be assumed that the ionosphere would have the same characteristics over Lisbon, Washington, San Francisco, and Peiping on the average for a given month and year at the same local time at each place. This seemed a logical assumption since it was believed from the limited studies made before the war that the characteristics of the ionosphere on the whole were not influenced by the actual nature of the surface of the earth below, nor by any other effect than the radiation from the sun.

Such a *latitude equivalence* hypothesis led to the assumption that a reasonable distribution of ionospheric stations in different geographic latitudes in any convenient part of the world would permit the construction of contour charts to show the predicted characteristics of the ionosphere for a particular month over the entire earth's surface. Prediction charts were made by the use of just such a latitude equivalence hypothesis. The accuracy of such forecasts for more than 6 months in advance was believed to be limited solely by the inability to forecast sufficiently accurately the variation of solar activity so far in advance.

With this set of ideas about ionospheric forecasting, the obvious thing to do when the war came was to install enough additional ionosphere recorders to fill in the larger gaps in our latitude coverage of the world. In the northern hemisphere there existed a number of stations between 38° North and 58° North latitude. These stations existed primarily in the United States and Europe. In addition to these there was a station at Huancayo, Peru, in latiude 12° South, and a few more stations in Australia and New Zealand. In fact for the temperate regions of both hemispheres it was believed that enough data existed to make confident forecasts, and predictions based on these stations were put out for use in these latitudes in the Pacific Ocean and Asia.

Now it was well known that the north polar regions presented special problems associated with the auroral regions but these peculiarities were believed not to extend far south of the auroral zone. The United States part of the Combined Communications Board's program was designed first to clarify our knowledge of ionospheric conditions in the Arctic, a region for which only a few scattered observations had been made, and second to extend our ionosphere coverage to more lower latitudes in the northern hemisphere.

With these objectives in mind a station was set up by the Carnegie Institution at College, Alaska, in June 1941. The Canadians installed a station at Churchill on Hudson's Bay, and the Combined Communications Board authorized the construction of a station at Reykjavik, Iceland, and one at Clyde River, Baffin Island. The three stations at College, Churchill, and Reykjavik lie approximately along the auroral zone. The station at Clyde River lies as far toward the center of that zone as it appeared feasible to install a station. For the southern extension of latitude coverage the Combined Communications Board authorized the installation of stations on Maui, T. H.; Trinidad, B. W. I.; and the University of Puerto Rico was aided in the operation of its station at San Juan. In this way it was felt that despite a few gaps of 10° to 12° the picture of the ionosphere would be fairly complete from the Arctic to at least 12° South of the equator.

Failure of the Latitude Equivalence Hypothesis—New Ideas

Despite this fairly satisfactory latitude distribution of observing stations, forecasts did not always work out as well as had been hoped. They generally erred in forecasting MUF's which were lower than the frequencies successfully in use in various parts of the world, particularly in Asia. Furthermore, the examination of small scraps of old ionospheric data from such places as Tokio and Wuchang, China, was disturbing in that they invariably appeared to show higher critical frequencies than could be expected on the basis of simple latitude equivalence. These scraps of data, however, did not cause undue alarm, for they were very small and taken at times when, or by persons whose, skill in the techniques of ionospheric measurements was not advanced.

Early in 1943 the British began circulating data from a station at Delhi, India. The daily characteristics of the ionosphere reported from this observatory were startlingly different from expectation as indicated in the forecast charts then being prepared, particularly for the summer season.

The critical frequencies were distinctly higher than had hitherto been expected. The incorporation in the forecast charts of these new data from latitude 29° North profoundly altered their appearance. Between Delhi and the latitude of Washington, a mere 10°, there appeared to exist an enormous gradient in ionization which was difficult to account for even qualitatively. Fortunately the Baton Rouge station at Louisiana State University came into operation shortly afterwards in a latitude essentially equivalent to Delhi. The information from Baton Rouge, beginning July 1943, showed characteristics completely different from Delhi and much more in line with what had previously been expected for such latitudes. Checks had already been made on the techniques, interpretation of records, and calibration of equipment at Delhi, and a new fact clearly emerged: *Ionospheric characteristics at two points on the earth's surface having the same geographical latitude need not be identical or even similar!*

This discovery might have thrown the whole problem of radio forecasting into utter confusion, had there not been other information such as the fact that the existing forecasts did give satisfactory results for many radio transmission problems. An immediate check over the old and imperfect data from nonpermanent stations together with some new data which arrived from three Russian stations, demonstrated clearly that in northern hemisphere summer the diurnal curves of critical frequency for the F2 layer were apparently highest for a given latitude in those parts of the world most removed from the geomagnetic pole, i. e. in the lowest geomagnetic latitude.

The geomagnetic north pole is located in latitude 78½° North and longitude 69.0° West. The geomagnetic south pole is located in latiude 78½° South, longitude 111.0° East. These poles are, to a fair approximation, at the center of the northern and southern auroral zones respectively. The two auroral zones are some 20° to 25° from the geomagnetic poles, i. e. between geomagnetic latitudes 65° and 70° North and South respectively. The geomagnetic equator lies furthest to the south geographically in longitude 69.0° West, i. e. not far from the Huancayo ionosphere station in Peru. It reaches its most northern geographical position in the South China Sea near the Philippine Islands and French Indo-China, a region near which no known ionosphere station exists, though the proposed British installation at Colombo, Ceylon, will be near this region. The geomagnetic equator intersects the geographic equator in two points. One intersection lies in the Central Pacific Ocean at longitude 159° West. The second intersection lies at a point in the interior of the Belgian Congo at longitude 21° East.

Discovery of Longitude Effect Results in Preparation of New World Charts

The discovery of a new element in the variations of the ionosphere, related even on preliminary examination to the magnetic field of the earth, and taken for initial convenience to be representable in terms of geomagnetic latitude, suggested an immediate explanation for some of the existing discrepancies between predictions and observations for radio transmission paths in the Orient and to Asiatic points. This new discovery, confined as far as is at present known, to the characteristics of the F2 layer, is now referred to as the *longitude effect* and was first brought into general operational use with the publication by Interservice Radio Propagation Laboratory on 14 October 1943 of predictions for January 1944. As a result of study of the preliminary new data as well as the existing data, it was decided to produce for a start two world charts, each showing distribution of ionospheric characteristics with latitude and local time, for the regions suspected of exhibiting the greatest differences. One such chart was for the Far East, where in the summer and in the northern hemisphere maximum usable frequencies (MUF's) and critical frequencies appeared to be highest in a particular geographic latitude, and the other for the longitudes of eastern Canada and United States where the same characteristics appeared to have the lowest values for any region of longitudes in a given north geographic latitude. A tentative division was made of the surface of the earth into regions where a chart for 110° East longitude and the chart for longitude 70° West could be used without special modification. In the two remaining regions of the world existing data showed that MUF's and critical frequencies were intermediate in value for a given geographic latitude, and in the absence of more precise data, a straight interpolation was made for these regions. An enormous improvement has been found by all users of these ionospheric forecasts.

