RADIOMAN 1 & C

NAVY TRAINING COURSES

NAVPERS 10229-B

RADIOMAN 1 & CHIEF

Prepared by
BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE

NAVPERS 10229-B

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PREFACE

This book is written for Radiomen of the United States Navy and Naval Reserve who are seeking advancement in rating to RM 1 or RMC. Study of this text should be combined with practical experience, with review of other applicable Navy training courses, with a study of pertinent communication procedural publications, equipment instruction books, and other appropriate material.

Qualifications for advancement to Radioman 1 and C are listed in appendix II. Since the examinations for advancement are based on these qualifications, it is suggested that you study them frequently.

It should be remembered that particular models of radio, teletypewriter, and direction finder equipment become obsolete rapidly, so you may find yourself working with equipment which differs from that described in this training course.

As one of the NAVY TRAINING COURSES, this book has been prepared by the U. S. Navy Training Publications Center for the Bureau of Naval Personnel.

READING LIST

NAVY TRAINING COURSES

Radioman 3 & 2, NAVPERS 10228-B
Basic Electricity (chapters 1 through 5; 7, 8, 13), NAVPERS 10086
Basic Electronics (chapters 1 through 9; 11, 12, 13), NAVPERS 10087
Electronics Technician 2, Vol. 1 (chapters 1 through 8), NAVPERS 10190-A

OTHER PUBLICATIONS

ACPS (effective editions) 121, 122, 124, 125, 126, 127, 149
DNC 5, 14, 26
NWP 16, NWIP 16-1
U. S. Navy Safety Precautions (chapter 18), OPNAV 34P1
Handbook of Test Methods and Practices (articles 3-1 through 3-6), NAVSHIPS 91828-A

USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your information and education officer.* A partial list of those courses applicable to your rate follows.

Correspondence

Number	*Title*
MB 290 or CB 290	*Physics I*
MB 291 or CB 291	*Physics II*
MA 332	*Typewriting II*

Self-Teaching

CA888	*Radio Communication I*
CA 889	*Radio Communication II*

* "Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll in USAFI courses, services, and materials if the orders calling them to active duty specify a period of 120 days or more, or if they have been on active duty for a period of 120 days or more, regardless of the time specified in the active duty orders."

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*Recommendation of petty officers, officers and approval by commanding officer required for all advancements.

INACTIVE DUTY ADVANCEMENT REQUIREMENTS

REQUIREMENTS*		E1 to E2	E2 to E3	E3 to E4	E4 to E5	E5 to E6	E6 to E7A
	FOR THESE DRILLS PER YEAR						
TOTAL TIME IN GRADE	24 OR 48 12 NON-DRILLING	9 mos. 9 mos. 12 mos.	9 mos. 15 mos. 24 mos.	15 mos. 21 mos. 24 mos.	18 mos. 24 mos. 36 mos.	24 mos. 36 mos. 48 mos.	36 mos. 42 mos. 48 mos.
DRILLS ATTENDED IN GRADE#	48 24 12	27 16 8	27 16 13	45 27 18	54 32 20	72 42 32	108 64 38
TOTAL TRAINING DUTY IN GRADE#	24 OR 48 12 NON-DRILLING	14 days 14 days None	14 days 14 days None	14 days 14 days 14 days	14 days 28 days 14 days	28 days 42 days 28 days	42 days 42 days 28 days
PERFORMANCE TESTS				Specific ratings must complete applicable performance tests before taking examination.			
PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS)		Record of Practical Factors, NavPers 1316, must be completed for all advancements.					
NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS)		Completion of applicable course or courses must be entered in service record.					
EXAMINATION		Standard exams are used where available, otherwise locally prepared exams are used.					
AUTHORIZATION		District commandant or CNARESTRA					BuPers

*Recommendation of petty officers, officers and approval by commanding officer required for all advancements.

#Active duty periods may be substituted for drills and training duty.

THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

The United States Navy is responsible for maintaining control of the sea and is a ready force on watch at home and overseas, capable of strong action to preserve the peace or of instant offensive action to win in war.

It is upon the maintenance of this control that our country's glorious future depends; the United States Navy exists to make it so.

WE SERVE WITH HONOR

Tradition, valor, and victory are the Navy's heritage from the past. To these may be added dedication, discipline, and vigilance as the watchwords of the present and the future.

At home or on distant stations we serve with pride, confident in the respect of our country, our shipmates, and our families.

Our responsibilities sober us; our adversities strengthen us.

Service to God and Country is our special privilege. We serve with honor.

THE FUTURE OF THE NAVY

The Navy will always employ new weapons, new techniques, and greater power to protect and defend the United States on the sea, under the sea, and in the air.

Now and in the future, control of the sea gives the United States her greatest advantage for the maintenance of peace and for victory in war.

Mobility, surprise, dispersal, and offensive power are the keynotes of the new Navy. The roots of the Navy lie in a strong belief in the future, in continued dedication to our tasks, and in reflection on our heritage from the past.

Never have our opportunities and our responsibilities been greater.

RADIOMAN 1 & CHIEF

CHAPTER 1

TRAINING AND SUPERVISION

INTRODUCTION

You have demonstrated ability in many areas of communications since you first started to strike for Radioman. You can operate and maintain transmitters, receivers, and associated equipment; stand watch on a 25-word-per-minute fleet circuit; keep essential radio logs and records; and work handily with call sign books and other important communication procedural publications.

Having mastered the skills of your present rate you are now ready to broaden your knowledge. As a First Class or Chief Radioman you must, for example, inspect and adjust electronic equipment in radio spaces, read and interpret circuit schematic diagrams, and serve as traffic checker at your ship or station. In addition to these technical skills you need the ability to lead men, for you will take on many supervisory responsibilities. You must, for example, be able to train Radiomen and TE(RM's) (those Telemen in the process of coverting to Radiomen) at underway watches and general quarters; instruct other communicators in CW and radiotelephone procedure; and supervise a communication office afloat or ashore. Appendix II lists these and other First and Chief quals which will test your ability as a leader and supervisor. Check up on yourself by reviewing these quals. You may find that, even though an experienced communicator, you need further preparation to qualify as a supervisor.

PREPARING YOURSELF

A review of the following sources of information will help prepare you for supervisory duties. If you have already served as a supervisor or instructor, the references may provide additional information to help improve your methods of supervision and instruction.

As a starter, study chapters 6 and 7 of *General Training Course for Petty Officers* (NAVPERS 10055). Chapter 6, The Navy's Training Plan for Enlisted Personnel, discusses the over-all Navy training organization and the factors and steps in training. Chapter 7, How to Teach Navy Men, reviews the various methods and presents typical teaching situations. You can apply this information in specific training situations afloat or ashore.

The *Manual for Navy Instructors,* NAVPERS 16103–B also contains information of value to the conscientious instructor or supervisor. Read this manual to improve your instructional techniques.

Study also the *Shipboard Training Manual,* NAVPERS 90110. Part I of the manual describes a shipboard training program. You can put some of these ideas to work in your own training program.

Make a habit of reading the *Naval Training Bulletin,* NAVPERS 14900. It contains articles on the latest training methods practiced ashore and in the fleet. You may find the answer to a training problem in one of the articles. The following training films will also be helpful:

MN 5795G Educational Services—Methods of Teaching.

MN 6753A Training Aids—Selection and Planning.

MN 6753B Training Aids—Classroom Utilization.

The publications and films referenced above provide general information useful in teaching almost any subject. From them you can learn much about organizing a training program and improving instruction methods.

YOUR TRAINING PROGRAM

Your ability as a supervisor can best be demonstrated in the communication division training program. Although the communication officer has direct responsibility for organization of a training program, a Radioman First or Chief is usually assigned to administer it. On a large ship or communication station you may be required to indoctrinate new communicators, supervise on-the-job training, organize classes and schedules, procure training aids, and prepare programs for advancement in rating. To assist you the communication officer may assign several other lower-rated Radiomen or TE(RM's).

On small ships the training program is usually administered directly by the communication officer as collateral duty. The senior RM is frequently designated as his assistant.

The next section of this chapter discusses suggested communication training programs both afloat and ashore. As supervisor, bear in mind that a training program must be flexible. Factors to consider are the size of ship, needed emphasis on certain phases of the program, and extent of integration with the all-hands shipboard training program.

COMMUNICATION TRAINING AFLOAT

Indoctrination

When a new man reports aboard to the communication division, it is to your advantage to set up an indoctrination schedule for him. The sooner a newcomer becomes adapted to his new assignment, the sooner he becomes a valuable member of the communication team. A man's background and previous tours are indications of how long the orientation period should last. Usually a few days to a week is enough time to square him away.

First you'll want to assign the new communicator to a bunk and locker, then introduce him to all hands in the "OC" division. Arrange a tour of the ship for him, concentrating on communication spaces. Encourage him to ask questions about unfamiliar equipment or procedures. A thorough explanation will square him away sooner. Go over the communication division watch, quarter, and station bill and show him just where he will fit in. He will realize he will soon be filling a responsible position on the bill.

Several publications should be made available to your new man to acquaint him with the ship's functions and with his own division's responsibilities. Check out copies of the ship's organization and regulations manual, ship's communication instructions, and the operations department or communication division organization manual. It's a tall order to read through these publications page for page; so point out sections of each that are particularly applicable and important to your new man.

The radio shack is the best place to review ACP's, JANAP's, and other communication publications. Your new man can study them during the regular watch stander's slack periods.

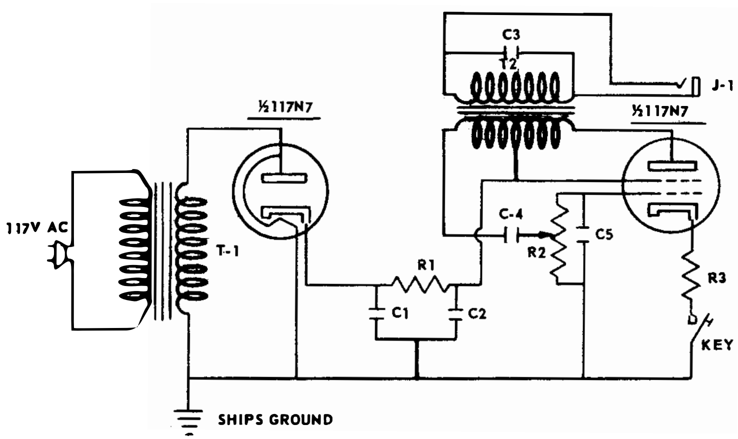
You'll find it will pay to spend as much time as you can with the new communicator during his orientation period. He'll get squared away faster and you'll save yourself time later on.

Qualifying for Circuit Watches

Graduates of Radioman school reporting aboard ship are often inexperienced in shipboard communications. They will need further training to qualify for circuit watches. Men recruited from other divisions because of communication personnel shortages must be trained immediately in the fundamentals of radiotelegraphy to prepare them for circuit watches. A situation of this kind calls for an intensive training program capable of producing quick and satisfactory results.

Equipment

Your first step is to request space for a training room; then install operators' positions. Build these from plywood, and wire hand keys and phone jacks to a control position. From scrap parts construct an oscillator similar to the one in figure 1-1 and mount it in the control position. (On board ships provided with this practice oscillator it is a simple matter to patch it into remote keying positions.) Next, track down all typewriters in radio central and other radio spaces not in use. You are now ready to set up a daily drill circuit for your strikers. For wiring diagram see page 6.



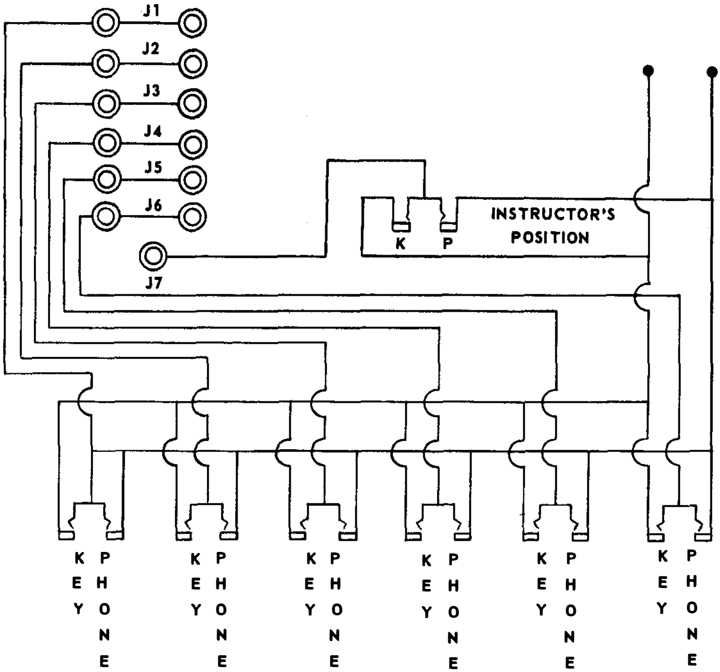
T-1	1:1 ISOLATION TRANSFORMER	C1/C2	20 MFD 150 VOLTS
T-2	ALMOST ANY TYPE OF INTERSTAGE AUDIO TRANSFORMER CAN BE USED	C-3	.01 MFD 200 VOLTS
		C-4	.01 MFD 200 VOLTS
R-1	300 OHMS 2 WATTS	C-5	.001 MFD 200 VOLTS
R-2	500 K POTENTIOMETER	J-1	PHONE JACK
R-3	600 OHMS ½ WATTS		

NOTE: GROUND CHASSIS TO SHIPS GROUND TO ELIMINATE SHOCK HAZARD

Figure 1–1.—CW code practice oscillator.

If you do not have space for the layout described above, utilize the CW oscillator with the transmitter remote station control modification similar to the one shown in figure 1–2.

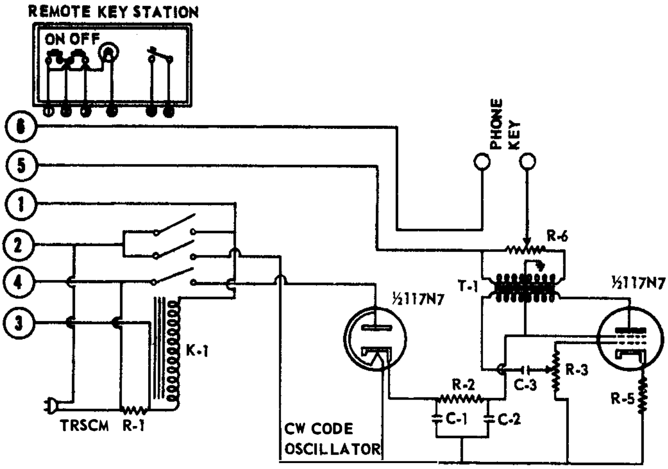
A one-tube oscillator used in conjunction with this modification makes it possible for multiple radio rooms and eight operators to be brought into play as a communication net. By connecting the transmitter remote station control modification through the transmitter telegraph panel, the oscillator may be brought up on the line by pressing the ON button and waiting



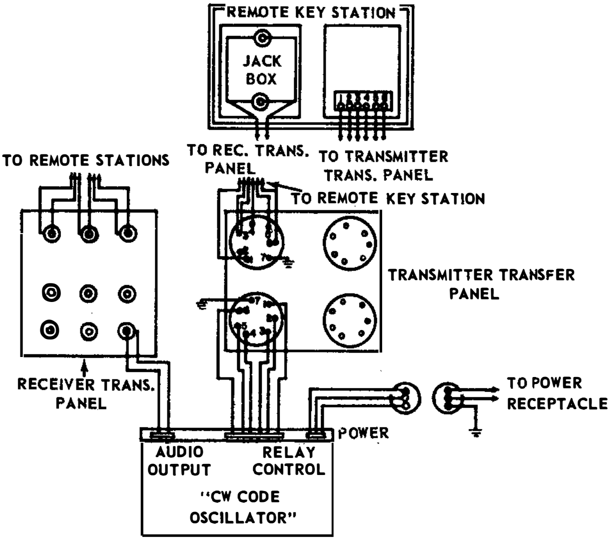
NOTE: THERE ARE TWO JACKS ASSOCIATED WITH EACH STUDENTS JACKS TO PROVIDE INFORMATION BETWEEN STATIONS.
STUDENTS KEYS AND HEADSETS ARE PLUGGED INTO JACKS MARKED "KEY" AND "PHONE". IF NET DESIRED BANANA PLUGS ARE USED TO COUPLE OPERATOR POSITIONS.
TO USE OSCILLATOR WITH THIS UNIT OF WIRING, CLOSE KEY AND THEN PATCH OSCILLATOR OUTPUT TO INPUT FOR OSCILLATOR

(WIRING DIAGRAM)
TRAINING ROOM POSITION-PATCHING AND WIRING SYSTEM

Figure 1-1.—Continued.



TRANSMITTER REMOTE STATION CONTROL MODIFICATION WITH CW CODE OSCILLATOR



WIRING DIAGRAM ILLUSTRATING TRANSMITTER REMOTE STATION CONTROL MODIFICATION USED IN CONJUNCTION WITH CW CODE OSCILLATOR AND SHIPS TRANSFER PANELS

Figure 1-2.—Transmitter remote station control modification with CW code practice oscillator.

until the glow of the indicator light signals the fact that the oscillator is ready to go.

Best results will be obtained by exact duplication of the electronic material designated in the following parts list.

T–1: Interstage Audio Transformer. (Ground center tap of secondary to reduce noise pickup effect in transfer lines.)

K–1: Three Pole Relay. (115v, 60 cps—a one, two, or three pole relay may be used.)

C–1: C–2: Electrolytic Capacitor. (50–50 Mfd 150v—any electrolytic cap. 20 to 100 Mfd may be used provided the working voltage is not below 150v.)

C–3: Capacitor. (1.0 Mfd 200v—if other size capacitors used, note that the smaller the capacitor the higher the frequency.)

R–1: Relay Current Limiting Resistor. (500 ohms 50w—used to release electrical holding feature of relay.)

R–2: Equalizing Resistor. (500 ohms lw—used to ensure correct voltage distribution across the individual condensers.)

R–3: Tone Control. (10,000 ohms.)

R–4: Bleeder Resistor. (10,000 ohms lw—used across output of power supply.)

R–5: Cathode Bias Resistor. (250 ohms lw.)

R–6: Volume Control and Attenuator. (5000 ohms.)