Point Equivalence and the Hypothesis Relating Geomagnetic Latitude to Ionospheric Characteristics—New Plans

The failure of the latitude equivalence hypothesis for mapping and forecasting the normal characteristics of the F2 region of the ionosphere is one of the major radio propagation discoveries of this war. Because the locations of the existing ionosphere stations have been largely determined on the assumption that latitude equivalence did exist, it became necessary to reconsider the entire distribution of ionosphere stations throughout the world. Existing data were not yet sufficiently extensive to permit the final establishment of the longitude effect in precisely the terms previously discussed, and further investigation was necessary.

In the determination of the relationship between ionospheric characteristics, geographic latitude, and geomagnetic latitude—a relationship which must be presumed to exist—there were certain critical regions from which ionospheric observations would yield results of particular key importance. Such locations were:

1. The interior of the auroral zone.
2. Along the auroral zone.
3. At different points in the temperate regions having the same geomagnetic latitude.
4. At different points in the temperate regions having the same geographic latitude.
5. On the geographic equator.
6. On the geomagnetic equator in regions where it is respectively farthest north and farthest south of the geographic equator.
7. At the intersection of the two equators.

It is fortunate that data of good quality are available from two stations well within the northern auroral zone, namely, the U. S.-operated station at Clyde River, Baffin Island, and the U. S. S. R.-operated station at Tikhaya Bay in Franz Josef Land. Data from these stations have well repaid the effort and expense required to install them, for the data have demonstrated a fact of considerable importance not only scientifically, but of potential importance to postwar aviation, namely, that high frequency radio communication within the auroral zone is fairly reliable and easy to maintain with relatively little power.

It has now been clearly demonstrated that the auroral zone itself, at a given instant never very wide, acts as a barrier to high frequency radio communication. The southern limit of the barrier zone is variable depending upon the magnitude of a particular magnetic disturbance. Communication from points to the south of the zone up to the very edge of the zone is not too difficult. Communication between points within the zone is quite simple. It is the communication paths which cross the zone, and paths extending along the zone which suffer the full effects of heavy absorption and skip which frequently exist in these locations, and give rise of the effects often described as polar radio blackouts.

In connection with these polar studies the stations at College, Churchill, and Reykjavik, have been invaluable in explaining the ionospheric phenomena associated with the auroral zone itself.

There existed a chain of stations in geomagnetic latitude 20° North, namely Delhi, Trinidad, and Maui. A comparison of the first few month's data from the last two named U. S.-operated stations and the further comparison with the available data from Delhi revealed some surprising similarities in the diurnal characteristics of the F2 layer as observed at all three, despite their dissimilarities in geographic latitudes (see Table I).

TABLE I

Group	Latitude	
	Geomagnetic	Geographic
Arctic group:		
Clyde River [1]	82° N	70. 5° N
Tikhaya Bay [1]	72° N	80. 3° N
College [1]	65° N	65° N
Churchill [1]	69° N	59° N
Reykjavik [1]	70° N	64° N
20° N Geomagnetic Group:		
Delhi [1]	19° N	29° N
Maui [1]	20° N	21° N
Trinidad [1]	23° N	11° N
20 S Geomagnetic Group:		
Cape York [1]	21° S	11° S
Suva [1]	22° S	18° S
Rarotonga [1]	21° S	22° S
Pitcairn [1]	19° S	25° S
30 N Geographic Group:		
Baton Rouge [1]	41° N	30° N
Alexandria [1]	28° N	31° N
Delhi [1]	19° N	29° N

[1] Denotes stations at present in operation.

There is as yet no equatorial chain. The only data available at present come either from Trinidad which is 11° North of the geographic equator or from Huancayo 12° South of the geographic equator. This last named station has been in operation for many years and the daily characteristics of the F2 layer critical frequencies are unique in a number of respects, and of considerable significance in connection with point-to-point communications in all equatorial regions. These peculiarities are such as to require further investigation both theoretical and experimental. In the light of the present information of the *longitude effect* it appears likely that the characteristics observed at Huancayo are due to its location very near the geomagnetic equator.

Since one can no longer assume a simple latitude equivalence but must also introduce geomagnetic latitude, it seemed logical, in the absence of further observational material, to suppose that the ionosphere was statistically equivalent at the two points in the same hemisphere having the same geographic and geomagnetic latitudes. In other words it seemed reasonable to suppose that each existing station was equivalent to another station. If this point could be established then *each ionosphere station became equivalent to two stations* and present world coverage would be increased twofold without the addition of a single new station. Furthermore, precise information about regions inaccessible because of war or natural obstacles would become available by putting equivalent ionosphere stations in more accessible regions having the same geographic and geomagnetic coordinates.

There was a further interesting possibility which suggested itself. It was that, apart from a 6-month phase difference owing to the reversal of seasons between the northern and southern hemispheres, and provided account could be taken of any change in the solar activity, stations having the same geographic and geometric coordinates may be equivalent irrespective of whether they are north or south of the equator. This suggested the possibility that *each ionosphere station was in fact equivalent to three other stations*, and if it was possible to establish this equivalence experimentally by the installation of suitably located stations it would mean quadrupling effective world coverage.

There was one known difficulty involved in this last suggestion: It first had to be ascertained to what extent the *annual effect* between the two hemispheres was still important when geographic and geomagnetic latitude effects were removed. The annual effect was at one time believed to be quite important. There is reason to believe that some of the differences attributed in the past to *annual effect* may have been due to *longitude* effect. Again, from the point of view of obtaining critical data with which to settle this crop of new problems, a station on the intersection of the geographic and geomagnetic equators becomes of particular significance, since at such a station the shape of the diurnal curves for the December—January period, and the June—July period, should be *identical*, apart from any change in solar activity, if there is no annual effect Any difference which may be observed when corrected for the change in solar activity between the measurements period should give a particularly direct measure of the *annual effect*, since there will be no seasonal assymetry whatever on the geographic equator.

In connection with the possible equivalence of stations having the same geographic and geomagnetic coordinates for corresponding local times irrespective of hemisphere, it became important also to consider locating stations in the same geomagnetic and geographic coordinates on opposite sides of the equator. Several such pairs of stations exist. (See Table II.)

TABLE II

North-South Pairs	Latitude	
	Geomagnetic	Geographic
1. Maui, T. H.[1]	20° N	21° N
Rarotonga, N. Z.[1]	21° S	22° S
2. Huancayo, Peru [1]	1° S	12° S
Colombo, Ceylon [1]	3° S	7° N
3. Campbell Island, N. Z.[1]	57° S	53° S
Prince Rupert, British Columbia [1]	58° N	54° N
4. Watheroo, Australia [1]	42° S	30° S
Baton Rouge, La.[1]	41° N	30° N
5. Washington, D. C.[1]	50° N	39° N
Hobart, Tasmania	52° S	43° S

[1] Denotes stations at present in operation.

When all these stations have operated for a year or so, the world picture of the ionosphere will be greatly improved. It should then be possible to say whether a given station is equivalent to another station in the same hemisphere or to three other stations, one in the same hemisphere and two in the opposite hemisphere, or whether in fact any equivalence exists.

Equipment Notes

USING MINE DETECTOR OVER METALLIC SOIL

Various theater reports have indicated that metallic soils are often encountered in the field. In such areas Detector Set SCR–625–( ) (Mine) does not operate satisfactorily when used in the normal manner; the signal from the soil is so strong as to interfere with that from the mine which is being sought.

Land in the Pacific area is often characterized by volcanic soils and other soils with appreciable metallic content. These soils are so metallic that a strong signal is heard in the phones or resonator of a normally adjusted Detector Set SCR–625–( ) even when the search coil is held 2 feet above the surface of the ground. This effect masks the signal caused by any mines which are present. It is possible to adjust controls of the mine detector so as largely to overcome this difficulty, and make unnecessary any modification of the equipment. In fact, the results are in all cases comparable and in many cases superior to those achieved by various suggested modifications which would involve circuit changes, and permanently reduce the sensitivity of the equipment.

The method of adjusting Detector Set SCR–625–( ) to detect mines buried in metallic soil is as follows:

1. The detector is balanced in the normal manner, holding the detector head at least 3 feet above the ground.
2. The fine R Compensator is unbalanced until a maximum signal is heard in the resonator or headphones.
3. The detector sensitivity is reduced by manipulation of the battery compensator until a reading of three or four is obtained on the meter.
4. The fine X Compensator is adjusted for minimum signal.
5. The detector is then operated in the normal manner as close to the ground as practicable.

When the mine detector is again used over ordinary soils, its adjustment can be returned to normal, as described in the Technical Manual TM 11–1122. This normal adjustment should be used wherever conditions permit, as it is by far the most sensitive.

HEADSET COMFORT

When Headset HS–30 is worn under Helmet M–1, the head harness tends to press the wire head band of the headset into the skin, sometimes causing some discomfort. The ear inserts are also uncomfortably pressed into the ear by the head harness. Shaping the wire head band of the headset to fit the contour of the user's head will reduce this effect.

During a recent service test conducted by the Infantry Board, another simple and effective method of wearing Headset HS–30 under the helmet with a minimum of discomfort to the operator has been discovered. That method is as follows:

1. Adjust the metal head band of Headset HS–30 to give only sufficient pressure of the ear inserts within the ear for a good acoustical ear seal. Make this adjustment when not wearing Helmet M–1.
2. Remove one headphone from the headset by unlocking the wire loop by which the headphone is secured.
3. Slide the end of the metal head band, from which the earphone was removed, between the head harness and the liner of Helmet M–1.
4. Replace the headphone in the wire loop and lock it in place.
5. Helmet M–1 is then placed on the head and the headset adjusted (by bending the head band) in the same way as without the helmet.

Wearing the standard Headset HS–30 under the steel Helmet M–1 in this manner was found to be effective and comfortable. The headset, so adjusted, is just as comfortable to the operator as when worn without Helmet M–1. This adjustment can be made in the field without the use of special tools. Approximately 1 minute is required to install and adjust Headset HS–30 in Helmet M–1 for greatest comfort, or to remove the headset from the helmet.

MAINTENANCE

OUTLINE FOR REPAIR SHOP

The Signal Corps Engineering Laboratories have prepared a general outline for establishing repair facilities for a Signal Base Maintenance Company, based upon T/O and E 11–587.

The purpose of the outline is to furnish technical advice and information of both general and specific application concerning the organizing, equipping, and establishing of signal repair facilities. The outline includes the preparation of a building, recommendations for light and power distribution, heating, water supply, and sanitary systems. It covers considerations preliminary to installation of machinery and equipment; it includes detail floor plans which will establish the lay-out and areas required for each section of the shop; suggestions pertaining to requirements peculiar to each of the shop sections; shop administration and operations, including suggested forms and charts.

Copies of the outline will be made available to theater signal officers, for distribution to interested organizations within the theater, and should be of value to signal officers and shop officers, in the activation of new shops and improvement of existing installations.

Technical advice and assistance is available on matters relating to installation and operation of signal maintenance shops. Inquiries should be directed to Field Service Section, Maintenance Branch, Signal Corps Engineering Laboratories, 17th and Sansom Streets, Philadelphia 3, Pa.

SALT REMOVAL

Use of Spirits and Ether is LIMITED

The following extract was printed in an Engineer Technical Information Bulletin and has been quoted and given wide recirculation: *As a means of freeing electrical parts from salt water after immersion, methylated spirits and commercial ether have proved satisfactory. For instance, if a set of electrical metal screened leads from distributor to plugs has suffered damage by sea water, it should be immersed in ordinary methylated spirits, allowed to dry, and finally dipped quickly in commercial ether.*

The proposed method of removing salt and sea water from electrical equipment by immersing it in methylated spirits and commercial ether should be *limited* to porous materials such as fabrics, textiles, textile jacketed cords, like telephone drop cords, and possibly leather. It would *not* be effective for lacquered wire braids or relatively nonporous materials, such as plastics, even though these materials are sufficiently absorptive to deteriorate electrically. Due to the complex nature of communications equipments and the multiplicity of materials used, it is not believed applicable to completed or assembled equipments.

The reconditioning of electronics equipments that have been immersed in sea water requires a thorough rinsing to remove any trace of salt. The proposed method on its face merely reduces the concentration of the salt solution and is, therefore, not considered adequate for electronic equipment.

It is recommended that such reconditioning be accomplished by the method outlined in paragraph 24 of TB SIG 13, which method has been tried, proved and long been advocated by the Navy which is experienced in such matters. This proposed method should be used only as an absolute emergency measure and the equipment be thoroughly reconditioned by the method given in TB SIG 13 when the emergency is over.

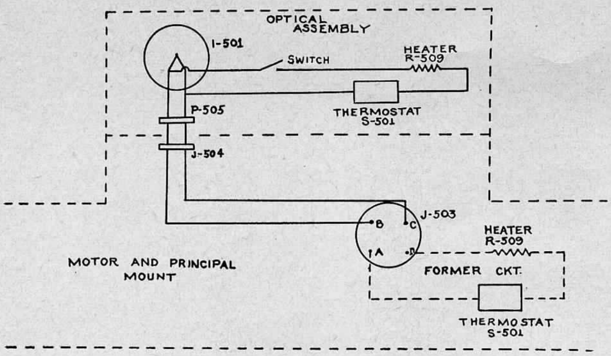
RELOCATING HEATER CIRCUIT IN SCR–291

The original circuit of BC–1159–A provided for a thermostatically controlled heater circuit to prevent the front bearing lubricant from stiffening at low temperatures. (See fig. 76 in TM 11–243.) Absence of low temperatures in tropical areas rendered this circuit useless.