NOTE.—Keep all wiring above the chassis. Do not use chassis as a common ground unless an isolation transformer is used. The chassis should be grounded to the ship's hull. Fuse both sides of the line to prevent damage to the oscillator should an overload occur. A pilot lamp should be mounted on the oscillator to indicate remote position use.

Choosing Instructors

Choose as instructors men who know the subject, are enthusiastic about it, and can present it in a well-organized, interesting manner. Check into each prospective instructor's service jacket to get an idea of his qualifications. Once he is selected, give him an intensive review in one phase of communications. He then will be able to teach his subject to the other instructors and other men in the division.

Show each instructor how to make out a standard lesson plan for each class. Use the sample lesson plan in figure 1–3 as a guide. Try to develop lesson plans in accordance with RM quals in NAVPERS 18068 (rev.), *Manual of Qualifications for Advancement in Rating,* to ensure that you cover all required subjects adequately.

Classes and Drills

Cover the following subjects in lectures: fundamentals of transmitter tuning, authentication and call sign cipher, write-up, filing, shipboard communications, and naval communication procedure. Follow up with on-the-job training soon after a certain topic has been covered in the classroom. Your trainees will do a better job if classroom information is fresh in their minds.

Hold typing and teletype classroom drills at least four times weekly. Conduct a speed test the last day of each week.

Be sure to include all classes and drills on the watch bill to prevent conflict with duty watches, working parties, and inspections.

Operator Supervision

RADIOTELEGRAPH (CW) OPERATOR.—A new man on the circuit soon learns that a slow, steady pace results in faster delivery. In addition to correct sending technique, make sure the new operator practices good circuit discipline from the beginning of his training. Use of unauthorized expressions and incorrect procedure result in confusion and ambiguity. It's always easier to practice correct procedure.

Check your new operator's radio log for consistent accuracy. Advise him that the information he records is often used to study circuit efficiency, atmospheric disturbances, and, in wartime, enemy deception techniques.

INSTRUCTOR'S LESSON PLAN

UNIT: RADIOTELEPHONE

TITLE: Radiotelephone Message Format

OBJECTIVE: To acquaint trainee with format of a radiotelephone message

MATERIALS:
- A. References
  1. ACP 125
  2. DNC 5
- B. Training aids
  1. Study guide
  2. Radiotelephone message placard
  3. Chalkboard

INTRODUCTION:
- A. Preliminary remarks
  1. Summarize, review previous assignment briefly
  2. Introduce subject
- B. Creating interest
  1. Encourage note-taking and questions
  2. Foster spirit of cooperation
- C. Summary of lesson objective

PRESENTATION:
- A. Format outline
  1. Main parts of a radiotelephone message (placard)
  2. Breakdown and explanation of each
- B. Step-by-step development of typical message (chalkboard)

APPLICATION:
- A. Oral questions on component parts of radiotelephone message
- B. Message drafting by students (chalkboard)
- C. Discussion of inconsistencies and errors

SUMMARY: Place radiotelephone message on chalkboard; review

TEST: Have students draft several radiotelephone messages

Figure 1–3.

Radioteletypewriter Operator.—The mark of a good teletypewriter operator is speed without sacrificing accuracy. A light, quick, positive touch of the keys is the best sending technique. See that he adheres strictly to authorized procedures, and that he does not let uncorrected typing errors slip through.

Radiotelephone Operator.—Give your new talker the benefit of close supervision. Make sure he acquires a natural delivery and uses standard phraseology. He will soon realize that proper delivery cuts down needless repetitions.

Excessive testing, adlibbing, and improper microphone technique are old foes of correct operating procedure. Warn your new operator about these pitfalls as soon as he dons earphones.

Your radiotelephone operator must have a thorough knowledge of radiotelephone authentication. Hold frequent authentication drills, making sure your procedure conforms with the effective authentication system in use by your command.

Advanced Training

When your strikers are sufficiently checked out on drill circuits, have them submit afterhours fleet broadcast and weather copy. A graduate from this assignment is ready to stand regular watches on a fleet CW circuit.

Records and Examinations

Your records should indicate where each man stands in each phase of the communication training program. Maintain a progress record to show the exact status of each trainee in the division. A good system is a chart posted on a bulkhead showing each man's name and the dates various lessons were completed.

Those who are behind in any phase of the training program should attend afterhours supervised classes. You may find the trouble stems from improper note-taking. Show your men how to record only the salient facts of a lecture and how to study them.

The examinations should be of the true-false, multiple-choice, and question-answer type. Issue a copy of *Radioman 3 & 2* (NAVPERS 10228–B) to each man and have him study it along with his class notes. Base your exams on material from both this publication and class notes.

Preventive Maintenance Program

Plan your preventive maintenance program in a systematic fashion. First, assign a specific piece of equipment to each trainee. Then give him a thorough indoctrination. Show him how to perform operating tests, the proper method of routine lubrication and cleaning, and correct procedure for troubleshooting. Have the instruction book for the equipment at your elbow, and let the trainee locate the sections on corrective and preventive maintenance. He will then become familiar with the book and realize the importance of following the recommended procedures.

When you feel the trainee can take over, give him a routine checklist to maintain. Make sure the list contains only those items which prevent or detect trouble. (See fig. 1–4 for routine checklist.) Examine the equipment daily at first, then weekly. Note deficiencies in checklist, if any, and make sure the trainee completes these items by a certain deadline date.

TRAINING ASHORE

Message Center

A good message center supervisor takes advantage of the opportunity to train a new man by breaking him in at an operating position as soon as he completes his indoctrination. On-the-job training is the best way to increase a new man's efficiency. At the same time the trainee has status as a regular watch stander.

Each operating position in the message center or relay center offers an opportunity for on-the-job training. In the message center the important billets are traffic checker, file clerk, distribution clerk, incoming and outgoing routing clerk, rewrite and delivery clerk, and service clerk. You no doubt have

What to check	How to check	Remarks
1. General operation.	Apply operating tests learned on the job.	If irregularities occur notify authorized maintenance personnel.
DAILY ROUTINES		
2. Paper supply	Replace roll if only a few turns remain on spindle.	Ensure that paper is straight under paper fingers, and that release lever is forward.
3. Condition of ribbon.	Change if copy is too light	Be sure ribbon is in guides on type box and ribbon reversing levers.
4. Condition of type.	If smudging is evident, remove type box and clean type with a stiff brush.	Make certain type box is securely attached and that ribbon is not disturbed.
5. Condition of cover glass.	Clean, if required, with soft cloth.	Make sure that paper or ribbon is not disturbed.
QUARTERLY ROUTINES		
6. Orientation range.	Note pointer setting on range scale. If disturbed, reposition it carefully.	Abnormal signal line conditions may require changes in setting as an expediency. When normal line conditions are restored, normal setting should be reestablished.
7. Motor speed	Check with speed indicator (120 vps tuning fork). Motor may be considered on-speed if not more than 12 target spots pass a given point in 10 seconds.	Applies to governed motors only. To adjust, turn governor adjusting screw in direction indicated by the stamping on governor cover.

Figure 1-4.—Routine checklist for Mod 28 teletypewriter.

filled many of these jobs. Now, as supervisor, you'll check and evaluate the performance of others in these billets.

The following section is a review of the principal message center positions. Emphasis is placed on the important duties of each job and what you, the supervisor, should watch for.

TRAFFIC CHECKER.—Your job can be made easier by an alert traffic checker. He is responsible for completely checking all incoming and outgoing messages.

Make sure he checks the call sign breakdown, precedence, circuit and internal routing, as well as complete delivery. When watch personnel have doubts as to routing and call signs they usually inquire first of the traffic checker. He must keep himself well informed on message center memoranda and routing information in the CWO's folder.

FILE CLERK.—Your file clerk should do more than the simple mechanics of filing messages chronologically by date-time group. Instruct him to pay attention to the details on the file copy of every message—breakdown, routing instructions, internal distribution, etc. In this way he will be better qualified to take over another message center position.

DISTRIBUTION CLERK.—To know the exact number of copies of each message necessary for complete distribution, your distribution clerk must be checked out on a number of things. He must know NTX routing, with particular emphasis on the more commonly addressed activities. He must watch for relay instructions in the text of a message and screen carefully for any other relaying instructions. An alert distribution clerk also keeps a close check on copies for legibility. He should inform the ditto clerk immediately if copies are not legible. Whenever the distribution clerk receives a PRIORITY or higher message, he must notify delivery immediately. In no case should messages pile up in the distribution clerk's basket.

INCOMING ROUTING CLERK.—After time-stamping each incoming message, your routing clerk should carefully check the precedence, time of receipt (TOR), relaying instructions, etc. He must also glance at the text of each message to see if there are additional addressees mentioned there. If these addressees are missed, a nondelivery will result. Your routing clerk should also check the confirmation line and text to spot garbles which may require servicing.

Outgoing Routing Clerk.—For all outgoing and incoming messages requiring relay the outgoing routing clerk should check address for completeness, check the text to ensure against sending classified material in plain form, confirm indicators of all outgoing codes, and contact originator or duty officer concerned for verification of any part of a message. In this work he assists the CWO and therefore must keep up to date on current routing instructions and all other memoranda in the CWO's folder.

Rewrite and Delivery Clerk.—Your delivery clerk should screen all traffic at delivery desk and rewrite messages that are not up to standard. All rewrites should be doublespaced and properly paragraphed. Appropriate parts of the message text should be tabulated when text reads "tabulate as follows" or "read in two columns." It is important on weekends and holidays to show the CWO all undelivered priority and personal messages.

Delivery Desk Clerk.—The delivery desk is the connecting link between the message center and the various offices which the center serves. Before an incoming message is passed over the counter to the authorized messenger, the man on the delivery desk must check the heading, text, and internal routing, making sure no activity has been omitted. He must also make sure the message is completely legible and that sufficient copies have been made.

When a message is received over the counter for transmission, the delivery desk clerk checks it for authorized releasing signature, sufficient number of copies, and correct date-time group if assigned. He must always notify the originator of changes made. Make sure he time-stamps each message and returns one copy to the messenger. If time permits, your delivery desk man should check the text of messages for discrepancies in communication procedure or reference to classified matter. At the beginning of each watch he should check memoranda concerning delivery of messages to certain individuals or offices. He should also check the CWO hours folder and index card file describing how important messages are to be handled after office hours.

SERVICE CLERKS.—A man striking for service clerk should be checked out in all other message center positions, for he is the man who clears up errors made by others. Make sure he reads and understands the communication organizational manual thoroughly. Also, when an individual or office wants an extra copy, a garble cleared, a reference, or a reroute, he telephones the service clerk. Your service clerk must be courteous at all times and honor all legitimate requests as expeditiously as possible.

He will gradually learn a number of ways to keep service messages at a minimum. For example, the address and text of an incoming message can sometimes be cleared by looking up the reference in the message. A message received in upper case can often be cleared by checking it against the teletype keyboard on the service desk. Quite often a call has been serviced and later serviced again because of a garble in the text. Both errors could be cleared up with one service.

When your new man is breaking in on the service desk, new problems will be coming up every day. There is no "routine" in the billet of service clerk. Your striker should feel free to consult either the senior service clerk or the CWO when he is in doubt as to action to be taken on a service.

Tape Relay Center

The three key billets in the tape relay center are send, receive, and tape factory operators. It's a good idea to break in a new man in one of these billets on a regular watch. Let him take over the assigned watch stander's job when traffic is slow. Then check his work closely.

SEND OPERATOR.—See that your new operator carefully removes tape from grid, keeping it off the floor. A dirty tape can cause garbles. Make sure he selects tapes from the washboard within precedence groups in proper order. See that he checks routing indicator before inserting tape under transmitter lid. Entries in his sent traffic log must be complete—incoming channel designator and message number, routing indicator of addressee, and operator's sign. Check the log frequently.

Receive Operator.—A receive operator's timely entries in the received numbers sheet can prevent duplicated or omitted numbers. Make sure your new operator at this position logs his entries correctly and on the spot. He must check each tape's channel number and cross that number off the sheet. See if your receive operator can spot garbled or mutilated tapes: A correction here may save a time-consuming station-to-station service.

Tape Factory Operator.—A new man should be thoroughly indoctrinated in tape relay routing procedure before he takes over as tape factory operator. When he does take over, he should keep posted on the latest routing changes. Make certain he has an up-to-date channel routing guide at his fingertips for immediate reference. Check each tape as your new operator circles the indicators to make sure he has not omitted addressees and that none have been duplicated in the routing. You may catch a misroute here. Glance at the tape factory log frequently. Does each indicator have a line drawn through it and an operator's sign opposite the routing line? See if your new man is alert for garbled or otherwise doubtful indicators. Make sure he turns these over to the service clerk for proper action.

TRAINING AIDS

As a supervisor you'll need visual training aids to help present clearly certain phases of the communication training program. You may have to improvise some of these from available material.

Let's assume you are scheduled to lecture on tape relay procedure. You'll need to describe how the various relay centers tie into each other. The latest diagram of the naval teletypewriter network and associated broadcasts should be used in conjunction with your talk. You could use the diagram in chapter 2 with opaque projector.

Teletype procedure can be taught with format placards. Place the 16 format lines on a piece of cardboard, then point out each line as you discuss it.

Chalkboard diagrams also can be used to advantage. An excellent method of explaining the organization of DNC, for example, is to prepare a block diagram of the offices of DNC on the chalkboard, then print in each block the function of that particular section. In your lecture, as you describe each section of DNC, use a pointer to emphasize its position in relation to other sections.

A training film is another useful device for instructing the new communicator. A good communication film presents the picture to him clearly and refreshes the older hand's memory on points that might have been forgotten.

Get all required gear together beforehand and have a qualified projectionist check operation of the equipment. Be sure that only a qualified movie operator operates the projector.

Review the film before it is shown to your men. You will then be able to point out important things and discrepancies (if any) to be noted. Tell them they will be tested on the subject. Be sure to sit through the entire showing; your absence will detract from the effectiveness of the lesson.

Sum up the important points in the film after the showing, and encourage your men to ask questions. Finally, test them on the film's subject matter.

Three excellent films for the new communicator are—

1. MN 8157A: US Naval Communication System. (Typical PRIMCOMMCEN operations.)
2. MN 8157B: US Naval Communication System. (Types of COMMCEN'S and services.)
3. MN 9235: Communicator's Job.

Check the *US Navy Film Catalog* (NAVPERS 10001) and *US Navy Film Catalog and Supplements* (NAVPERS 10000) for other pertinent films. These catalogs contain a brief description of the subject presented in the film as well as total running time. You will find such information useful in preparing your training program.

ADVANCEMENT IN RATING

Your men want the opportunity to advance in rating, but they may not know how to prepare themselves. By drawing on your own experience, you can help them on their way toward that higher pay grade.

Make sure each man knows the minimum qualifications he must have in order to be advanced. This information is found in the *Manual of Qualifications for Advancement in Rating,* NAVPERS 18068, as well as in appendix II of the Navy Training Course, *Radioman 3 & 2.* "Quals" in the appendix are current only as of the date of the change shown. Be sure your men use the latest revision of NAVPERS 18068 when they prepare for examinations.

The practical factors portion of the qualifications for advancement is also contained in NAVPERS 760 (RM), *Record of Practical Factors.* This is actually a checkoff sheet. As the man demonstrates proficiency in each practical factor, his division officer initials two copies. One is for the man, and the other remains in the files of the division officer until the man transfers, at which time it is signed and forwarded in his service record.

Besides *Radioman 3 & 2,* your men must study certain doctrinal publications and basic Navy texts to prepare for the fleetwide advancement in rating examinations. You can find a working list of these books in *Training Courses and Publications for General Service Ratings,* NAVPERS 10052. Your men should use the books listed in conjunction with the *Manual of Qualifications for Advancement in Rating.* NAVPERS 10052 is revised annually, so have the latest edition available for your men.

Numerous other publications, such as operational and maintenance manuals, bureau publications, and library reference books, are also valuable in helping men qualify for advancement. Make sure your men have access to publications they need for study during their off-duty hours.

Rotating your men in their duties will also help their advancement. If a man is anchored to one job he seldom gets needed training in other important areas of his rating. Remember, the fleet-wide exams cover all facets of his rating. Be sure your men are prepared in all areas of communications.

Encourage your men to take advantage of USAFI courses of help to communicators. These are contained in the reading list of *Radioman 3 & 2.* Your I and E officer has the latest USAFI catalog and necessary enrollment forms.

The *List of Training Manuals and Correspondence Courses* (NAVPERS 10061, effective edition) lists Radiomen correspondence courses especially designed for self-study. Urge each man—particularly a newcomer—to enroll in one of these courses. The form for application is Enlisted Correspondence Course Application—NCCC Administration, NAVPERS 580.

FOR BEST RESULTS

It's obvious that careful planning and hard work are essential to the success of your training program. Equally important is your attitude toward your job and your men. Be enthusiastic about every phase of communications. Take every opportunity to cite examples of how good communications pay off. Your men will soon apreciate your insistence on high performance standards and will put them into practice.

A warm, friendly attitude toward your men is as important as enthusiasm for your work. Take a personal interest in every man under your supervision, especially the new communicator. Let it be known that his duties as a Radioman are important and that you are personally interested in his progress. Your men will appreciate this attitude, and it will pay big dividends.

When you have finally achieved a successful training program, the ease of operation of your radio section will be a direct measure of your ability as a supervisor to give the COMM officer the type of support he needs from you.

QUIZ

1. What ability does a candidate for PO 1 or C need in addition to technical skills?
2. What major factors must be considered in setting up a training program?
3. During his indoctrination, what communication publications should be made available to the new communicator?
4. What are the basic qualifications for a good instructor?
5. What is the best training method to increase a new man's efficiency?
6. At a message center, who is responsible for checking all incoming and outgoing messages?
7. Name the three key billets to supervise in a tape relay center.
8. Why are visual training aids helpful?
9. Name the publication which contains a working list of publications to study for advancement in rating.
10. What is the advantage of job rotation?

CHAPTER 2

NAVAL COMMUNICATIONS

With every passing year fleet operations are becoming more intricate. Technological improvements in ships, planes, and weapons, combined with the development of new tactics, bring new demands for faster communications without loss of reliability, security, or speed. The Navy has kept pace with these demands by constant expansion and improvement of communication facilities and by intensive training of communication personnel. Today, many millions of dollars worth of equipment and thousands of trained communicators are employed in the large and important operations of naval communications.