Excessive precipitation and high humidity gave rise to a problem in the optical assembly of Bearing Indicator BC–1159–A. Moisture would form on the acetate mirror in the optical housing, distorting the pattern on the scope. To solve this problem, the heater circuit was adjusted and relocated. A detailed description follows:

1. Heater R–509 and Thermostat S–501 are disconnected from A and D of J–503. (Reference fig. 76, section 3 of TM 11–243.)

2. Thermostat S–501 is adjusted to open at approximately 300° F.



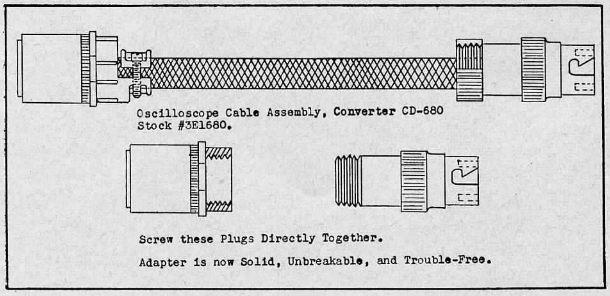
3. Electrical circuit: Heater R–509, Thermostat S–501, and a single-pole single-throw switch are wired in series from the terminals of P–505 (fig. 76, TM 11–243.)

4. When moisture is present on the mirror, the switch is thrown, closing the heater circuit and evaporating the moisture. The thermostat becomes merely a safety feature.

5. Physical location of circuit: Heater R–509 and Thermostat S–501 are set beneath the acetate mirror in the optical housing. The switch is installed on the removable panel on right hand side of optical housing, easily accessible to operator. (Fig. 6, sec. 1, TM 11–243.) Wiring does not interfere with the optical housing when it is swung back to remove cathode-ray tube.

MODIFICATION OF ADAPTOR CABLE

It has been suggested by a technician of the 9th Service Command that a simple modification of Adaptor Cable 108, CD–680 will save time in its repair and prevent further trouble. Cable 108 is employed when the spare oscilloscope BC–412 is used in the azimuth or elevation position on Radio Set SCR–268 (the spare oscilloscope is normally wired to display range and IFF signals when used with SCR–268). Cable CD–108 is shown in Technical Manual TM–11–1118, sketch g, figure 37, page 34. This cable is short in length and is often broken, shorted, or loosened by twisting and use.



The proposed modification results in a rigid, trouble-free adaptor.

The modification is made as follows:

1. Cut a thread on the inside of the outer end of amphenol plug No. 3106W–24–684P to the same size as the thread on the end of the Russell-Stroll plug No. 8098 BRC, A–55–A–1514–1.

2. Connect separate flexible wires to these plugs and screw the plugs together, thus eliminating the flexible interconnecting cable.

ARMY PICTORIAL

PORTABLE FOLDING PROJECTION SCREENS

The Signal Corps requirements for projection screens have been considerably modified by two factors, the shifting of the military balance to the Pacific area, and the general increase in the size of motion-picture audiences. According to reports received from the Pacific and China-Burma-India theaters, screens now in use are too small for present audience sizes, and are in addition bulky, difficult to transport, and highly subject to weather attack.

Two large, new portable folding projection screens, PH–555/GF and PH–556/GF, will soon be available in the field, and will meet the need for a large, compact, and weather resistant screen equipment. The screens, as illustrated in figure 1, are the first in Signal Corps use which have been designed especially for large audience projection under difficult weather and field conditions. Screen sizes are supplied with effective picture areas of 7′ 11″ x 9′ 6″ (Screen PH–555/GF), and 10′ 6″ x 14′ (Screen PH–556/GF).

The screen is composed of three units: Screen proper, frame assembly, and fiber carrying case. The frame is of rigid, lightweight, corrosion-

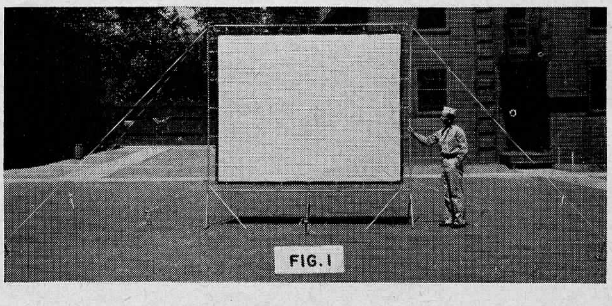


FIG. 1

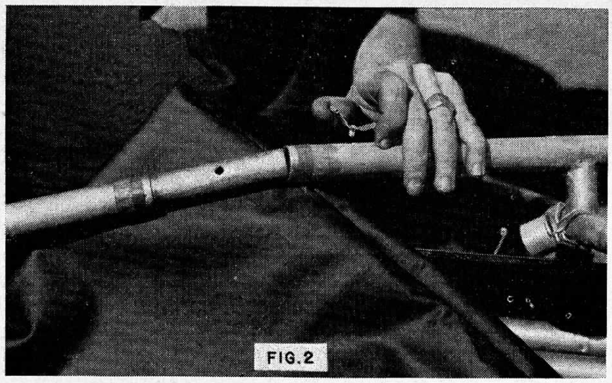


FIG. 2

resistant metal construction. Each frame section locks into its mating part by means of a pin and socket joint with a locking pin and spring, as shown in figure 2. Mating parts are indicated by coded rings or numbers for facilitation of assembly.

When assembled, the frame is braced to stand without support in reasonably still air, and is fitted with rings or eyes to accommodate eight guy ropes. Each rope is fitted with a snap fastener for attachment to the screen frame, and held at the ground end by eight metal tent stakes. When all guy ropes are installed, the screen is stable and usable even under windy conditions. The entire screen is adjustable in height from 2 to 6 feet above the ground and may be set up by two operators within 30 minutes time.

The screen proper is made of a semidiffusing white reflecting material with a black border and fittings permitting spring attachment to the frame as shown in figure 3. The screen material is capable of compact folding during transportation, and will withstand several hundred complete folding and unfolding operations over a considerable temperature range without surface cracking. In addition, it may be stored at temperatures as high as 185° F. and as low as minus 40° F.

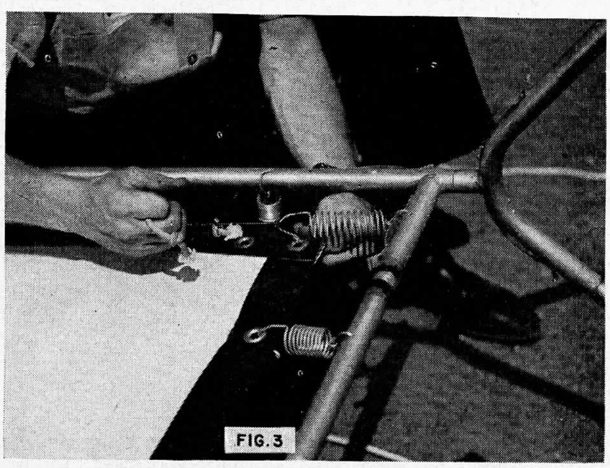


FIG. 3

These screens conform in construction, finish, and screen size with the proposed American War Standard Z52.58, and with Signal Corps Tentative Specification No. 75–449. The characteristics of the screen were developed by manufacturers and representatives of the armed forces in conjunction with the American Standards Association War Committee on Photography and Cinematography.

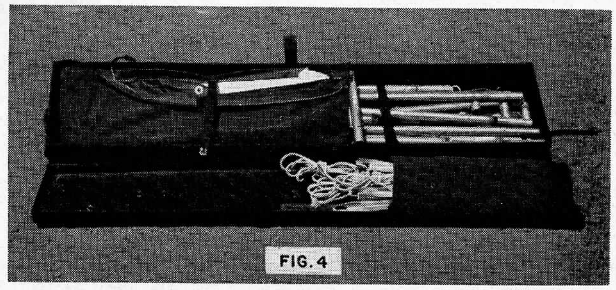


FIG. 4

The practicality of screen design and construction is illustrated in figure 4. The folded screen material fits compactly in the zipper carrying bag at the upper left. The frame sections are nested in the upper right, while guy ropes, stakes, and accessories are stowed in the pocket at lower right. The entire equipment weighs about 70 pounds, and may be carried by one person.

WIRE WD-1/TT

(Correction)

THE TABLE of field wire characteristics, published in the article on Wire WD–1/TT is SCTIL No. 43, June 1945, contained an error in the figures for breaking strength. Wire WD–1/TT has a breaking strength of 150 pounds per twisted pair or 85 pounds per single conductor. The other figures for breaking strength are all for single conductor. Weight of Wire WD–1/TT is 48 pounds, per twisted pair mile as indicated in table.

Winter is the time for the discomforts of snow, ice, and battery failures. To keep a battery in satisfactory condition and to insure long life, keep the battery clean outside, add pure water at regular intervals, and maintain a healthy state of charge without overcharging. Overheating of batteries is caused by overcharging or charging at too high a rate.

MILITARY TRAINING

ANTIJAMMING RECORD SET

Record Set AN/GNQ–11 is used for radio antijamming training and contains the following 12-inch, 78 r. p. m. (standard size, standard speed) phonograph records:

1. Instructional records.
2. Jamming sounds (three records).
3. Code and jamming (three records).
4. Test of ability to listen in noise (two records).
5. Test of ability to listen in bagpipes jamming (two records).

Instructional record.—A phonograph record of two sides playing for approximately 10 minutes and illustrating sounds described in TB Sig 5, including several types of jamming, and sounds of antijamming techniques. Illustrated are: spark jamming, sweepthrough jamming, bagpipes jamming, noise jamming, howl jamming, c-w jamming, random keyed c-w jamming, the sound of the techniques of telling whether interference is jamming or not (disconnecting the antenna and checking the tuning of the interference signal), use of crystal filter, use of beat frequency oscillator, use of tuning control, use of gain control and the effect of changing from voice operation to c-w operation.

Jamming sounds records.—Three records of two sides each, consisting of a single type of jamming for approximately 5 minutes on each side. Six types of jamming are thus illustrated: noise, bagpipes, spark, random keying, howl and sweepthrough. These records are useful for furnishing jamming sounds for listening through jamming training in connection with code training or separately for voice radio operators. They can be used in connection with special playback equipment to modulate radio transmitters for jamming for training.

Code and jamming records.—Three records of two sides each with international Morse code and two types of jamming at three different levels. All code is 10-words-per-minute and taken from tape No. 9, appendix II, TM 11–432, Code Practice Equipment, 2 February 1942. There are the following six sides of approximately 5 minutes each:

1. One record with one side code with low-level noise, and the other side code with low-level bagpipes.
2. One record with one side code with medium-level bagpipes, the other side code with high-level bagpipes.
3. One record, code with medium-level noise, the other side code with high-level noise.

Test of ability to listen in noise.—Two records of two sides each with instruction sheet, sample test blanks and list of answers constituting a test for ability to understand sentences spoken in noise.

Test of ability to listen in bagpipes jamming.—Two records of two sides each with instruction sheet, sample test blanks and list of answers constituting a test for ability to understand sentences spoken in bagpipes jamming.

BC–610 CONVERSION FOR HIGH SPEED KEYING

When the fixed station radio course of the Officers' School, ESCTC, was implemented by the addition of a simulated administrative net in which field operating conditions were to be duplicated as nearly as possible, one problem of considerable interest arose. A transmitter was required for use in Boehme and keyed carrier radio teletype circuits with the following characteristics:

1. It had to be small and capable of operation from mobile power units in order to reduce the installation time and effort to a minimum.
2. It had to have sufficient power output and frequency stability to provide good operation of Boehme and radio teletype circuits over limited distances.
3. It had to be capable of providing a good wave shape at high keying speeds (up to 150 words per minute).

The transmitter finally selected as most nearly meeting the requirements was the BC–610, principal component of Radio Set SCR–299/399/499. However, to satisfy the high keying speed requirement, it was necessary to modify the keying arrangements normally used in the BC–610.

Keying in the BG–610 takes place in the cathode circuit of the oscillator stage, either directly by means of a key, as in the older models, or indirectly by means of a relay, as is used in the newer models. Neither of these arrangements is suitable for operation at high speeds. It was therefore decided to

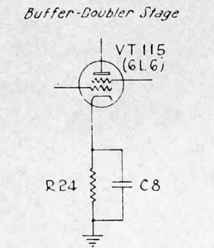


FIG. 1

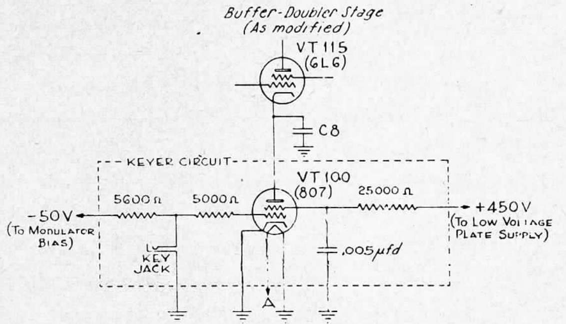


FIG 2

install an electronic keyer in the cathode circuit of the buffer doubler tube and to permanently close the cathode circuit of the oscillator stage, thus making the oscillator continuously active.

The electronic keyer used for this purpose is one which was employed by the radio division of the Sixth Army Group, and is described in a publication entitled, *Mobile Wire and Radio Installations—Sixth Army Group.* Figure 1 shows the cathode circuit of the buffer doubler stage before modification. Figure 2 shows how this circuit was modified by inclusion of the electronic keyer. The keyer components, those within the area bordered by the dashed lines in figure 2, were all mounted on a bakelite base (see fig. 3) and installed within the BC–610 in the space adjacent to the final amplifier tube.