MISSION

You help accomplish the mission of naval communications while performing your assigned duties. This mission is to provide fast, reliable communications adequate to meet the Navy's needs, both in peace and war. In carrying out its mission naval communications has two obligations: first, to serve command; second, to aid administration. COMMAND is responsible for the direction and control of the operating forces.

ADMINISTRATION provides the men, material, and supplies to support command.

POLICY

The policy of naval communications is to—

1. Maintain and operate adequate, efficient, and secure communications, capable of providing the means essential for

exercising command and facilitating administration throughout the entire Navy.

2. Promote the safety of life at sea and in the air, and maintain facilities for adequate communication with the United States merchant marine, aircraft, over the sea, and with appropriate domestic and foreign communication stations.
3. Encourage development of amateur and commercial communication activities to enhance their value and safeguard the interests of the Nation.
4. Cooperate with the Army, Air Force, and other departments and agencies of the Government to integrate military communications; improve governmental communications; avoid unnecessary duplication of facilities; promote standardization of communication methods, procedures, and material; and assist in the determination of national communication policy.

Naval communications frequently shares its facilities with those of other activities. A policy for each activity sets forth its relationship with the Navy in communication matters.

NAVY-COAST GUARD COMMUNICATION POLICY

The Navy-Coast Guard communication policy provides for cooperation in all communication matters so that efficient communications will be available to each in peacetime. In time of war such cooperation provides orderly integration of the Coast Guard communication service with naval communications.

Each service is further pledged to establish, maintain, and operate efficient communication facilities with its own units and for communication with ships and aircraft in distress. If the communication facilities of either the Navy or Coast Guard can serve both services adequately, facilities will not be duplicated.

NAVY-MSTS COMMUNICATION POLICY

The policy of the Military Sea Transportation Service (MSTS) is to adhere to communication procedures established by higher authorities for other naval organizations, consistent with restrictions imposed by economy and the operating requirements peculiar to MSTS.

MSTS is further pledged to make maximum use of the facilities of naval communications, supplemented if necessary by those of the Coast Guard, Army, and Air Force. Commercial facilities may be used only if Government communication facilities are not available or are not as economical.

NAVY-COMMERCIAL COMMUNICATION POLICY

The Navy uses commercial radio, television, cable, telephone, and telegraph communications whenever naval communication facilities are not available or adequate. Arrangements to use the facilities of commercial communication companies during national emergencies are made by the Chief of Naval Operations. Such use is subject to executive order of the President, and is effected in accordance with allocations of facilities by the Joint Chiefs of Staff. *Commercial Traffic Regulations* (DNC 26) contains instructions for handling message traffic on commercial circuits.

ELEMENTS OF NAVAL COMMUNICATIONS

There are three elements of naval communications:

1. Office of Director, Naval Communications;
2. The Naval Communication System;
3. Communication organizations of forces afloat.

Office of Director, Naval Communications

The Office of the Director, Naval Communications serves as the headquarters of naval communications. The Director of Naval Communications (DNC) is responsible for the planning and coordination of naval communications. Since establishment of the Office under the Chief of Naval Operations in 1916, there has been a continuous increase in its functions and duties. Radio and visual communications were originally its primary concern, with landline systems added shortly afterward. It was next given control over registered publications and the Navy postal service.

DNC heads the Naval Communications Division of the Office of CNO, and is administratively responsible for the field activities comprising the Naval Communication System. He maintains liaison with other agencies on matters pertaining to communications, and is a member of a number of Navy, joint, and allied committees, including Joint Communications-Electronics Committee (JCEC), Canadian-U. K.-U. S. Joint Communications-Electronics Committees (CANUKUS JCECS), Navy Department General Planning Group, Telecommunications Coordinating Committee, Air Defense Board, National Security Agency Council, National Committee of the International Scientific Radio Union, and U. S. Communications Security Board. He is an associate member of the Navy Department Ship Characteristics Board.

In the CNO organization, the Office of DNC is designated OP–30. There are four branches: Administrative and Support, Shore System, Plans and Policy, and Fleet. Their work falls into eight categories:

1. Frequencies.—Considerable effort must be expended to obtain, allocate, and protect the frequencies used by the Navy. The present frequency spectrum ranges from about 10 KCS to 30,000 MCS. When measured in terms of the many users here and abroad, this is not the generous supply it might appear to be.

Distribution of frequencies to the various nations is made by international treaty. The international agreement regarding allocation of the radio spectrum among the various radio services is contained in the Final Acts of the International Telecommunications and Radio Conference, Atlantic City, 1947. Within the United States, assignment of radio frequencies to Government radio stations is effected by the Interdepartmental Radio Advisory Committee (IRAC), through the Office of Defense Mobilization, acting in the name of the President of the United States. Assignment to non-Government stations is the responsibility of the Federal Communications Commission (FCC). Radio frequencies are allocated to such diverse users as commercial AM, FM, and TV broadcasters, maritime

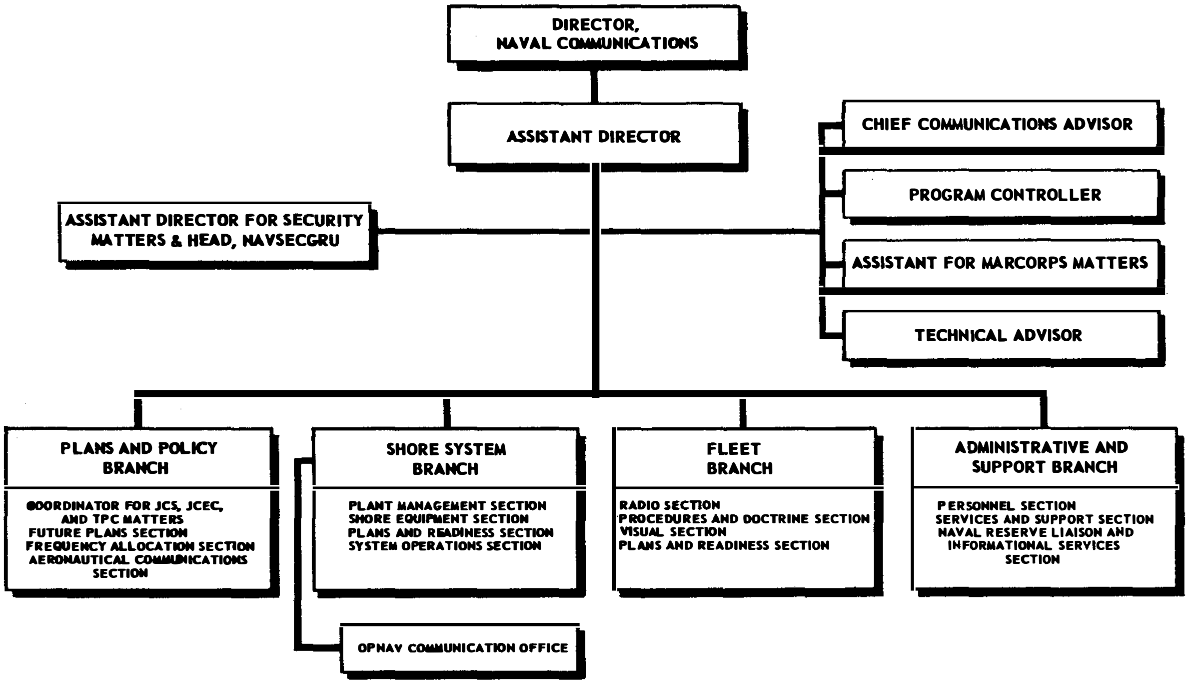


Figure 2-1.—Naval Communications Division of CNO.

communication facilities, public safety stations (police and fire-fighter radio, rescue squads, etc.), military and civil radar, air navigational aids, amateurs, airport control, scientific and medical devices, the military services, and a host of others.

The Frequency and Allocation Section of DNC allocates frequencies within the Navy. These, and their prescribed uses, are published in the effective edition of JANAP 195.

2. PROCEDURES, POLICY, AND PLANNING.—DNC establishes standard procedures for all means of communication employed by the Navy. These are developed in cooperation with the Army, Air Force, and Allied Nations. Authorized procedures are found in effective editions of the following publications:

PROCEDURE	PUBLICATION(S)
Radiotelegraph	ACP 124; DNC 5
Radiotelephone	ACP 125; DNC 5
Teletypewriter and tape relay	ACPS 126 and 127; DNC 5
Visual and sound	ACPS 129, 168, 175; DNC 5
Wartime merchant ship communication procedures.	ACP 149

Besides establishing communication procedures, DNC draws up communication plans for peacetime and wartime operations. Results of this planning are found in NWP 16, NWIP 16-1, and pertinent ACPS and JANAPS.

3. RESEARCH AND DEVELOPMENT.—OP-30 is continuously working to improve communication equipment and to devise new means of communication.

4. LIAISON.—The Office maintains liaison with the Army, Air Force, Marines, and civil governmental agencies in regard to communication matters of mutual interest.

5. FISCAL AND SUPPLY.—OP-30 handles its own fiscal, supply, and other services, and maintains the required records.

6. SECURITY.—Measures to prevent the enemy from obtaining information from United States communications are a basic part of the work of the Office. OP-30 promulgates security regulations, monitors radio transmissions for violations, and devises codes and ciphers.

7. Activities Associated with Radio Communications.—The Office of DNC contributes significantly in such fields as electronic countermeasures, monitoring, and direction finding.

8. Operations.—OP–30 furnishes and maintains a number of basic communication services, such as fleet broadcasts, high-speed point-to-point radio and landline communication, and distribution of registered publications.

Naval Communication System

The Naval Communication System, under the direction of DNC, maintains and operates the shore facilities and services required to provide communication support for operating forces, the Navy Department, and the Shore Establishment.

The operating forces comprise the seagoing forces, yard and district craft, sea frontier commands, Fleet Marine Forces, and any other military activities assigned by the President or SECNAV.

The navy department, Washington, D. C., is the central executive authority of the Naval Establishment. It is composed of the bureaus, boards, and offices of the Navy Department, the Headquarters of the Marine Corps, and the Headquarters of the Coast Guard (when assigned to the Navy).

The shore establishment consists of all other naval activities not belonging to the operating forces or to the Navy Department.

The Naval Communication System consists of the following activities:

1. Shore communication stations: the NAVCOMMSTAS and NAVCOMMFACS (designated as primary or major communication centers), minor communication centers, and tributary stations. Except for tributaries, most of these stations are equipped to issue registered publications.
2. Registered publication issuing offices not part of a NAVCOMMSTA or NAVCOMMFAC.
3. Naval Communication Units.
4. Naval Security Group.

NAVCOMMSTAS AND NAVCOMMFACS.—The major components of the Naval Communication System are its naval communication stations (designated FACILITIES if located on foreign soil), of which the Navy has about 20 in strategic locations throughout the world. These are tied together into a global network of teletypewriter and radiotelegraph circuits.

A NAVCOMMSTA normally includes a communication center (COMMCEN), transmitting and receiving radio stations (NAVRADSTAS), a registered publication issuing office (RPIO), and a Navy Post Office (NPO), if postal services are needed but not otherwise provided.

A COMMCEN is the major activity of a NAVCOMMSTA. It is charged with responsibility for receipt, transmission, and delivery of messages via naval communications. It normally includes a message center, a cryptocenter, control center, facsimile branch, tape relay station, and facilities for telephone and teletypewriter conferences.

A NAVRADSTA performs radio transmitting or receiving functions at a location some distance from the COMMCEN.

A type-designating letter (T or R) is added in parentheses to indicate whether a NAVRADSTA is a transmitting or receiving radio station. Later chapters of this manual contain details of the operations of a COMMCEN and NAVRADSTA.

An RPIO issues the latest publications and devices distributed by the Registered Publication Section (RPS) of DNC. To ensure that each ship has up-to-date RPS material, the ship's custodian of registered publications is required to make frequent draws from the nearest RPIO.

An NPO is a postal activity established by the Post Office Department at the request of the Navy Department. It is staffed by military personnel, and provides postal service to military units and other activities or persons authorized to use its facilities.

Most message traffic is processed through five NAVCOMMSTAS and a NAVCOMMFAC. They furnish complete radio coverage of the major portions of the world's strategic areas,

U.S. NAVAL TELETYPEWRITER NETWORK ......
AND ASSOCIATED BROADCASTS

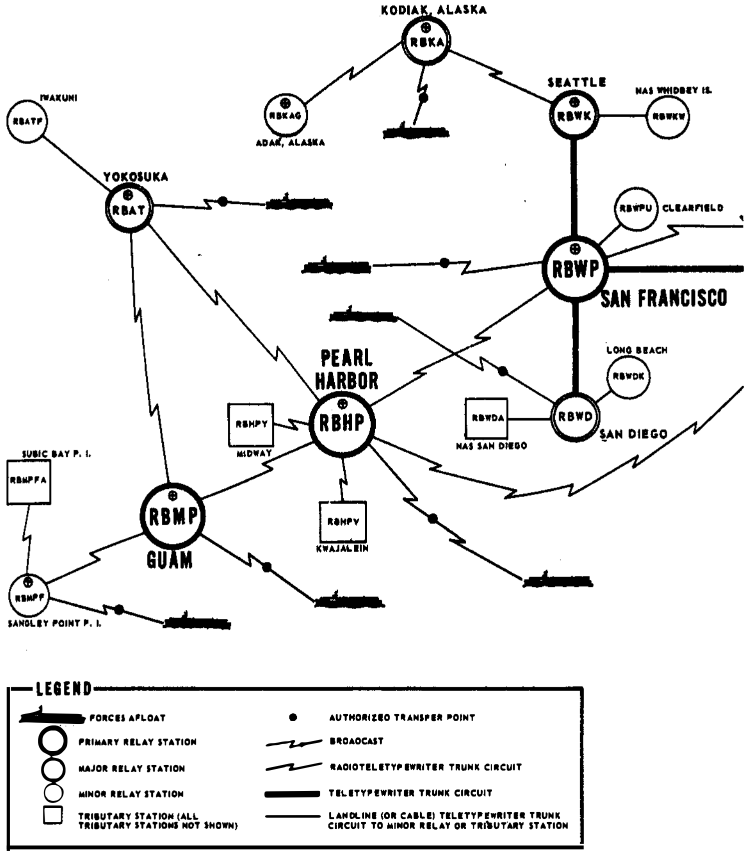


Figure 2-2.—Navy teletypewriter and tape relay networks cover the globe.

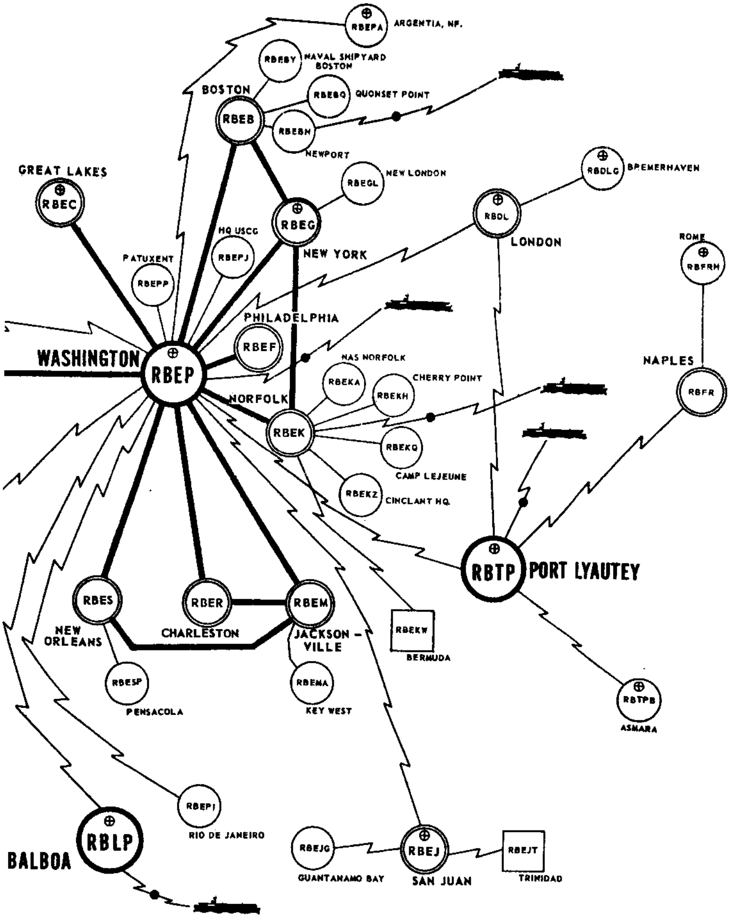


Figure 2-2.—Continued.

and are designated as primary communication centers. They are:

NAVCOMMSTA	Washington, D. C.;
NAVCOMMSTA	San Francisco, Calif.;
NAVCOMMSTA	Pearl Harbor, T. H.;
NAVCOMMSTA	Guam, M. I.;
NAVCOMMSTA	Balboa, C. Z.;
NAVCOMMFAC	Port Lyautey, Morocco.

Each primary center maintains a primary fleet broadcast, over which messages are sent to ships in its area. Vessels in the Mediterranean, for example, receive traffic from NAVCOMMFAC Port Lyautey, Morocco. Those in the Pacific may copy broadcasts from either NAVCOMMSTA Guam or NAVCOMMSTA Pearl. All the major oceans of the world are covered in similar manner.

Each primary center also sends out a general broadcast of hydrographic information, weather forecasts and warnings, time signals, and press. Facilities are also provided for ship-shore communication.

Primary communication centers are linked by radio and landline circuits to each other and to the 15 MAJOR COMMUNICATION CENTERS throughout the world. These are also NAVCOMMSTAS, NAVCOMMFACS, and NAVCOMMUS, but their traffic volume is not heavy enough to justify designation as primary centers. NAVCOMMSTAS Norfolk, San Diego, and Seattle, for example, are major communication centers. They maintain these facilities: secondary fleet and general broadcasts to relieve the load on primary broadcasts; local harbor nets; and ship-shore circuits.

MINOR COMMUNICATION CENTERS are located wherever the traffic volume is not heavy enough to justify a primary or major center. Most are situated at such activities as naval air stations and supply and ammunition depots. They handle local communications and relay messages between tributary stations and the major and minor communication centers.

Each primary, major, and minor communication center maintains a TAPE RELAY STATION, whose function is to forward

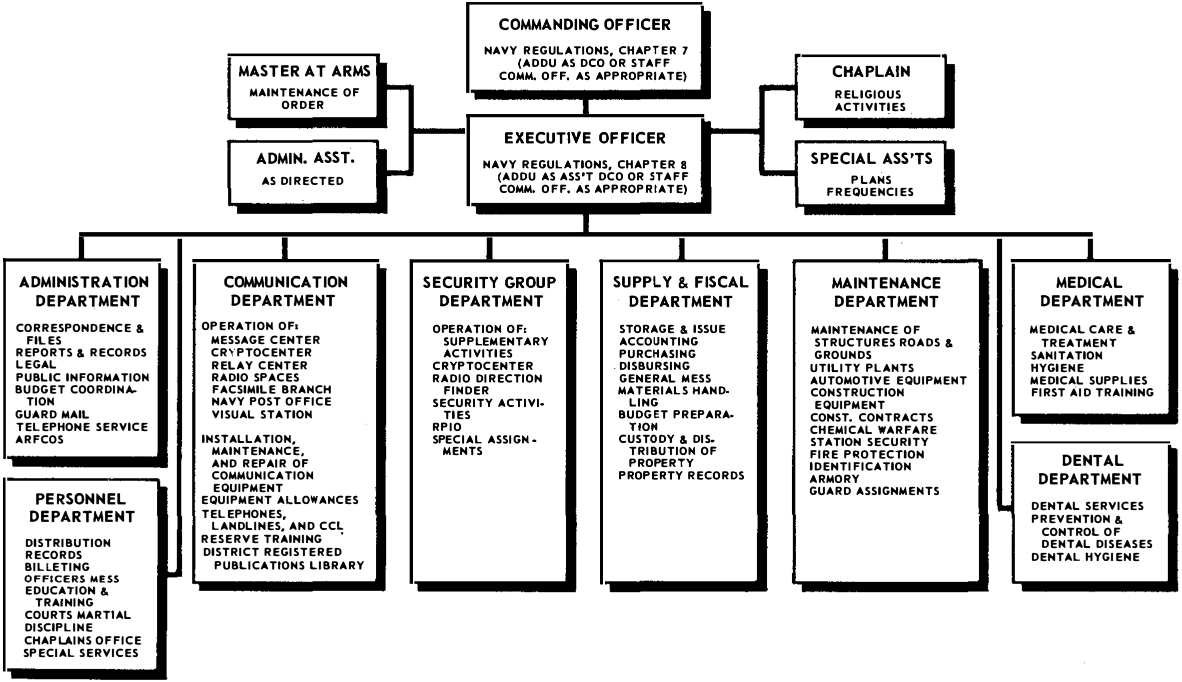


Figure 2-3.—NAVCOMMSTA organization.

messages in tape form via automatic or semiautomatic tape relay equipment. Chapter 5 discusses tape relay practices in detail.

TRIBUTARY CENTERS are small stations serving a particular command. They may be located, for example, at a net or mine depot or even on a flagship docked for a long period of time. Tributaries are links into the worldwide arterial network of the Naval Communication System. They send out and receive messages as necessary to serve local command.

RPIOS AS SEPARATE ACTIVITIES.—Most registered publications issuing offices (RPIOS) are located at NAVCOMMSTAS and NAVCOMMFACS, but it is not always possible for a ship to draw from these activities. For this reason independent RPIOS are established where there are large concentrations of fleet units but no NAVCOMMSTA or NAVCOMMFAC. RPIO New London and RPIO Guantanamo Bay are examples of issuing offices which are separate activities of the Naval Communication System.

NAVAL COMMUNICATION UNITS.—Although most of the work of the Naval Communication System is done through NAVCOMMSTAS, NAVCOMMFACS, and smaller stations, important functions are performed by Naval Communication Units (NAVCOMMUS). These activities are set up by CNO to perform limited support and/or special communication functions in the United States and overseas. They usually are established at places remote from a naval shore activity. There are about 11 NAVCOMMUS at present. A NAVCOMMU is much smaller than a NAVCOMMSTA or NAVCOMMFAC, and performs fewer functions. NAVCOMMUS are designated by numbers, such as NAVCOMMU No. 8, Bremerhaven, Germany.

NAVAL SECURITY GROUP.—The Naval Communication System performs special communication intelligence functions as directed by CNO. These operations may be performed by NAVSECGRUS assigned to the fleet or to naval activities ashore. Because of the classified nature of their activities, they cannot be covered in this manual.

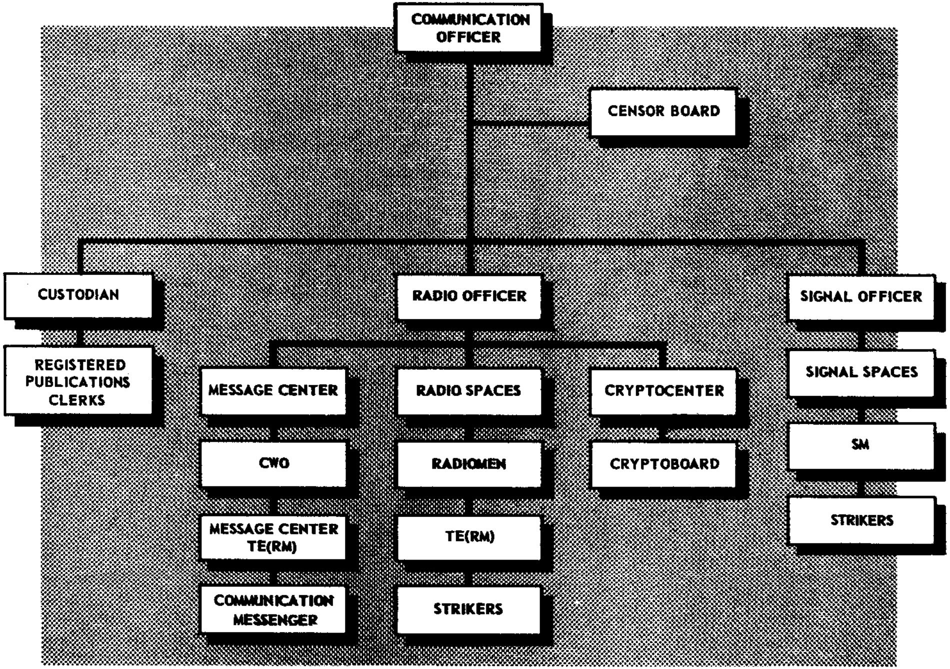


Figure 2-4.—Communication division organization.

Communication Organizations of Forces Afloat

The communication organizations of forces afloat provide communication services needed to control and employ fleet units. These services include sending and receiving orders, instructions, reports, and other forms of intelligence. Communication facilities are provided for rapid ship-shore and air-surface communication as well as for communication among individual units.

The shipboard organization responsible for coordination of such services and facilities is the operations department. This department collects, evaluates, and disseminates combat and operational information relating to the mission of the ship and airborne aircraft under her control.

The communication division is responsible for the actual operation of communication facilities in compliance with general communication instructions from CNO and specific instructions issued by responsible senior officers. It coordinates the ship's radiotelegraph, radiotelephone, radioteletype, facsimile, visual, and courier facilities. It is also responsible for the following:

1. Care and maintenance of equipment to conduct radio and visual communications.
2. Preparation of communication reports.
3. Procurement, custody, correction, distribution, and reporting of publications issued to the ship by the Registered Publications Section of CNO.
4. Supervision and training of the cryptoboard.
5. Cleanliness and upkeep of assigned spaces.

PLANS AND DIRECTIVES

Command decisions are passed down to fleet units by means of PLANS and DIRECTIVES. There are four types of especial interest to communicators:

1. Operation plans.
2. Operation orders.
3. Battle plans.
4. Battle orders.

Op Plans and Op Orders

An OPERATION PLAN is a plan for operations extending over considerable space and time. It may cover a single operation or a series of related operations. It is the form of directive employed by high echelons of command to aid subordinate commanders in preparing supporting plans and orders.

An operation plan is made up well in advance, when several vital elements of information are almost certain to be lacking. It must, therefore, be based on assumptions. The following are typical of the assumptions that might be found in an Op Plan pertaining to the seizure of an Arctic objective.

It must be assumed that—

1. During September and October 19__, the enemy will not be able to seize control of the air within a 500-mile radius of the objective.
2. The operation against Grenfell Point will be completed at a sufficiently early date to allow availability of one Marine division.
3. Good operational weather will prevail until 25 October, at which time the weather will deteriorate to the point where tactical and logistic support will be virtually impossible. Overland travel will be exceedingly difficult. Bay Peary will be choked with ice, and dense fog will prohibit aerial support. The objective area will thus be secure from enemy counteroperations until the spring thaw.

Instructions for making an Op Plan effective are carried in a special paragraph numbered 3-x. For example, "This plan effective at 0000 (zone Zulu) 26 June 1957."

An OPERATION ORDER is a directive to conduct an operation. It is not issued until the situation has developed to the point where assumptions are no longer needed, availability of own forces is known, and ordinarily the intentions of the enemy have been clearly indicated.

Operation plans and operation orders follow closely the same format and carry similar information. Both Op Plans and Op Orders always have five numbered paragraphs:

1. General discussion of the strategical and tactical picture, together with data on own and enemy forces, and in the case of Op Plans, the assumptions upon which the plan is based.
2. Mission of the force.
3. Tasks for specific units (execution).
4. Administrative and logistical matters.
5. Command and communication matters.

The communicator studying an Op Plan or Op Order is principally interested in the task organization (invaluable in preparing a list of calls), in paragraph 5, and in the communication annex (if there is one). Paragraph 5 usually contains little specific information on communications. It will generally make a reference to a standard doctrinal communication plan and (if any elaboration or addition to the plan is necessary) to a communication annex which will be affixed.

The communication annex is usually one of several annexes. It will instruct the communicator in such matters as these:

1. Contact reports—to whom made, how authenticated and acknowledged, and whether to be sent plain or encrypted.
2. Recognition and identification, including IFF.
3. When radio silence will be observed.
4. Use of MHF and VHF/UHF.
5. Radio discipline and procedures.
6. Use of command circuits.
7. Use of call signs.
8. Use of voice codes and ciphers.
9. Visual communications.
10. Frequency plans for surface ship circuits, CIC communications, and aircraft communications.
11. Movement reports.

Bat Plans and Bat Orders

Battle plans set forth the methods for the coordinated employment of task subdivisions, or subdivisions of command, during battle. Like Op Plans, they are prepared well in advance, and are based on certain assumptions which are clearly stated—such as composition of enemy forces, anticipated conditions of the wind and sea, and so on. The form followed is similar to that of the Op Order.

A BATTLE ORDER is generally limited to a message, such as a general signal used to place a battle plan in effect, to amend such a plan, or to initiate detailed action as may be necessary during the progress of a battle. Following is an example of a battle order that might be sent on the eve of an important engagement.

AIR UNITS WILL ATTACK ENEMY CARRIERS THEN LARGE UNITS OF BATTLESHIPS AND CRUISERS X INFLICT ALL POSSIBLE DAMAGE X IF ENEMY WILL FIGHT TASK GROUP TWO EIGHT POINT SEVEN WILL ENGAGE AND DESTROY X IF ENEMY RETREATS THIS TASK GROUP WILL SINK SLOW AND CRIPPLED SHIPS X ALL HANDS MUST DO THEIR UTMOST TO DESTROY THE ENEMY FLEET X ACTION AGAINST THE ENEMY MUST NOT MITIGATE X DESTROYERS SHORT ON FUEL RETURN TO QUEEN BAY FOR REFUELING X COMMANDER TASK FORCE TWO EIGHT PASS TO COMMANDER BATTLE LINE AND COMMANDER CARRIER GROUPS

JOINT COMMUNICATIONS

The need for coordinated and standardized communications among the United States military services was clearly shown during the early stages of World War II. Army and Navy facilities were sometimes duplicated in one location, and differences in procedures made truly efficient communications virtually impossible.

Navy, Army, and Air Force communications are now coordinated by the Joint Communications-Electronics Committee (JCEC). Members of the committee are high-ranking communicators from each of the services. The Navy's member is DNC. As a result of the committee's efforts, unnecessary duplication of facilities is avoided. No matter which service builds or operates a particular facility, communication channels may be lent to the others on a full- or part-time basis, as required. Under joint practices, for example, the Naval Communication System handles traffic for the Army, Air Force, and Coast Guard when it can do so better than the regular networks of those services.

Communication procedure is now standardized throughout the Department of Defense, and has made interservice message handling much easier. Joint procedure is set forth in Joint Army-Navy-Air Force publications (JANAPS) and in Allied Communication Publications (ACPS). You no doubt have worked with many of these publications when on watch in the message center or radio central.

COMBINED COMMUNICATIONS

Communication procedures not only are identical within the United States military services, but in many respects are the same as those used by the United Kingdom and Canada. Messages may be sent from the national communication system of any of those countries into the system of another with very little delay or reprocessing. Combined communication policies are published in ACPS. The ACP series will eventually replace JANAPS.

United States allies belonging to the North Atlantic Treaty Organization (NATO) have adopted many of the combined methods and procedures contained in ACPS. Besides the United States, the NATO nations are Great Britain, Canada, France, Belgium, the Netherlands, Luxembourg, Norway, Denmark, Iceland, Italy, Portugal, Turkey, Greece, and Western Germany.

Nations in the Southeast Asia Treaty Organization (SEATO) also use procedures contained in the effective ACPS. Besides the United States, SEATO countries are Great Britain, France, Australia, New Zealand, Pakistan, Thailand, and Republic of the Philippines.

QUIZ

1. What is the mission of naval communications?
2. Name the elements of naval communications.
3. How are frequencies distributed to the various nations?
4. Within the United States, what agency has the responsibility for the assignment of radio frequencies to Government radio stations?
5. Name the central executive authority of the naval establishment.
6. Name the principal components of a COMMCEN.
7. What are the principal services provided by a primary communication center for forces afloat?
8. What is the mission of the Naval Security Group?
9. What is the function of a ship's operations department?
10. What military committee coordinates Navy, Army, and Air Force communications?

CHAPTER 3

OTHER COMMUNICATION SYSTEMS

INTRODUCTION

In addition to intimate knowledge of his own communication organization, a First Class or Chief Radioman must be familiar with the communication systems of the other military services and of commercial telecommunication companies. A message center supervisor, for example, is responsible for the expeditious handling of Army and Air Force traffic, messages received via TWX, and those forwarded to commercial radio or cable companies.

Other military services maintain and operate communication systems similar to our own to provide the same rapid and reliable exchange of information and intelligence. Basically, the same methods of transmitting traffic are used, but a particular method may come in for greater use by one service than by another. Once firmly entrenched in the field, for example, the Army relies on landline wire systems in preference to radiotelegraph and radioteletype networks. Naval task forces, operating over watery distances, must necessarily depend on visual and radio communications to exchange traffic.

Commercial telecommunication companies blanket the globe with their telegraph and telephone networks, furnishing essential communication services to business, industry, and the general public. These companies are vitally important to the Nation in peace or in war. They increase the circuit capacity and flexibility of our military communication systems in wartime, furnish additional telephone and telegraph service to defense industries, and develop communications and weapons systems for military and civil defense use.

Besides commercial telecommunication systems, there are thousands of safety and special radio networks used for protection of life and property. These are operated by police and fire departments, highway and forestry agencies, public utilities, amateur radio organizations, and a host of others. Because of spectrum limitations some of these networks are required to share frequencies. Others are permitted temporary use of frequencies, and some can use frequencies as long as they cause no interference.

It is not within the scope of this text to discuss the small communication systems serving limited geographical areas. This chapter describes the communication systems of the Army, Air Force, and Coast Guard, major commercial telecommunication companies of the United States, and the work of the Federal Communications Commission—the agency which regulates electrical communications.

ARMY COMMUNICATIONS

Army communications is the direct responsibility of the Army Signal Corps, which furnishes communications to activities in the continental United States (CONUS) and to the various theaters of operations. For signal communication purposes, the rear area of a theater is designated the communication zone; the forward area, where armies are active in the field, is the combat zone. The Chief Signal Officer is responsible for the installation, maintenance, and operation of communication facilities in all zones.

Chief Signal Officer

The Chief Signal Officer can be compared to Director, Naval Communications. His responsibilities to the Secretary of the Army and the Chief of Staff are equivalent to DNC's responsibilities to the Secretary of the Navy and Chief of Naval Operations. Integration of the entire Department of the

Army signal communications system is his direct responsibility. This requires standardization of equipment and procedures as well as technical direction and control of theater signal communications systems and signal communications in combat areas. He is also responsible for training signal communications personnel and for procurement of all signal communication equipments for the Army.

The Chief Signal Officer has direct technical control of that component of the Army signal communications system known as the Army Command and Administrative Network (ACAN). In joint communication matters he maintains liaison with the communication departments of the other services, and is the Army's ranking member of the Joint Communications-Electronics Committee (JCEC).

ACAN

The Army Command and Administrative Network (ACAN) is an integrated system of wire and radio circuits connecting Army installations in CONUS and overseas. Figure 3–1 shows the primary routes of ACAN. The over-all planning, engineering, and management of this network is the responsibility of the Chief Signal Officer. Certain installations at Washington, D. C., Asmara (Eritrea), Seattle, and throughout Alaska, known as class II installations, are operated by personnel under direct command of the Chief Signal Officer. Other communication stations of the ACAN are operated under the supervision of the local commander, through whom the Chief Signal Officer exercises operational control. Operational control in this sense ensures complete standardization of operational practices throughout the network.