To facilitate installation and removal of the keying circuit, flexible leads terminating in alligator clips were provided for the necessary circuit connections. Since the keyer tube is identical to those used in the intermediate amplifier section of the BC–610, filament voltage was obtained by merely tapping onto the filament circuit of the intermediate amplifier tubes. Screen voltage was obtained by tapping onto the low voltage plate supply, and grid bias by connection to the modulator bias rheostat on the front panel. The cathode circuit of the oscillator tube was closed by shorting the keyer terminals in the rear of the transmitter. Thus the only physical change necessary in the circuit of the BC–610 was made by opening the cathode circuit of the buffer doubler tube on the cathode side of Resistor R–24, and clipping on the keyer plate lead at this point.

In actual use the BC–610 thus modified works satisfactorily at speeds up to 150 words per minute. The system is capable of operation at speeds in excess of 150 words per minute but may produce undesirable interference, since no effort has been made to shape the keying pulses. Both Boehme and keyed carrier radio teletype transmissions have been made using this equipment, with entirely satisfactory results. Particularly good results were noted when the transmitter was used as part of the keyed carrier radio teletype circuit in which a maximum keying speed of no more than 60 words per minute was required. Use of the BC–610 for this purpose is not new. It has already found fairly wide application in the field, particularly in the CBI Theater.

(A similar method of keying Radio Transmitter BC–610 is utilized in Radio Set AN/MRC–1. Radio Set AN/MRC–1 is a mobile high-speed high-power radio set which is based on Radio Set SCR–399 and includes in addition a 2-kw. amplifier and high-speed Boehme equipment.)

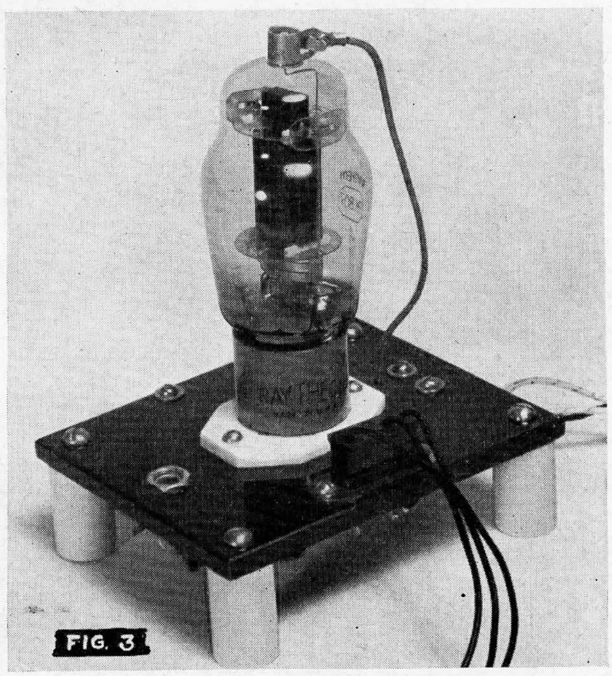


FIG. 3

(*Continued from page 6*)

Comparative measurements have not been obtained on Group III, IV, and V equipments, but it is estimated that the ratios between the maximum number of tandem relay sets operable in the field to the maximum number operable under laboratory conditions will remain approximately the same for the later models as for Group I and II models. It is believed, however, the maximum number of tandem radio relay sets that may be operated satisfactorily with Group V models on a multichannel basis when using only channels 1, 2, and 3 or on a single-channel basis will be determined by the cumulative practical operating limitations.

There are a number of improvements that have been incorporated in the later models that may be of interest when planning long or parallel systems. One of these improvements has to do with the audio filter in the *order wire* input circuit of the radio transmitters. In the Group I sets this filter did not cut off at the upper edge of channel 1, but passed frequencies that appeared in the upper channels, especially in the lower edge of channel 2. This fault was corrected to a slight extent in Group II and III models and further corrected in the Group IV and V models to the extent that crosstalk from the *order wire* into channel 2 is no longer noticeable.

Spurious radiations of serious magnitude were produced by Group I transmitters. These radiations were reduced in magnitude progressively in the Group II, III, and IV models. A modification has been developed for these early models that will reduce the spurious radiations and increase the output power obtainable from the transmitters. This modification consists of substituting double tuned transformers for the original single tuned transformers, T3 and T4. The new double tuned