The Chief Signal Officer allocates certain facilities of ACAN to other governmental agencies when such allocations are necessary and more economical to the Government. Certain communication facilities are operated on a joint basis; that is, Signal Corps, Air Force, and Navy personnel are assigned from a joint manning table to install, operate, and maintain facilities serving all three services. In addition to direct allo-

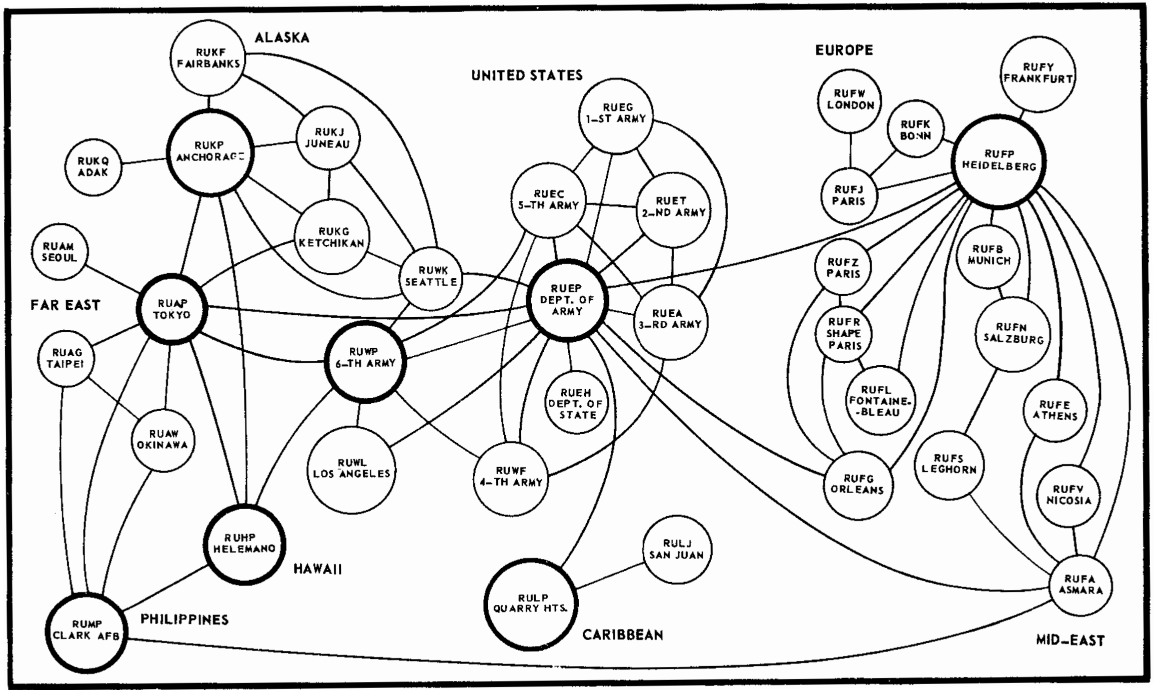


Figure 3-1.—ACAN traffic routing diagram (primary and major relay stations).

cation of channels or facilities, message traffic of other military departments and authorized governmental agencies may be filed for relay to other military or commercial networks for users not served by direct ACAN channels.

The Chief Signal Officer has organized the U. S. Army Signal Corps Engineering Agency (USASCEA) in Washington, D. C., to provide centralized communication engineering and installation assistance for all Army activities requiring such aid. Special teams are sent to Army activities to engineer and install those facilities beyond the normal means of the using organization. Teams remain for a "breaking-in" period after the equipment is installed to ensure proper installation and to instruct operating personnel assigned to the equipment.

THEATER SIGNAL COMMUNICATIONS

Existing commercial communications in the CONUS are expanded to meet the needs of the military. In the theater, however, all signal communications are controlled by the military; and the major part of such communications is installed, operated, and maintained by the military. In addition to the military communications installed, existing local communications facilities are generally rehabilitated to augment the new military facilities. Within the theater, the manner of controlling signal communications in the combat zone and in the communication zone is somewhat different. Each commander in the combat zone controls the signal or communication troops who maintain and operate signal communications for the command. Conditions in the communication zone more nearly approach those in the CONUS.

In the communication zone, the theater signal officer organizes the theater signal communications service. Each unit in this zone is assigned only those signal or communication troops necessary to install, maintain, and operate its local signal communications facilities and those point-to-point radio circuits which the command requires for operation. All other signal or communication troops under the command of the communications zone commander are then assigned to the theater signal communications service. The commander of the theater signal communications service, operating directly under the theater signal officer, establishes the long-distance signal communications system in the communication zone. This system consists of wire facilities, radio facilities, combinations of the two, and courier service. The system also operates communications centers and long-distance switchboards. Switching centrals are installed in areas where one large switchboard can replace several small ones, improving telephone and teletypewriter service.

Examples of the signal communications established by separate units with assigned signal troops in the communication zone are: local communications within a post, port, or depot area, antiaircraft artillery operational circuits, and interunit communications systems.

The theater signal communications system serves the entire theater and furnishes long-distance signal communications to all units and activities. It is planned with a view to expansion in those areas where activity may be expected to increase. In the long-distance system the route of long-distance circuits will often follow railways and principal roads or existing communications lines to simplify construction and maintenance. Construction of facilities which eventually will be incorporated into the theater signal communications system is pushed forward into the combat zone as rapidly as possible and as far as the tactical situation will permit. The theater signal communications system must always reach at least to the general line formed by the rear boundaries of armies. It is always pushed forward to give signal communications to the headquarters of an army group, and continues constructing facilities well ahead of the army group headquarters. When the theater network is being constructed within the combat zone the theater signal communications system uses routes employed by major units, increasing existing facilities rather than duplicating them.

The theater signal officer incorporates all facilities within the communications zone into the theater signal communications system. He coordinates construction to prevent interference with the signal communications of the major unit.

In planning and constructing the theater signal communications system, provision is made in the theater for other Government services and for the press. If a theater is allied, the system is coordinated to meet the needs of all allies in the theater, at the same time retaining one integrated system for the whole theater. When one ally is responsible for a specific sector, responsibility in that sector may be delegated to that ally by the supreme theater commander.

The theater signal officer is responsible for operation of those stations which join the theater signal communications system with ACAN. He follows, of course, the policies and instructions of ACAN. The theater signal officer represents the theater commander in all matters concerned with radio frequencies and radio call signs. He also provides a monitoring service to enforce frequency and procedure discipline and is in charge of radio countermeasures and radio deception plans.

GROUND FORCES COMMUNICATIONS

Success of the ground forces in the field requires fire, movement, and contact with the enemy. Control of units down to the individual squad and soldier is accomplished chiefly by signal communications. The methods used, and the manner of applying those methods, are adapted to the problems created by the control of fire and movement of widely dispersed forces. In many instances these forces are in contact with the enemy. For this reason, and because units often have occasion to act independently, each ground force commander is given the necessary troops to provide signal communications required to complete the unit's combat mission. The nearer the unit operates to the front, the more clearly this principle applies and the more closely it is followed.

In larger units (corps or army) the task of providing signal communications extends beyond the combat requirements of the unit itself and includes other signal communications needed to accomplish the over-all mission. Army, army group, and sometimes even corps may take advantage of connection to the theater signal communications system to furnish part of the required trunk communications.

The division is the smallest unit to which Signal Corps troops normally are assigned, although some special-purpose units, such as the engineer special brigade, have a signal company. In regiments and smaller units, signal communications personnel belong to the arm or service of the unit (infantry, artillery, engineers, etc.). The fact that all personnel engaged in signal communications in the ground forces are not of the same arm or service demands greater emphasis on cooperation than might otherwise be necessary. This is especially true since the signal communications system of each unit must fit into that of the next larger unit to provide an integrated system.

Signal communications in the ground forces can be divided into three parts:

1. Command and administration.
2. Control of fire and movement, or both.
3. Liaison with supporting forces such as the Navy or Air Force.

Command and Administration

Each commander, from army group down to battalion, must have command communications with each next subordinate unit. Since each commander is provided the necessary facilities, command communications become his direct responsibility. However, the unit signal officer (much as a Navy communication officer) assumes this responsibility when he acts in the name of his commanding officer.

While each communications system is primarily for the use of the commander of that echelon of command, it is designed and planned to fit into the signal communications system of the next higher commander. Responsibility for establishing signal communications is not limited by tactical areas. Therefore, signal communications troops from the superior unit frequently work forward of the command posts of the next subordinate unit. It is customary for division signal officers to furnish radio teams at regimental headquarters for operation in the division command network. In the same manner, wire construction teams from the division signal company may be attached to regiments to extend the division wire system.

Fire and Movement Control

The communication channels provided in lower combat units of the ground forces are primarily for fire and movement control. Examples of the use of such channels is the fire control system employed by the field artillery and the infantry battalion command network. Field wire and field telephone equipment, backed up by small portable and vehicular radio equipment, provide the basis for these systems. Another type of fire and movement control circuit is the so-called through circuit from a higher headquarters to an observation post or other installation well forward. Special circuits required for intelligence purposes also fall into this class, as do liaison circuits between supporting artillery and supported units.

Communications for Air Support

The principal air support for ground forces is provided by the tactical air command. Wire and radio relay operational channels normally are used for processing air request missions and for exchange of battle information and intelligence. In addition, a separate radio communications system may be provided at army, corps, and division level to ensure this support. This separate radio communications system provides radio nets that directly link the air-ground operations section at the Joint Operations Center with corps, divisions, and ground liaison officers stationed with units of the tactical air command. The Joint Operations Center is manned by ground forces, air forces, and Navy personnel (when necessary).

During amphibious operations, support is given by the Navy, and support communications must be provided for both naval gunfire and naval air support. Communication plans for this must be prepared well in advance of an operation so that the necessary personnel and equipment can be provided at the proper places and at the proper time. Each operation must be planned separately since the number and type of circuits required will depend on the number of naval units available for support, the number of landing beaches, etc.

Since support by other forces is vital to the success of any operation, it is necessary that support communications be the best obtainable. The signal officer of the ground force unit, by close liaison with the supporting units, ensures establishment of adequate signal communications.

New Concepts of Ground Forces Communications

Plans are now underway to reorganize Army ground force combat units into Pentomic Divisions. Adjustments are presently being made in the signal communications units assigned these divisions to provide increased flexibility and mobility.

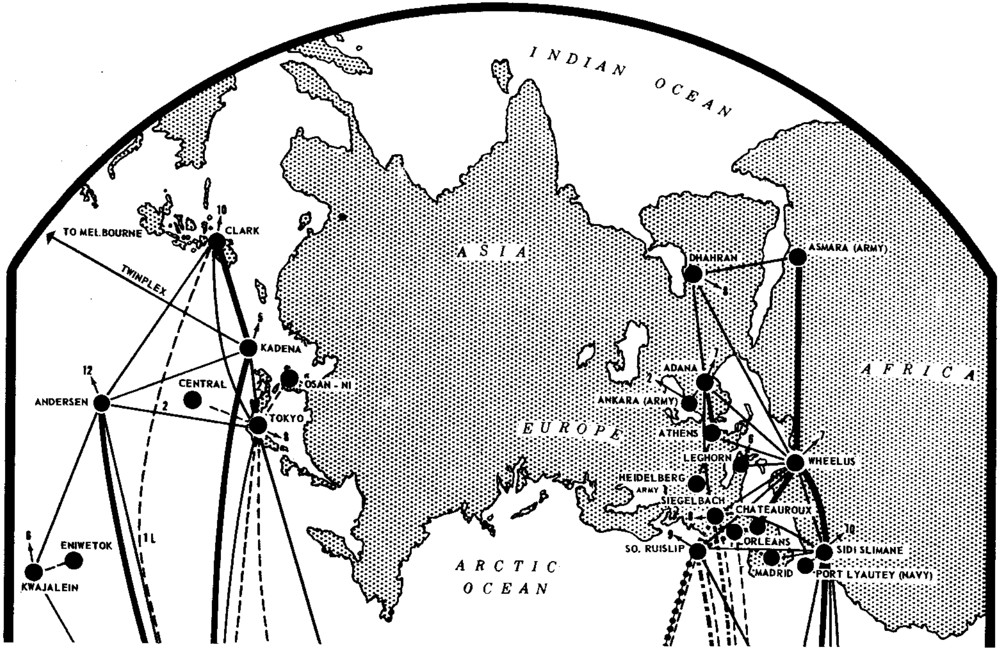
AIR FORCE COMMUNICATIONS

The increasing speed and range of aircraft demands that the Air Force be supported by the most rapid, flexible, and efficient communication system possible. In the Air Force as in the Navy, radio is the primary means of communication. Wire communications are used between ground installations and at various points in the field as operations progress.

AACS

The most important communications element in the Air Force is the Airways and Air Communications Service (AACS). This is the agency responsible for a continuous system of airways communication services along military air routes. These communication services provide facilities for point-to-point, air-ground-air, airdrome control, and meteorological communications. AACS establishes cryptographic sections, message centers, direction-finding facilities, instrument approach landing facilities, and radio and radar aids to air navigation. In addition, AACS has operational responsibility for all trunk circuits (wire and radio) installed between all major and primary relay stations of the USAF Communications Network (AIRCOMNET).

Messages pertaining to movement and operation of military aircraft are handled over the AIR OPERATIONAL NETWORK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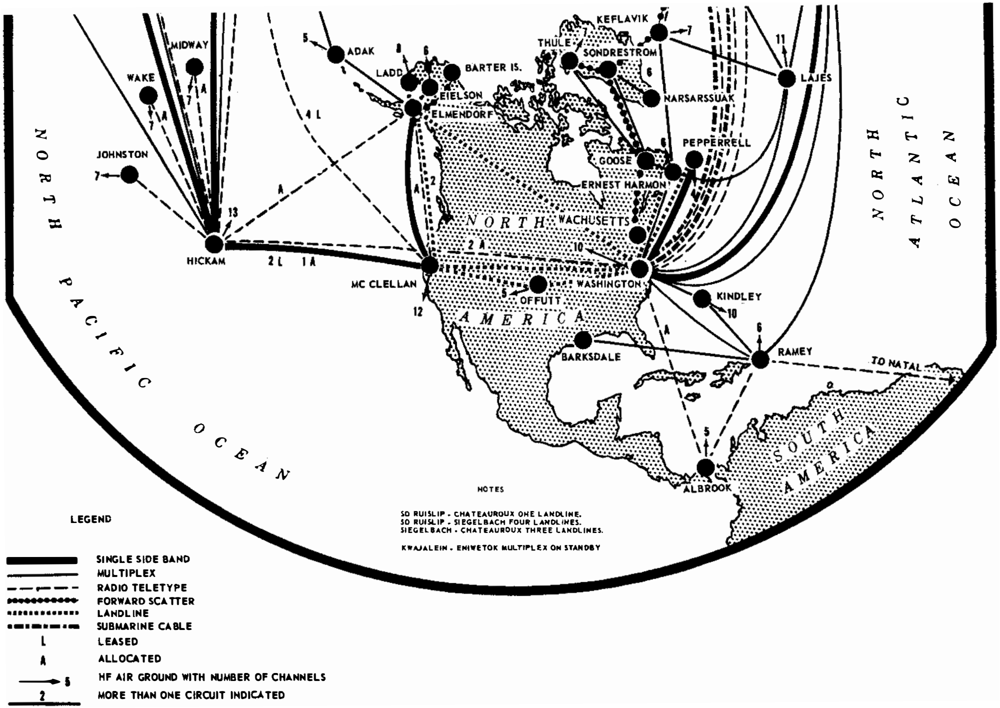


Figure 3–2.—USAF worldwide communication circuits.

(AIROPNET). This network, also under jurisdiction of AACS, serves Military Air Transport Service and flight service. The latter organization operates the flight service center of the system, including both interphone and teletypewriter circuits, to support all U. S. military aircraft movements (departure, arrival, and en route reports) within the continental U. S. This network is being expanded to provide worldwide flight service. Collection and dissemination of weather information required to support aircraft movement are performed by the Air Weather Service in conjunction with AACS.

Air Communication Officer

The duties of the Air Force communication officer are about the same as those of an Army signal officer. However, the Air Force communication officer has a number of duties in connection with electronic devices which are not generally the concern of the Army signal officer or the Navy communication officer.

Among the electronic devices which come under his cognizance are ground radar reporting and control systems, electronic navigational systems (radio ranges, beacons, LORAN, etc.), and automatic bomb-dropping mechanisms.

Functioning under the communication officer are assistants and advisers called communication unit commanders. Each unit commander conducts the training and operation of his unit according to the orders of the communication officer. Unit commanders and the communication officer work as a team, each acting for the other when necessary. However, responsibility for the conduct of signal communications operations cannot be delegated by the communication officer to any assistant. The duties of a unit commander are similar to those of signal and radio officers functioning under a Navy communication officer.

Operational Traffic

Messages pertaining to operations must be delivered promptly. The Air Force establishes direct circuits—apart from "common user" administrative circuits—for such traffic. Direct operational circuits may be by voice or teletypewriter or both, depending upon the particular situation. To get the maximum use from them, the normal practice is to provide such circuits with automatic cryptographic equipment, associated directly with the circuits, thus speeding up their use and maintaining necessary security.

When an Air Force headquarters is set up to handle operational traffic, the communication center and the operations room are in the same building. One copy of all incoming operational traffic is passed immediately to the operations room. (Recording, duplicating, and headquarters distribution are secondary to this primary requirement.) Outgoing traffic is passed directly from the operations room to the communication center for immediate transmission.

COAST GUARD

During World Wars I and II, the Coast Guard functioned as a component of the Navy, and adhered to the Navy's communication doctrine. Since World War II, this agency has resumed operations under the Treasury Department, but with joint communications now a reality, communication procedures of the Coast Guard are the same as those of the Navy, Army, and Air Force.

The United States Coast Guard is a service combining the functions of the former Revenue Cutter Service, the Lifesaving Service, the Lighthouse Service, and the Bureau of Marine Inspection and Navigation. It is, by law, a military service and a branch of the Armed Forces of the United States at all times, although in peacetime it is normally a service of the Treasury Department. The Coast Guard is required by law to maintain a state of readiness to function as a specialized service of the Navy in time of war, and it so operates upon a declaration of war or when directed by the President.

The Coast Guard functions under a Headquarters in Washington, D. C.; Eastern and Western Area Commanders in New York, N. Y., and San Francisco, California, respectively; and

12 district commanders. (See fig. 3-3.) Each district commander is responsible for communications within his district, and area commanders retain responsibility for interdistrict communications within their areas. Communication facilities for an area commander are provided by the district in which he has his headquarters. This is similar to the organization of naval communications. For example, Commander, Eastern Sea Frontier (COMEASTSEAFRON) has his headquarters in New York City, which is in the Third Naval District. Communication facilities for COMEASTSEAFRON are provided by the Third Naval District.