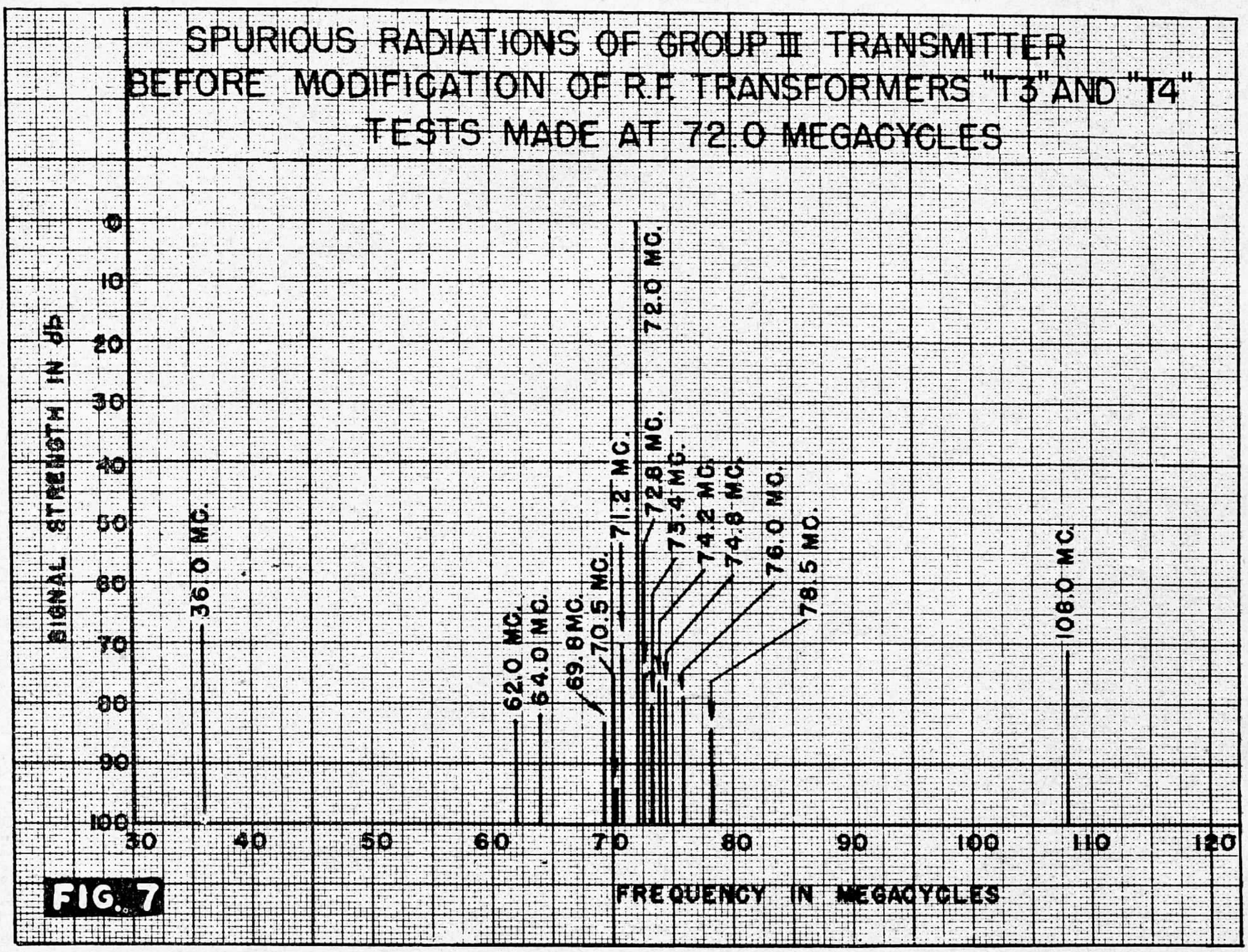


FIG. 7

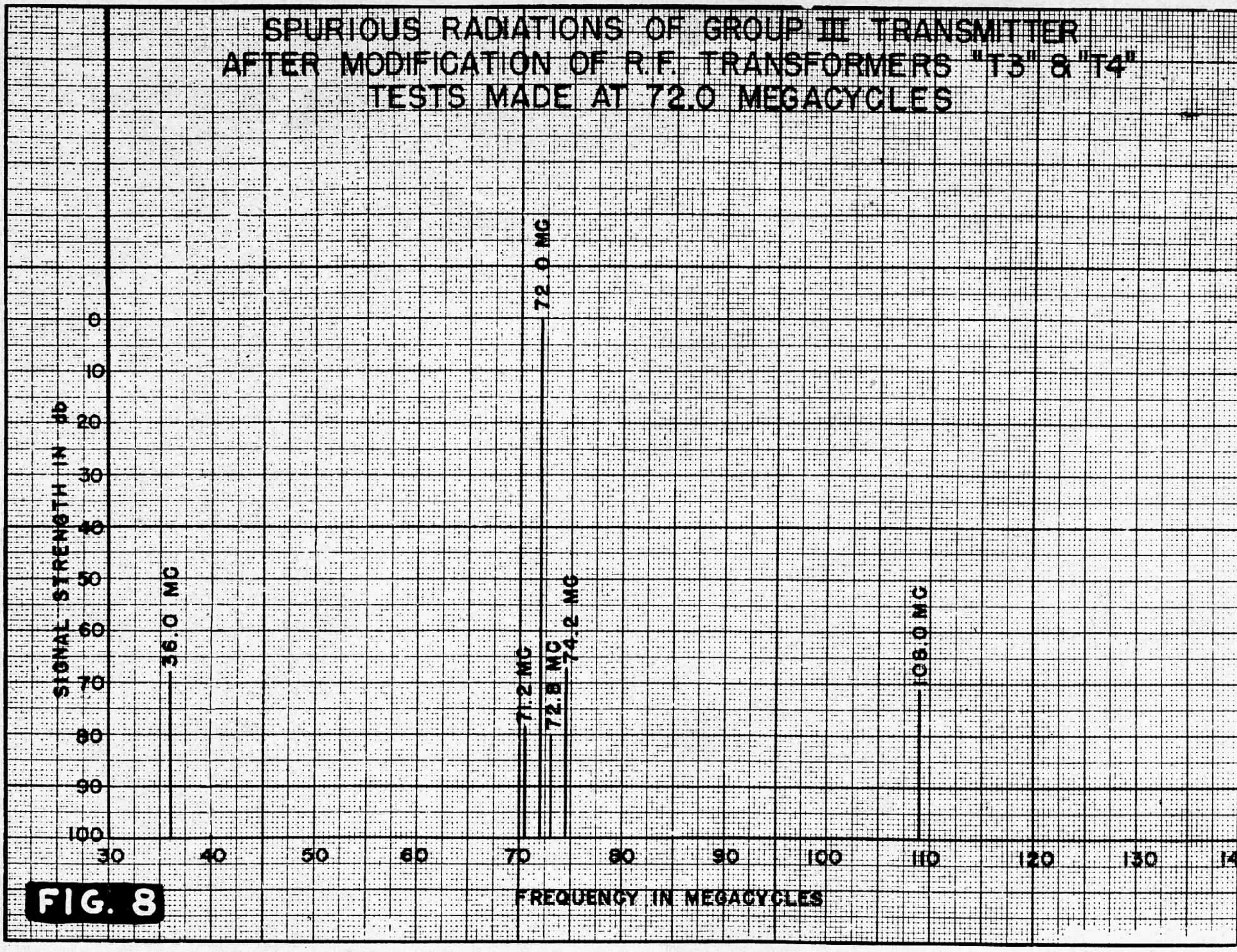


FIG. 8

transformer T3 is Rauland Corporation Part No. LW–0038 or Lear, Inc. Transformer T3, Model T–14G, Lear Drawing No. B71764–1. The new double tuned transformer T4 is Rauland Corporation Part No. LW–0039 or Lear, Inc. Transformer T4, Model T–14G, Lear Drawing No. B71726–1. Figure 7 shows the signal strength of the spurious radiations relative to that of the carrier for an average Group III transmitter. Figure 8 indicates the improvement achieved by the modification and is indicative of Group V transmitter performance.

The transmitters associated with Groups I, II, and III all have dead spots from 83 mc. to 85 mc. inclusive. This fault was inherent in the original design of the crystal oscillator circuit. A modification has been devised to correct this fault, and information concerning the modification was published in the Signal Corps Technical Information Letter for June 1945 (No. 43, p. 28, fig. 6).

(Note.—Capacitor values shown in the drawing in June SCTIL are not critical, and small deviations may be made in order to utilize components more readily available in the field. For instance, 5100-mmf. capacitors may be substituted for the 0.005-mf. capacitors shown, and a 39-mmf. unit may be used in place of the 40-mmf. capacitor which bypasses the 770-microhenry coil added between R6 and the 6SN7 plate. Such small changes will not affect the performance of the modified equipment.)

The dead spot has been eliminated in production of Group IV and Group V models.

The receivers associated with Groups I, II, and III have a tendency to oscillate during the tuning procedure. This fault has been corrected in the receivers of later models. The oscillator amplifier stage tends to act as tuned-grid tuned-plate oscillator, but by the insertion of a 50-ohm, ¼-watt carbon resistor in the grid lead of the oscillator amplifier tube V112 this can be overcome. The first limiter stage tends to oscillate continuously due to improper bypassing of the tuned plate circuit to ground. The lead from the +B terminal on Transformer T108 to capacitor C130 is cabled with other wiring for a length sufficient to provide the coupling necessary to cause this stage to oscillate. This fault can be overcome by connecting a 0.005-mf. (or 5100-mmf.) capacitor between the +B terminal of Transformer T108 *at the transformer*, and the ground lug of the first limiter tube socket (V107). This modification was fully described in SCTIL No. 43, June 1945 (fig. 7, p. 28).