Principal duties of the Coast Guard include Federal law enforcement; search and rescue; administration and enforcement of shipping, navigation, and associated laws; and maintenance of aids to navigation, including LORAN stations. In carrying out these duties the service maintains a fleet of vessels, small craft, and aircraft. The floating units range from 327-foot gunboat-class cutters down to small motor lifeboats capable of operating in the roughest seas. The aircraft are largely patrol plane types and helicopters. These units are supported ashore by a chain of bases, lifeboat stations, light stations, and air stations interconnected by radio and landline communication facilities.

Coast Guard communication procedures conform with naval, joint, and allied procedures as outlined in DNC 5, NWP 16, NWIP 16-1, and pertinent JANAP and ACP publications. Communications between ships and between ships and shore stations are handled in the same manner as Navy communications between similar units, except that only the receipt (R) method of transmission is used. Communication equipment aboard Coast Guard vessels has the same general capabilities as that found aboard comparable Navy ships.

The equipment and facilities of the two services are used jointly whenever mutually advantageous. This spirit of cooperation is expressed in the previously mentioned Navy-Coast Guard communication policy.

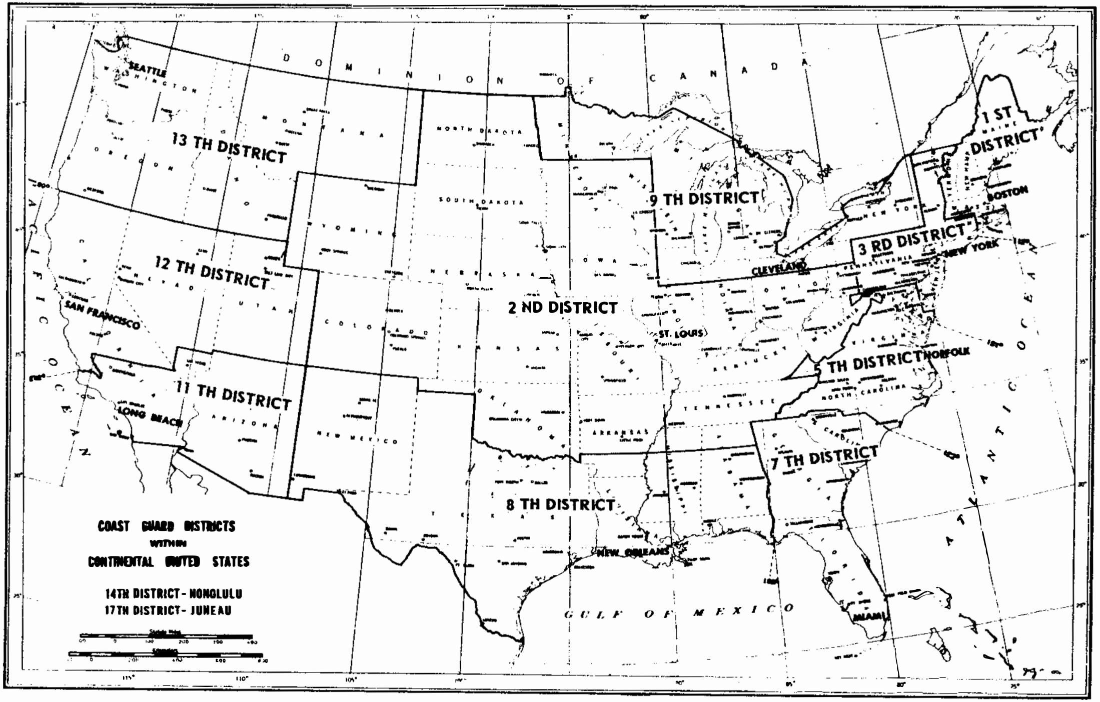


Figure 3-3.—Coast Guard districts.

U. S. COMMERCIAL TELECOMMUNICATION SYSTEMS

The private telecommunication industry of the United States is one of the Nation's most valuable assets in time of war. Defense industries and the vital supporting industries depend on the efficient and continuous operation of our common carrier telecommunication networks: landline and radio, telephone and telegraph, and submarine cables. Maximum utilization of these facilities would be a major factor in the event of another world war.

The Bell System

Bell Telephone, together with independent companies, blankets the entire United States with a network of interconnecting telephone circuits. There are some 160,000,000 miles of wire in service in cities and towns, and 40,000,000 miles of intercity telephone lines.

Elements of the Bell System are American Telephone and Telegraph Company, Bell Telephone Laboratories, Western Electric Company, and subsidiary and other associated telephone companies.

The Bell System uses four methods to interconnect our cities:

1. Open Wire.—Here a single pair of conductors may carry one voice channel, or this type of plant may have carrier systems applied which permit up to 16 channels per pair.
2. Ordinary Types of Cable.—With multiple copper conductors, ordinary types of cable carry voice circuits on the individual pairs and may also have carrier systems applied to them to produce up to 10 telephone channels per pair.
3. Coaxial Cable.—This provides a center conductor with a concentric tube around it permitting transmission of large numbers of telephone circuits at one time. The usual coaxial cable has eight of these tubes.

The most recent design of carrier equipment for these cables makes it possible for each pair of tubes to handle 1800 telephone circuits. Normally, of the eight tubes comprising a complete cable, only six are used for regular service. The other two are retained for spares in case of trouble. A fully loaded coaxial cable will therefore handle 5400 telephone circuits.

Instead of the 1,800 telephone circuits, each pair of tubes can, if necessary, carry two one-way television channels and 600 telephone circuits. Three pairs would therefore carry six one-way television channels—three in each direction—plus 1800 telephone circuits. The remaining pair of tubes in the cable would be held as spares to meet emergency conditions.

4. RADIO RELAY.—This method requires towers at intervals of about 30 miles for transmission of either voice circuits or television from city to city. These towers usually have four large rectangular antennas, two facing in one direction and the other two in the opposite direction. These antennas focus the radio beams on similar antennas at the next station. One of each pair is the transmitting unit; the other, the receiving unit. The radio relay system handles 12 one-way broad-band communication channels and provides for a total of 3000 telephone circuits or 10 one-way television channels. Spare channels are provided for emergencies.

The Bell System utilizes LOCAL FACILITIES in conjunction with these four methods for telephone communications between cities of this country. The following system in use by a large American city provides a typical example:

There are five regular cable routes into the city: two coaxial routes and three radio relay routes. All routes terminate either in the downtown or uptown switching center. These centers feed incoming calls to local offices and collect outgoing calls from local offices for distant calls. Because the switching centers are within 2 miles of each other, an enemy attack might put them out of service simultaneously. To guard against interruption of intercity telephone service, the local telephone company provides alternative arrangements.

Three dispersed switching centers have been established in suburban areas. These switching centers are on the main routes coming into the city, and terminate approximately 25 percent of the circuits entering and leaving the city. They have trunk facilities to the various offices in the metropolitan area. This is not a standby arrangement—it is working daily. In other words, 25 percent of traffic in and out of the city is handled by dispersed offices every day. Consequently, in case of an emergency, no time would be required to put them into service.

Bell Telephone maintains and operates major long-distance routes on a vast scale. There are seven transcontinental routes: four open wire, a cable equipped with the ordinary type of carrier, a coaxial cable, and a coast-to-coast radio relay route. A major addition will be another radio relay route across the southern portion of the country, terminating at Los Angeles.

Overseas radio circuits of the Bell System connect the United States with various parts of the world through radio channels originating from transmitter and receiver sites near New York City to the east, near Miami to the south, and near San Francisco to the west. Connection is made with Army transmitters and receivers at Seattle for communications to the north. There are approximately 150 direct radio circuits. They interconnect with other places on the European, African, Asiatic, and South American continents.

Voice Cable

In spite of technical advances in electronics, radio communication to Europe has not been completely successful. Magnetic storms sometimes completely interfere with both voice and telegraphic communication. Consequently, a voice cable between the continents of America and Europe—under consideration for many years—has been constructed and placed in service.

Selection of the route was an important part of the construction plans. Consideration of the many hazards led to the choice of a route from New York to Newfoundland to Scotland. It is the shortest practical route, goes through a minimum of pack ice, and misses most of the trawling grounds.

The length of the main link is about 1800 miles. There are two cables, one for transmission in each direction. The link from Newfoundland to Nova Scotia is a submarine cable. From Nova Scotia into Portland, Maine, the conventional type of radio relay system is employed. At present there are 36 voice circuits in the cable.

To provide adequate communications, underwater repeaters are installed in the cable at intervals of about 40 miles. These repeaters have three low-power vacuum tubes and will last for many years without attention. The cable itself is designed to last at least 20 years without attention.

Western Union

Western Union has been serving the nation since 1851, when it was organized to create a unified national telegraph system. The system operates under the provisions of the Communications Act of 1934, which authorized the FCC to regulate interstate and foreign communications. While purely interstate wire communication does not fall within the FCC's jurisdiction, the Company's interstate operations are regulated by 45 state public utility commissions.

Western Union provides its nationwide service through a network of automatic transmission facilities built around 15 high-speed message centers. Each center serves from one to six states. Through these centers messages are flashed automatically without manual relay. These centers function similar to the Navy's semiautomatic tape relay centers.

Principal services of Western Union include domestic and international message services, telegraphic money orders, private wire systems, leased facsimile systems, domestic and international metered communications, and a variety of nontransmission services such as correct time and messenger errand.

TRANSMISSION FACILITIES.—Western Union is making extensive use of the new microwave radio relay system. The unique possibilities of this system result from the fact that radio wavelengths of 10 centimeters and less can be directed in space either by horns or suitable reflecting devices. The towers in the beam system, located many miles apart, have replaced former pole lines. Superhigh-frequency radio waves are transmitted by directional beams from tower to tower. Unattended stations automatically amplify and instantaneously flash the radiotelegraph signals on their way. This method of transmission is highly important in times of national emergency, not only for its extensive circuit capacity, but also because it can be more readily protected from sabotage.

For distribution of messages to small towns and hamlets, the telegraph company has over a million miles of open wire. Within cities and towns 400,000 miles of cable conductors are used to provide service from patrons to Western Union main offices.

Reperforator Switching Systems.—The reperforator switching system of Western Union is integrated with its radio relay and open wire transmission facilities on a nationwide scale.

The distribution system for the entire country has been scientifically plotted to provide the most direct paths from any given city, town, or village to any other point with a minimum number of handlings. The 48 states are divided into 15 geographical areas. Each area comprises one or more states in which all the localities have direct connection to the "area center" which serves them. Each area has direct circuits to each of the other 14 area centers. No telegram will be transmitted through more than two area centers from origin to destination, while many will be transmitted through only one. The system is designed to provide direct point-to-point service on the majority of telegrams.

Eight of the centers now in operation, and the new ones to be constructed, provide the selective switching feature. In this type of system, the originating operator automatically selects a direct connection to a distant reperforator center. This system increases speed of service and ensures greater accuracy of transmission.

Private Wire Service.—Thousands of American business firms and Government and military agencies lease Western

Union private wire facilities, utilizing more than 1,500,000 miles of telegraph circuits. The world's largest private wire network is the specially designed system installed by Western Union for the United States Air Force. The USAF system uses more than 130,000 miles of line circuits, and links more than 200 Air Force stations throughout the country. Other nationwide private wire systems furnished by Western Union serve vitally important defense production and other essential industries.

Western Union has also developed, and is now leasing to Government and industry, facsimile equipment to connect scattered departments, branches, and plants. These leased facsimile systems, known as Intrafax, make it possible to transmit in picture form all types of written, typed, printed, or pictorial matter. Western Union's Intrafax systems are in use by the steel, oil, and chemical industries, by airlines and railroads and by many other commercial enterprises.

Western Union's overseas operations are conducted by a separate international communications organization, under a vice president. Its accounts are kept separate from domestic system accounts, but it is part, not a subsidiary, of the parent Western Union Telegraph Company.

Western Union's cable system handles by itself or through connecting carriers messages to all parts of the world, including Europe, South America, and the Caribbean area.

American Cable and Radio Corporation

American Cable and Radio Corporation (AC&R) is an associate of the International Telephone and Telegraph Corporation. Its operating companies are: All America Cables and Radio, Inc., The Commercial Cable Company, and Mackay Radio and Telegraph Company in the United States, and Sociedad Anonima Radio Argentina in the Argentine.

All America Cables and Radio.—All America operates both radio and submarine cable telegraph circuits directly connecting the United States with practically all countries in Central and South America and most of the principal islands of the West Indies. International radiotelephone circuits are also operated by All America from several South American countries.

The Commercial Cable Company.—Commercial provides direct transatlantic cable service connecting the United States, Canada, and Newfoundland with the Irish Republic, United Kingdom, France, Belgium, the Netherlands, and the Azores. It maintains connecting lines with other points in Europe, the Middle East, and Africa. The company maintains six transatlantic cables and a number of coastal cables along the American seaboard and on the European side.

To keep its cable lines operating at top efficiency, AC&R's cable companies employ ships especially fitted for cable laying and repair operations. At present, AC&R operates three cable ships: *All America, John W. Mackay,* and *Marie Louise Mackay.*

Sociedad Anonima Radio Argentina (RADIAR).—"Radiar," a wholly owned AC&R (Argentine) subsidiary, provides radiotelegraph service from the Argentine to the United States and certain South American and European countries. The service between Buenos Aires and New York via Radiar supplements other cable and radio routes of the company serving South America.

Mackay Radio and Telegraph Company.—As AC&R's principal radio company, Mackay Radio operates high-speed radiotelegraph circuits connecting the United States with many foreign countries and territories. In the east traffic is transmitted from Mackay's operating center in New York City via control lines to its long-distance transmitting station at Brentwood, Long Island. These signals are beamed overseas to Europe, the Middle East, India, Africa, and Latin America.

In the west, Mackay's operating center is located in San Francisco. From here traffic is transmitted to islands in the Pacific and points in the Far East via control lines and high-power transmitters at Palo Alto, approximately 30 miles from San Francisco. The operating centers at New York and San Francisco are linked by a radio trunk circuit to provide service from the east coast to Honolulu and the Far East as well as from the west coast to points in Europe, the Middle East, India, Africa, and Latin America.

Mackay also provides a presscast service for the principal United States news agencies. News copy originated by these agencies is transmitted on a teleprinter circuit to all parts of the world.

SHIP-TO-SHORE RADIO.—In addition to its point-to-point services, the Marine Division of Mackay Radio operates six coastal stations in the United States. These stations offer radiotelegraph service to ships at sea all over the world. WSL Amagansett (Long Island) and KFS Palo Alto are high-powered, multichannel stations. Besides serving major ports of New York and San Francisco, respectively, these stations function as principal outlets for marine traffic from all other points routed "Via Mackay" and destined to ships on all the sealanes of the world.

Located at WSF, New York City, is Mackay's Marine Bureau. It offers a 24-hour ship location and routing service to the public. Available to Marine Bureau personnel is the latest information regarding the movements of vessels throughout the world. The Marine Bureau routes traffic through the most favorable stations on the east, west, or gulf coasts. Other coastal stations operated by the company are located at Galveston, Texas; Paramount, California (near Los Angeles); and Kent, Washington (near Seattle).

RESEARCH AND MANUFACTURE.—The Marine Division of Mackay Radio develops and manufactures shipboard communication and navigation aids such as direction finders, radiotelephone and radiotelegraph equipment, lifeboat radio sets, and other devices. It installs and maintains electronic equipment on ships throughout the world.

To maintain and service this equipment, Mackay Radio Marine Division has a network of service depots at more than 180 principal ports throughout the world. Maintenance of its own equipment as well as that of other manufacturers is provided.

Radio Corporation of America

Radio Corporation of America was organized in 1919. Ten years later RCA Communications, Inc., was formed to carry on the communications business under the general control of the parent company. Organization of a separate company for communications permitted intensive concentration on development of new circuits, services, and apparatus. Marine messages are handled by Radiomarine Corporation of America, another subsidiary of RCA.

The RCA radiotelegraph network includes 86 circuits serving 68 countries in every part of the world. The 5-unit code printing telegraph method is utilized, replacing the slower manual processing method.

RCA uses an automatic tape transmission and reception system on all the major circuits of its network. To ensure signal accuracy, RCA's Multiplex ARQ equipment monitors incoming signals, permitting only those which are perfect to pass; it automatically orders retransmission of rejected signals until they are perfect.

In addition to its radiotelegraph network, RCA maintains and operates an international teleprinter exchange service called TEX. The teleprinter signals are beamed overseas on an RCA radiotelegraph channel. This overseas teleprinter-to-teleprinter service is much the same as TWX communication between two cities within the United States. TEX is available between the United States and all of the countries included in TELEX, the European teleprinter service. It is also available between San Francisco and Honolulu.

RCA'S radiophoto service provides fast overseas transmission of pictorial material in much the same manner as the Navy's facsimile system. Commerce, industry, government, and private individuals use this service to send overseas copies of all types of drawings, legal documents, and pages of copy and illustrated material.

Leased channel radiotelegraph circuits are available to activities with large volumes of overseas traffic. RCA leased channel service is utilized on full-time 60-WPM channels, and on subchannels of 15-, 30-, and 45-WPM capacity. The military uses only full-time 60-WPM channels. RCA leased channels are being used by the Department of State, United Nations, the Armed Forces, and international airlines.

RCA Communications' Program Transmission Service offers facilities for exchanging broadcast studio and press programs between the United States and foreign points. Program circuits are available between the United States and 35 overseas points. Upon arrangement, this service may be extended to any point in the world. Facilities are also available for ship-to-shore programs.

Globe Wireless Ltd.

The international radiotelegraph system now known as Globe Wireless Ltd. was founded in 1928 by the late Captain Robert Dollar. For the first 6 years it was known as Dollaradio and was operated on an experimental basis by the Dollar Steamship Line to communicate with Dollar Line ships.

In 1934 it was incorporated as Globe Wireless Ltd. and entered the public communications field. The company owns terminals at New York, San Francisco, Honolulu, and Manila and Cebu (Philippines). Its connecting terminals are located at Havana, Shanghai, and Taipeh (Formosa). Other offices of Globe Wireless are maintained in Washington, D. C., Los Angeles, and Seattle.

Traffic Routes and Special Services.—Globe Wireless Ltd. handles commercial and Government traffic of all classifications to all world points and to ships at sea.

Traffic originating at and beyond the east coast terminal (New York City), destined transpacific, is handled by semiautomatic relay at the west coast terminal (San Francisco), to Honolulu, Manila, and Shanghai. Traffic originating beyond the west coast terminal, destined to and beyond the east coast terminal, is also handled by semiautomatic relay at San Francisco.

Traffic destined to points throughout the world not covered by direct Globe circuits is transferred to connecting carriers at

New York City for Europe, Africa, and South and Central America; at Honolulu for other Hawaiian Islands; and at Manila for Australia and Far East countries.

Globe maintains its own messenger service at all terminal offices for local message pickup and delivery. Traffic from and to localities other than terminal offices is received from and transmitted to the Western Union Telegraph Company in the United States, Hawaiian Telephone Company in Hawaii, and the Bureau of Posts in the Philippines. Such activities are handled by Cuban Wireless in Cuba, and by the Chinese Government Radio Administration at Shanghai and Taipeh.

In addition to handling message correspondence, Globe offers three other types of service.

1. STS (Scheduled Press Transmission/Reception Service).—STS provides radiotelegraphic transmission of press traffic from San Francisco, and reception at Honolulu, and vice versa, on a scheduled basis. Press traffic is filed in the form of perforated tape with the company's central traffic office at either city through the customer's connecting tie line facilities. It is transmitted by the company to the other city without further processing. The press is delivered to the addressee office by the company's central traffic office at the destination city over connecting tie line facilities without further processing.
2. TELEX.—This transpacific international teleprinter service provides facilities for direct telegraph communication between teleprinter stations in the continental United States and teleprinter stations in the Hawaiian Islands. Service includes communication in both directions but not simultaneously. (This is similar to the Navy's Simplex.) Operating speed is approximately 60 words of five characters each per minute. The company does not undertake to transmit messages in the usual telegram form but furnishes the use of its facilities to customers for the exchange of direct telegraph communications with the parties called.

3. LEASED RADIO CHANNEL SERVICE.—In its leased radio channel service, Globe provides a two-way radio channel between the company's radio terminals at San Francisco and Honolulu for the direct transmission and reception of teleprinter signals. This service is furnished on a contract basis for the customer's exclusive use. It enables two-way teleprinter communication simultaneously at a maximum operating speed of approximately 60 words of five characters each per minute.

EQUIPMENT.—Globe Wireless Ltd. electronically controlled radiotype printers and Teletype Corporation teletype printers are used on all of Globe's point-to-point circuits. Globe radiotypes, a wartime development of International Business Machines Corporation, are now owned and used exclusively by Globe Wireless Ltd.

The machine uses an electronic permutation unit, based on a 6-unit code instead of the older, 5-unit system. This gives a wider range of code combinations with increased speed and accuracy. The keyboard has 42 keys instead of the standard 31 used on older teletypes. The conventional shift of the type basket has been eliminated, thereby increasing speed of operation by approximately 20 percent and considerably reducing error potential.

All receivers operate in dual diversity. Arrays, vees, and rhombics are utilized as directional antennas. Transmitters run from 3.5 KW to 20 KW. They may be operated on a single-channel basis (Simplex) or on a 2-channel basis (Duoplex). Here again arrays, vees, and rhombics are used as directional antennas.

At Globe's marine coastal stations, receivers on nondirectional antennas scan the high-frequency and intermediate-frequency ship bands 24 hours a day, prepared to accept messages. Transmitters run from 3.5 KW to 10 KW and also operate on nondirectional antennas.

Tropical Radio Telegraph Company

Tropical Radio Telegraph Company was incorporated in Delaware in 1913, and is owned by the United Fruit Company.

Tropical operates public service radiotelegraph stations at Boston, Miami, and New Orleans, in the United States, and combined public service radiotelegraph and radiotelephone stations in cities of Central America and in Cuba. It maintains connections with RCA, AT&T, Western Union, and with foreign companies such as Cable and Wireless Ltd. (Jamaica), French Cables, Italcable, and Radiomex.

Since World War II, Tropical's system has been wholly converted to radioteleprinter. Morse circuits are still maintained with certain foreign communications systems which have not yet been able to meet Tropical on printer.

Because of severe electrical disturbances, Tropical's frequency bands require extensive forking to utilize fully each assigned frequency. In the new teleprinter system, selective calling devices are used which activate only the desired receiving point.

Besides the changeover to radioteleprinter, Tropical intends to convert its Westinghouse standard MW-type composite transmitters to single sideband rather than double sideband for telephone transmission.

In addition to operating MW equipment, Tropical maintains a Western Electric 3-channel, single sideband transmitter working directly with AT&T, New York. Its other radiotelephone transmitters are primarily for inter-Central and South American and West Indies communications. These transmitters are double sideband.

Tropical also operates microwave control channels at a number of its stations, notably Miami, New Orleans, Guatemala City, Tegucigalpa (Honduras), and San José (Costa Rica). Underground cable wire controls are utilized at Panama City, Managua (Nicaragua), and La Lima (Honduras).

FEDERAL COMMUNICATIONS COMMISSION

The Federal Communications Commission is the agency charged with regulating interstate and foreign communications, including radio and wire services. It also licenses operators and non-Government radio stations.

Regulation by the FCC provides for development and operation of radio broadcasting services and makes available rapid, efficient nationwide and worldwide wire and radio communication service. It makes these available with adequate facilities at reasonable charges.

The FCC is not a part of any Government department. It was created by an Act of Congress (the Communications Act of 1934) and reports directly to Congress. Formerly, jurisdiction over electrical communications was shared by the Commerce Department, Post Office Department, the Interstate Commerce Commission, and later by the Federal Radio Commission. With the Communications Act, all supervisory and regulatory functions were assigned to the FCC.

The FCC is administered by seven commissioners appointed by the President and subject to confirmation by the Senate. One of the commissioners is designated chairman by the President. Not more than four commissioners may be members of the same political party. Except for filling an unexpired term, the term of a commissioner is 7 years.

In matters national and international, the FCC cooperates with various Government agencies, including State, Army, Navy, Treasury, Interior, and Commerce Departments, and other users of radio in the Federal establishment. It also cooperates with state regulatory commissions in matters of mutual interest. This is done largely through the National Association of Railroad and Utilities Commissioners.

The Communications Act applies to the 48 States, to Alaska, Hawaii, Puerto Rico, and other United States possessions. It does not apply to the Panama Canal Zone. Functioning within these areas, the FCC has 24 radio district offices, 6 suboffices, and 1 ship office. There are also various monitoring stations and a field engineering laboratory. Field duties include monitoring and inspecting all classes of radio stations, examining radio operators, making various radio measurements and field intensity recordings, and conducting related investigations. In addition, there are three common carrier engineering field offices. (A common carrier is any person or company furnishing wire or radio communication to the public for hire, with the exception of broadcasters.) Since broadcasting sta-

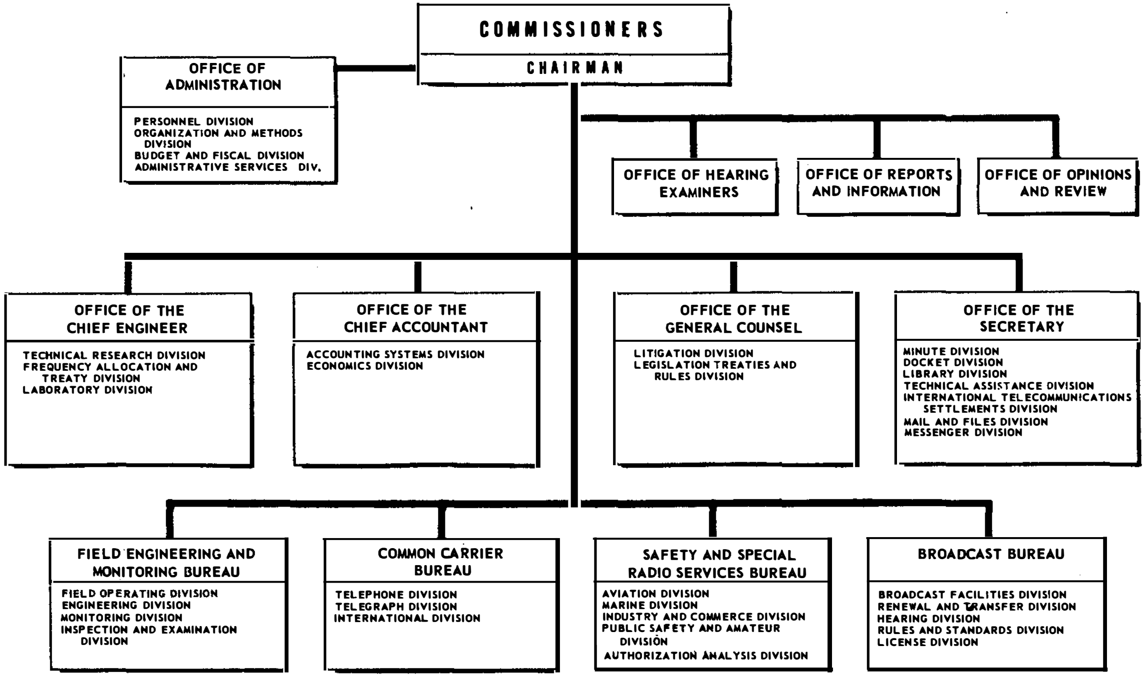


Figure 3-4.—FCC organization.

tions are not deemed common carriers, the FCC does not regulate charges for program time. Even though the Commission monitors broadcasts, it has no power to censor radio programs.

Licensing

Since only a limited number of radio transmissions can be on the air at the same time without causing interference, the Communications Act requires all non-Government radio operations to be licensed. Courts have held that radio transmission anywhere within the United States or its possessions requires licensing both the transmitter and its operator.

Although FCC issues licenses to both operators and transmitting stations, the Commission collects no fee or charge of any kind in connection with this licensing. When the FCC issues a license, it first makes sure the license will serve the "public interest, convenience, and necessity." Because channels are limited and are a part of the public domain, it is important that they be entrusted to licensees who have a high sense of public responsibility. The license privilege is extended by the Communications Act only to citizens of the United States. It is denied to corporations wherein any officer or director is an alien, or if more than one-fifth of the capital stock of the corporation is owned or voted by aliens or their representatives.

Assigning Call Letters

International agreement provides for the national identification of a station by the first letter, or first two letters, of its assigned call signal, and for this purpose assigns the alphabet among the several nations. The FCC is authorized to assign call signals for all United States stations except mobile stations of the Army. The Commission presently uses the initial letters A, K, N, and W. Except blocks of call signs assigned to particular Government agencies or departments for their own use, call signals are assigned by the Commission upon an individual station basis. The initial letter N is reserved at the present time for the Navy and Coast Guard; A is for exclusive use of the Army and Air Force. Letters K and W are shared by other stations, both Government and non-Government.

Broadcast stations are assigned call signals beginning with K or W. Generally speaking, call letters beginning with K are assigned to broadcast stations west of the Mississippi River and in the territories and possessions, while W is assigned to broadcast stations east of the Mississippi.

Monitoring

One of the important functions of the FCC is "policing the ether." This is done by field stations which monitor transmissions to see that they are in accordance with treaties, laws, and regulations. There are 10 primary monitoring stations and 18 secondary monitoring stations. If necessary, mobile equipment can trace illegal operation or sources of interference. Monitoring stations also furnish emergency directions to Government and civilian aircraft.

The Commission periodically inspects radio equipment on United States ocean vessels and on foreign ships calling at our ports. FCC ascertains that radiotelegraph installations comply with the International Convention for the Safety of Life at Sea, and the shipboard radio requirements of the Communications Act. About 14,000 such inspections are made each year.

FCC in Wartime

During World War II, the FCC cooperated with the Army Air Forces in maintaining a constant vigil on the coasts, ready to close down radio transmissions which might furnish bearings for enemy aircraft. With the Office of Civilian Defense, it worked to guard vital communications facilities against sabotage. Also, the Board of War Communications, headed by the chairman of the FCC, coordinated communication activities for emergency purposes. The Commission established a foreign intelligence service which monitored foreign broadcasts for the military and other Government agencies. Its own radio intelligence division policed the domestic ether and helped furnish bearings to our aircraft.

CONELRAD

CONELRAD (**CON**trol of **EL**ectromagnetic **RAD**iation) is a method of using electrical radiations as a defense measure. Its purpose is to deny the enemy use of our electromagnetic radiations for navigational purposes in attacks on the United States, its territories, and possessions.

The Federal Communications Commission regulates CONELRAD programs implemented by the various radio services. As applied to broadcasting companies, CONELRAD works as follows:

During an alert, FM and TV broadcast stations are silenced, but designated AM stations use 640 or 1240 kilocycles to broadcast essential news, information, and civil defense instructions. This operation is juggled in such a way as to confuse the enemy regarding the location of participating stations. The alert is sounded by the Air Defense Command of the Air Force.

Tests of the CONELRAD broadcast system indicate that it is performing satisfactorily. Air Defense Command observations showed that broadcast operations under CONELRAD are of no value to a possible air enemy. Broadcasting of civil defense information to the public has been adequate in approximately 80 percent of cities having CONELRAD stations.

The FCC recently extended the CONELRAD plan to aeronautical radio stations, public safety systems, and the amateur radio service.

In event of an alert, aeronautical radio stations would operate under instructions from the CAA Air Route Traffic Control Centers. The public safety systems would be subject to direction of the Air Defense Control Center of the Air Force. All amateur stations would cease operation unless specifically authorized by the FCC to continue on the air.

It is expected that virtually all radio stations licensed by the FCC will eventually be included in CONELRAD programs.

CONELRAD plans have also been developed for United States territories and possessions. Methods of exchanging air defense warnings between the United States and Canada and between the United States and Cuba are also complete.

In summary, the major activities of the Federal Communications Commission are—

1. Allocating frequencies for all licensed radio stations.
2. Licensing and regulating radio services and radio operators.
3. Regulating common carriers engaged in interstate and foreign communication by wire or radio.
4. Promoting safety through the use of radio on land, water, and in the air.
5. Encouraging more effective and widespread use of radio.
6. Utilizing its regulatory powers over wire and radio communications to aid the military effort.
7. Regulating CONELRAD programs of the radio services.

QUIZ

1. What are the three ZONES for which the Army Signal Corps must furnish communications?
2. What is ACAN?
3. What officer in the Army holds a position corresponding to that of Director of Naval Communications?
4. What is the smallest unit to which Signal Corps troops are normally assigned?
5. Name the principal Air Force communication network.
6. What are the principal duties of Air Force communication unit commanders?
7. Who is responsible for communications within a Coast Guard district?
8. Name the Government agency charged with regulating interstate and foreign communications, including radio and wire services.
9. What is a common carrier?
10. Why does the FCC monitor transmissions?
11. What is CONELRAD?
12. Name the four methods used by Bell Telephone System to connect cities.
13. What are the principal services of Western Union?
14. What services are performed by MacKay Radio's Marine Bureau?
15. What system does RCA use on major circuits of its network?
16. Name three services of Globe Wireless in addition to handling message correspondence.
17. What type of transmitter does the Tropical Radio Telegraph Co. use to work directly with AT&T, New York?

CHAPTER 4

COMMUNICATION CENTER PRACTICES

INTRODUCTION

The communication center (COMMCEN) of a large combatant vessel is the hub of shipboard communications. It includes a message center, radio central, and cryptocenter. (The message center is usually called the COMM office or main COMM). All messages received or sent by radio or radioteletypewriter must clear the COMM office before internal routing or release from the ship. Outgoing traffic must be cleared accurately with a minimum of delay, and incoming messages must be written up and routed correctly to officer(s) and/or departments concerned. Mastery of these and other traffic-handling operations spell sharp communications for your ship.

The COMMCEN of a large NAVCOMMSTA is likewise responsible for prompt transmission, receipt, and delivery of messages to designated naval activities. Many COMMCENS also process TWX traffic for allied civilian activities such as technical laboratories and atomic energy experimental installations. Smaller COMMCENS (sometimes called COMM offices) such as those at naval air stations or ammunition depots have a lighter traffic load. Procedures are similar to those followed at the larger centers, for each message must meet the same exacting standards of format and routing.

This chapter describes your supervisory billets and traffic-handling operations in COMMCENS both afloat and ashore.

Bear in mind that no procedures are exactly the same for all commands, due to varying local requirements and conditions. You will, however, be able to adapt the information herein as a guide in setting up COMM office procedures at your activity.

Supervisory Billets Afloat

Your assignment to the COMM office or radio central of a large combatant vessel makes you an important assistant to the radio officer. Here are some billets you can expect to fill: Radioman in charge, COMM office or main COMM supervisor, leading Radioman, or supervisor in radio central. You'll supervise lower rated Radiomen, TE(RM's), and strikers such as circuit and transmitter room operators, communication messengers, and writeup men. In addition to your many supervisory and routine duties you will also maintain close liaison with supervisors in the OS and OI divisions.

Radioman in Charge

The Radioman in charge—sometimes called traffic chief, chief in charge, or leading petty officer—is the senior Radioman in the OR division and has direct charge of all personnel in the division. He checks preparation of all watch lists before submission to the radio officer, making sure that all men are equitably rotated among the various watches. He also organizes a training program for Radiomen, TE(RM's), and strikers. This requires him to conduct periodic examinations, assist in training communication watch supervisors, and set up all radio drill circuits.

To avoid loss or delay of messages, the Radioman in charge should check all radio files and logs frequently (preferably on a watch-to-watch basis). His initials on each message certify that a final check has been made. He sees that files are complete, neat, and efficiently organized, and that certain files are destroyed at specified times. (Types of files and disposal times are discussed in chapter 8 of the *Radioman 3 and 2* training course.)

He must keep up to date on all force, fleet, and type commander COMM instructions, Op Plans and Op Orders (especially the Communication Annexes), and keep his men informed of all such directives.

Checking Spaces and Equipment

If you are appointed Radioman in charge, one of your earliest acts should be to make a thorough inspection of communication spaces. This serves a double purpose: to get thoroughly acquainted and to sight everything for which you are responsible. The type and quantities of electronic equipment for each class of ship are shown on the BUSHIPS allowance list and the NAVSHIPS 4110, and a record of equipage is kept on cards prepared for this purpose. An instruction book should be available for every type of equipment on board.