The details of a modification to suppress the harmonics generated within Test Oscillator TS–32( )/TRC–1 that fall within the i-f bands of the Radio Receiver R–19( )/TRC–1 are shown in figure 9, page 29, SCTIL No. 43, June 1945, which illustrates the insertion of a 120 microhenry choke (Sig. C. Stock No. 3C362–2) in the lead between switch S401 and pin No. 4 of Plug P402. (The ungrounded side of Capacitor C414 should be connected to the junction of Switch S401 and the 120 microhenry coil.) This modification applied to Test Oscillators TS–32/TRC–1, TS–32A/TRC–1, and TS–32B/TRC–1 except the following specific TS–32B/TRC–1 model equipments:

(*a*) All on Order No. 533–MSCPD–45, manufactured by Lear Inc.

(*b*) On Order No. 532–MSCPD–45, manufactured by Rauland Corp., serial numbers 78, 129, 185, 217, 238, 247, 251 through 256, 259, 261, 264 through 267, 269, 272, 273, 279, 281 through 283, 287 through 291, 294, 295, 299, 302, 305, 316, 326, 333, 336, 337, 357 through 359, 365, 367, 368, 385, 403, 411, 415, 422, 424, 425, 431, 433, 435, 448 through 450, 466, 477, 478, 487, 489, 700, 702, 703, 713, 737, 755, 802, 808, 818, 830, 831, 858, 867, 870, 888, 890, 1134 and higher. The modification is incorporated in the equipments listed in (*a*) and (*b*) above and all of the later models.

With the carrier control switch on local operation, receiver muting is provided for simplex operation on Group IV and V models. This is accomplished by short-circuiting the loud speaker voice coil through contacts on the throw-over relay. This feature is not provided on the earlier models.

(NOTE.—Additional engineering data concerning multichannel radio relay systems appears in TM 11–486, Electrical Communication Systems Engineering, chapter 6, par. 622).

TABLE II.—*Summary of Signal-to-Noise Requirements for Talking Circuits*

	Maximum tolerable combined noise and crosstalk per channel (line weighting) [1]	
	At broadband output of terminal radio receiver—nominal "0" level	At 2-wire output of carrier tel. terminal-nominal —6db level
Case 1.—Point-to-point system containing 3 radio relay sets (4 relay sections):		
Per system	64 dbRN [2]	58 dbRN.
Per relay section	58 dbRN	52 dbRN.
Case 2.—Radio Relay System containing 3 radio relay sets (4 relay sections) with 6 db extensions at each terminal:		
Per system	58 dbRN [2]	52 dbRN.
Per relay section	50 dbRN	44 dbRN.
Case 3.—Radio Relay System as "via" circuit:		
(*a*) 5 systems in tandem, each containing 3 radio relay sets (4 relay sections) connected on a 4-wire basis. 6 db over-all circuit:		
Per system	57 dbRN [2]	51 dbRN.
Per relay section	51 dbRN	45 dbRN.
(*b*) 5, 6 db systems in tandem, each containing 3 radio relay sets (4 relay sections) 30 db over-all circuit.		
Per system	39 dbRN [2]	33 dbRN.[3]
Per relay section	33 dbRN	27 dbRN.
Case 4.—Same as case 2 except with 12 db extensions:		
Per system	52 dbRN [2]	46 dbRN.
Per relay section	44 dbRN	38 dbRN.
Case 5.—Push-to-Talk Single Channel System:		
Per system (voice only)	70 dbRN	
Per relay section	70–10 log (No. of relay sections).	

[1] Line Weighting refers to a weighting network, the attenuation versus frequency characteristic of which takes account of the relative interfering effects of different noise frequencies in a telephone receiver.

[2] With terminal radio receiver output adjusted to —5 dbm as called for in TB Sig 78, reduce these values by 5 db.

[3] It should be noted that this particularly severe requirement at the —6 db level point for a single system results from the fact that this same point is a —30 db level point when the particular circuit is used as a "via" truck at the terminus of a built-up connection.

NOTE.—90 dbRN = "0" dbm = 1 milliwatt into 600 ohms.

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A Victory Message

Our third and probably our toughest objective is the return to civil life of all the officers and men whose services are no longer needed and who wish neither extended active duty nor selection for the Regular Army. With millions of men overseas as well as here in the United States, this is a tremendous job that will take many long months to accomplish. I know that today the thoughts of nearly everyone of you are on home and how soon you can get there. I wish it were possible for every man to eat his Thanksgiving Day turkey with his family and to open his presents by the Christmas tree in his own home. I can only ask you to be patient and reasonable and to do everything in your power to help speed the rate of return of our men to the United States.

Our fourth obligation is to assist the communication industry in the United States—which has backed us up so valiantly—to reconvert their plants and resume their normal peacetime operations. This applies to the manufacturing industry and the operating communication companies. We must keep faith with the industry which dropped everything immediately after Pearl Harbor and devoted all its resources toward helping the Armed Forces win the war. There are many ways in which we can assist. In the United States, we must push contract terminations, promptly remove Government equipment and material from plants, and promptly make partial payments to enable our former contractors to finance early conversion of their plants to meet civilian needs. Our people overseas can help by prompt and accurate inventory of their stocks, repair of unserviceable equipment, immediate and secure packaging of equipment, disposal or return to the United States of excess stocks, and particularly by a realistic reduction in requirements to meet only the needs of the occupational forces.

And now I come to our last objective: *the molding of a large and well-qualified Officers' Reserve Corps and Enlisted Reserve Corps.* America's tradition does not call for a large Regular Army, and our country has always depended in its time of need largely upon a citizen army since our forefathers gathered in the town square with their squirrel rifles to meet trouble.

Our military policy of the future won't be much different from that of a century or two ago, but we must realize that war has changed from the flintlock to the Garand, and from Paul Revere to radio relay. Consequently, we must fashion our traditional policy of a citizen army to meet the complexities of modern warfare. This will be done by organizing those officers and men who wish to be available when an emergency arises into an efficient Reserve Corps.

For the necessity of a Reserve, I can point to the Signal Corps Enlisted Reserve numbering more than fifty thousand that was built up in 1942 to meet the great deficiency of technically qualified communications men that faced the Army in those gloomy days. This Reserve, hastily as it was formed and trained, provided the Signal Corps with a backbone of young men who knew their job. But if there had already existed in 1942 a large Enlisted Reserve of skilled signalmen, that desperate last-minute rush could have been avoided.

I have enumerated and explained to you our five objectives. But whether you choose to continue in the service or return to civil life, I hope you carry with you an appreciation of what your Army has done and the knowledge that it has saved our way of life. If you do not lose sight of the lessons learned, then you will keep that Army strong and vigorous and able to guard in the future what has been saved.

H. C. Ingles

H. C. INGLES
Major General
Chief Signal Officer

Radio
Transmission
Security is

YOUR RESPONSIBILITY

HIS PROTECTION !