When you make your first tour of communication spaces, inspect everything. Give special attention to cleanliness of communication equipment and areas. This includes the often overlooked emergency radio rooms, as well as certain separate portable emergency radio equipment, which should be clean and ready for use at a moment's notice. In particular make sure that "good" batteries are left in the portable gear. You never can tell when the landing party or other emergency assistance teams will be called away without prior notice.

In radio central check reception of broadcast schedules. Determine if weather and press are being copied regularly. Learn the schedules. Check the radio patchboard panels for proper operation. If the panels are unfamiliar to you, learn to operate them as soon as possible. Compare the status board with the transmitter switchboard to be sure they coincide. A typical status board is shown in figure 4–1.

Examine loudspeakers, earphones, and plugs. Check calibration of receivers and transmitters to see if they are properly tuned. Make sure they are marked plainly with frequencies to which tuned, that antennas are not closed if they should not be, and that heaters are on in nonoperating transmitters. Are transmitters receiving a daily check to correct filament supply voltages? Are transmitter frequencies checked daily? Find out

SAMPLE RADIO STATUS BOARD

CONFIDENTIAL

CKT	NET	NCS	FREQ	EM	POS	TRANS	RCVR
B1	FOX	NSS	VAR	CW	2	-----	RAK-2
A17	S/S	NAM	2840	CW	SUP	TBL-1	RBB-4
D106(c)	TGC	V3F2	495	CW	Bridge-1 CIC-1	TCS-2	TCS-2
E1.5	C1	Watchdog	145.08	V	CIC-3	TDQ-3	RCK-1
D1 (a)	Pri Tac	Watchdog	72.9	V	Bridge-3 CIC-2	TCS-1	TCS-1

Figure 4–1.—Radio central status board.

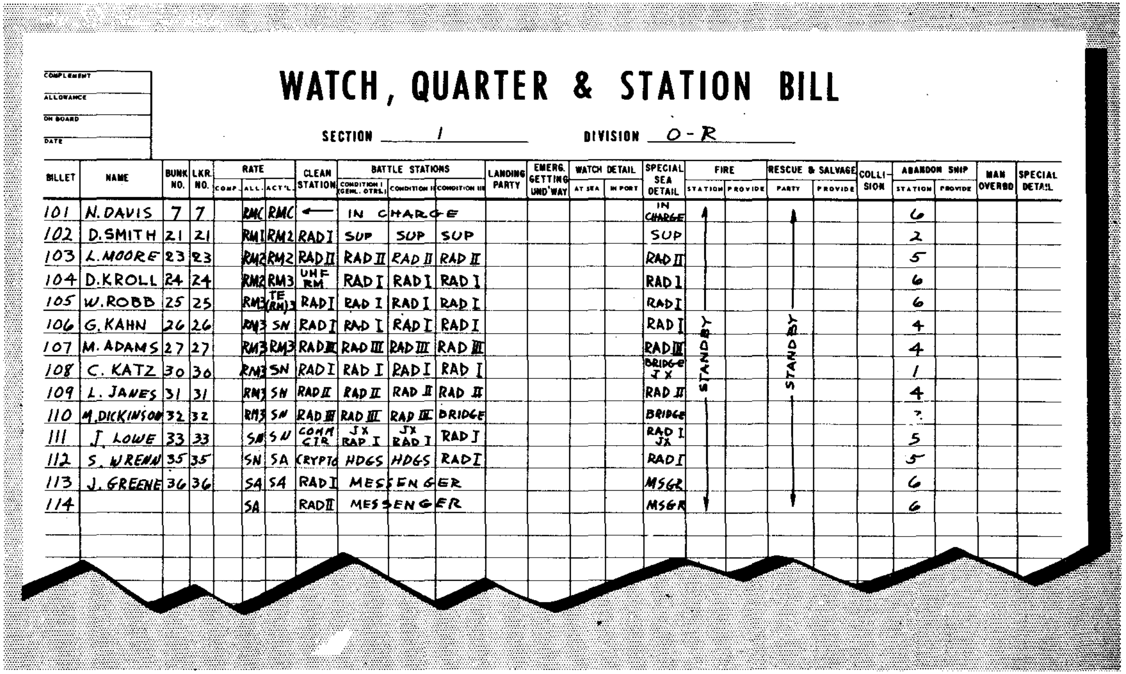
if motor generators in operation are being checked once a watch for noise and unusual heating, and whether idle generators are being inspected once a day.

Topside, make frequent inspections of the antenna system, including leads to antenna trunks. Look for excessive sagging, fouling, and other readily detectable conditions which affect antenna efficiency. See that there is enough antenna wire on hand to meet any emergency. If there are no emergency antennas or jury rigs, have some made up as soon as possible.

See that there is an ample supply of fuses. Make sure extras are kept conveniently near equipment requiring them. Post location of fuses.

Make sure proper bills are made out for watch standers, messengers, cleaning gang, and destruction crew. (The OR division watch, quarter, and station bill is shown in figure 4–2.) Look for posted lists of safety precautions, resuscitation charts, and DANGER/HIGH VOLTAGE warning signs.

Daily inspections will keep you in close touch with everything going on in the radio spaces, and give you an opportunity to assist and advise your men. It is the best way to keep the OR division efficient and help prevent communication blunders. Following is a list of questions worth answering when you inspect.



WATCH, QUARTER & STATION BILL

COMPLEMENT
ALLOWANCE
ON BOARD
DATE

SECTION 1 DIVISION O-R

BILLET	NAME	BUNK NO.	LKR. NO.	RATE COMP.	RATE ALL.	RATE ACT'L.	CLEAN STATION	BATTLE STATIONS CONDITION I (GENL. QTRS.)	BATTLE STATIONS CONDITION II	BATTLE STATIONS CONDITION III	LANDING PARTY	EMERG. GETTING UND'WAY	WATCH DETAIL AT SEA	WATCH DETAIL IN PORT	SPECIAL SEA DETAIL	FIRE STATION	FIRE PROVIDE	RESCUE & SALVAGE PARTY	RESCUE & SALVAGE PROVIDE	COLLISION	ABANDON SHIP STATION	ABANDON SHIP PROVIDE	MAN OVERBD	SPECIAL DETAIL
101	N. DAVIS	7	7		RMC	RMC	←	IN CHARGE							IN CHARGE						6			
102	D. SMITH	21	21		RM1	RM2	RAD I	SUP	SUP	SUP					SUP						2			
103	L. MOORE	23	23		RM2	RM2	RAD II	RAD II	RAD II	RAD II					RAD II						5			
104	D. KROLL	24	24		RM2	RM3	UHF RM	RAD I	RAD I	RAD I					RAD I						6			
105	W. ROBB	25	25		RM3	TE (RM)3	RAD I	RAD I	RAD I	RAD I					RAD I						6			
106	G. KAHN	26	26		RM3	SN	RAD I	RAD I	RAD I	RAD I					RAD I						4			
107	M. ADAMS	27	27		RM3	RM3	RAD III	RAD III	RAD III	RAD III					RAD III	STANDBY		STANDBY			4			
108	C. KATZ	30	36		RM3	SN	RAD I	RAD I	RAD I	RAD I					BRIDGE JX						1			
109	L. JANES	31	31		RM3	SN	RAD II	RAD II	RAD II	RAD II					RAD II						4			
110	M. DICKINSON	32	32		RM3	SN	RAD III	RAD III	RAD III	BRIDGE					BRIDGE						[illegible]			
111	J. LOWE	33	33		SN	SN	COMM CTR	JX RAD I	JX RAD I	RAD I					RAD I JX						5			
112	S. WRENN	35	35		SN	SA	CRYPTO	HDGS	HDGS	RAD I					RAD I						5			
113	J. GREENE	36	36		SA	SA	RAD I	MESSENGER							MSGR						6			
114					SA		RAD II	MESSENGER							MSGR						6			

Figure 4-2.—Watch, quarter, and station bill.

1. Does handling of traffic meet the requirements for reliability, security, and speed?
2. Are security regulations and fire hazard precautions observed in every compartment (including unoccupied compartments)?
3. Are all files carefully and properly maintained?
4. Are watch-to-watch publication custody logs maintained?
5. Are contents of wastebaskets being burned?
6. Are all radiotelegraph and radiotelephone logs properly kept?
7. Are call signs broken rapidly and accurately?
8. Do all Radiomen understand voice radio procedure, authentication, and use of enciphered operating signals?
9. Can all Radiomen tune every transmitter aboard?
10. Can all Radiomen use a frequency meter?
11. Are frequently meters checked weekly against WWV? Is the log for this kept current?
12. Is the radio equipment log being kept properly?
13. Are all safety precaution and warning posters or equipment operation instructions displayed?
14. Is all communication equipment operative? If not, is effective action being taken to get it into working order?
15. Are transmitters and receivers calibrated to frequencies specified in the current Op Plan or Op Order?
16. Do all your men know the present condition of radio silence, and under what circumstances and by whose authority it may be broken?
17. Do they know what channel and major frequencies are in use? What standby frequencies are available? The call signs of ships in the force?
18. Are all frequencies in use checked hourly?
19. Do all communications spaces have adequate emergency lighting conditions?
20. Are jettison bags available in radio rooms for emergency destruction?
21. Does equipment cleanliness indicate proper maintenance?

Leading Radioman

The leading Radioman coordinates all phases of radio communications with the Radioman in charge. He is responsible for the proper operation of all equipment in radio central and associated spaces. The leading Radioman sees that equipment is in satisfactory operating condition, and properly maintained. He instructs strikers in proper tuning and calibration of equipment, connection of remote control positions, and correct procedures for operation of equipment.

Supervisor in Radio Central

In radio central, the supervisor is responsible to the CWO for keeping traffic clear and maintaining discipline on radio circuits. He must be familiar with all communication instructions and have at hand all pertinent publications for ready reference. At sea, he should know the cruising disposition of the fleet to handle traffic properly. He should be familiar with his own radio equipment and with that of the various types of vessels in company. With this information he will be able to recognize and allow for personnel and material limitations of other units.

Before taking over a watch, the supervisor obtains all information possible concerning circuit conditions, special orders, cruising disposition, traffic on hand, acknowledgments and replies pending, officers aboard, guardships, ready-duty vessels, medical guard vessels, control circuits in use, frequencies guarded, scheduled frequency shifts and transmitters/receivers in use. He should see that all necessary publications are in radio central. Publications in custody of the supervisor must be sighted before the oncoming supervisor signs for the watch.

When in port, a list of all Radiomen aboard should be maintained to provide for extra watches in emergencies. This list will include Radiomen who rate liberty but have remained aboard.

Before turning the watch over to his relief, the supervisor should assure himself that the men under him have been relieved and that all traffic in the daily file has been checked for delivery. He informs his relief of the radio organization in effect, status of traffic on circuits being guarded, call signs for which the ship is responsible, and condition of receivers, transmitters, and controls. Be sure he has ALL relevant information and thoroughly understands the situation.

To reduce to a minimum the time required for delivery of traffic and to eliminate errors and unnecessary transmissions, established procedures must be strictly enforced. The supervisor should monitor frequencies in use to correct operators who violate instructions. Be alert for swinging of call signs, gossip on the circuit, transmission at speeds beyond the capabilities of receiving operators, and similar examples of bad operating practices. Every radio shack has copies of ACPS, JANAPS, and DNC 5 which contain examples of each type of message. When following these instructions, there is no excuse for misrouting, incorrect framing of messages, and service messages with garbled meanings.

Supervisor in the COMM Office

The supervisor in the COMM office is the principal assistant to the CWO. He is responsible for the correct and expeditious writeup of all traffic, and ensures that all data required for identification and routing are recorded on each writeup. The supervisor also sees that all messages are promptly and properly delivered. His office duties include maintaining a tickler system and other prescribed watch logs and records, and filing unclassified traffic.

Make sure the messenger continuously reviews the routing board to ensure that no addressee has been overlooked. He should remove all unclassified messages which have been completely routed and place them on the completed routing files for final filing. Doublecheck the board frequently to ensure complete routing. Remember that messages should be delivered only to those who need to know. Make sure the messenger understands that contents must not be revealed to any persons except those indicated in the routing.

If the importance of a message warrants, the supervisor must exercise initiative and act promptly and positively to get the message delivered at once. This may mean bypassing normal delivery methods. Remember, information received too late is of little value.

It is important for the supervisor to examine the writeup man's work carefully. Check each message for accuracy, neatness, and ease of reading. The latter includes factors such as proper abbreviations, punctuation, spacing between lines, and inclusion of references. Make sure your writeup man turns over to his relief any special orders and informs him of all messages not written up, outgoing messages written up but not released, status of the writeup board, and status of the routing board.

On smaller ships where there are no CWO's, there is one supervisor on each watch. He is responsible to the COMM officer for all routing, filing, and delivery to the addressee. He should see that acknowledgements and replies are promptly made and, in general, should assume the duties of a CWO.

Before being relieved, the supervisor reviews each current message with his relief, and notes initials still to be obtained. He should explain reasons for nondelivery if it has been impossible to obtain initials, and pass along any special instructions.

TRAFFIC HANDLING

Communications is one matter that comes under surveillance by all senior officers daily. From their personal observations of your message handling techniques they form an opinion of the worth of the OR division. There are two things you can do to ensure the COMMCEN enjoys a reputation for smart traffice handling. First, lay down procedures to follow from the time a message is received until it is ready to be placed on the routing board. Then there will be no doubt in any man's mind as to how a message is to be written up and handled. Second, check frequently to see that these procedures are being followed to the letter.

Use the following section as a general guide for setting up message-handling procedures. Modify these operations as necessary to fit your type of ship and particular situation.

Incoming Radio Messages

Your operator should devote his utmost attention to copying the message accurately. For other than messages received by broadcast, ensure that operators check accuracy of group count against groups received before receipting for the message.

After taking the message from the operator, the radio central supervisor examines the address, precedence, checks the group count, and looks for any obvious errors. He passes the message to the breakdown man who breaks down all call signs in the heading. After the heading of the message is broken down, the supervisor rechecks the message. The message is then delivered to the COMM office supervisor. He signs for it, and returns a copy to the radio central supervisor. The radio supervisor places his copy on the incoming radio station file board.

When the supervisor in the COMM office receives the message he logs it, assigns an internal message number, and hands it to his writeup man. In typing the message the writeup man should be accurate and neat, and fill in all applicable spaces. Just below the text on one line the TOR, operator's sign and internal message number must appear. References should be typed at the bottom of the message blank.

The CWO proofreads the writeup, initials it, and designates ACTION and INFO officers. A sufficient number of copies is then run off. The writeup man or supervisor places a copy of every message requiring an answer on the tickler file board, pulls one copy for retention in the COMM office, and gives the communication messenger copies for delivery. The messenger delivers the message(s) as expeditiously as possible to officers concerned. If the message is an ALNAV, the messenger places one legible copy on the ALNAV board in the wardroom. The CWO may also designate one copy to go on the general information file board in the wardroom.

After the message is completely routed, the original plus all remaining copies are returned to the writeup man. He checks to ensure complete routing, places the original on the awaiting file board in numerical order, and then indicates on the message log sheet that routing is complete. Extra copies plus the one retained while the message was being routed are placed in the burn bag. Figure 4–3 summarizes for you the important steps in processing a plain language incoming message.

When an encrypted message is received in the COMM office from radio central, the CWO or supervisor checks the message and records it in the incoming message log. He initials the original code copy and returns it to the radio central supervisor. A copy is then turned over to the cryptocenter for decryption. The CWO or COMM office supervisor indicates in

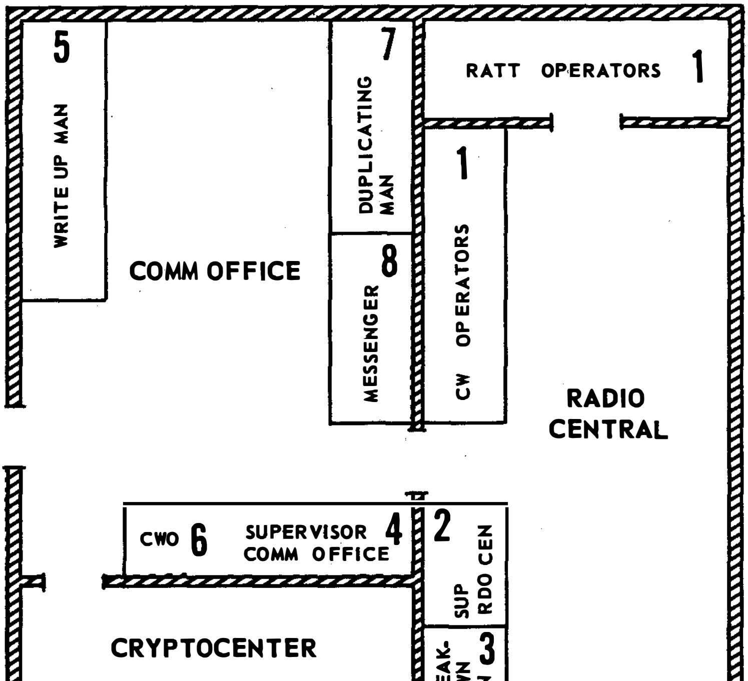


Figure 4–3.—Processing an incoming message.

the incoming log that the message has been delivered to the cryptocenter. (On some ships the name of the cryptocenter duty officer is entered in the log.) After decryption, the translation copy is forwarded to the CWO, who designates ACTION and INFO officers. After writeup, the message is checked in the same manner as unclassified messages and is delivered as rapidly as possible. For CONFIDENTIAL message, each officer receipts for a copy by initialing the original; for higher classification, a full signature is normally required. The original translation, after routing, is placed in the cryptocenter file chronologically by DTG.

NOTE.—TOP SECRET messages are ALWAYS written up in the cryptocenter. On some ships ALL classified messages are written up there.

Outgoing Radio Messages

The CWO or supervisor checks the rough draft for accuracy of contents, originator's initials, releasing officer's signature, precedence, and classification. The writeup man then types up smooth copies. He checks references to see that they are unclassified and types in REFERENCE(S) UNCLASSIFIED. The message is then handed to the CWO who proofreads the writeup, initials it, and passes the message to the supervisor in radio central for transmission. The supervisor in radio central rechecks the message and passes it to his breakdown man who records the proper heading. The supervisor rechecks the heading and logs the message in the outgoing log. The message is then passed to the operator for transmission.

After transmission the radio central supervisor retains one copy for his outgoing radio station file and hands a copy back to the COMM office for internal routing and filing. The message is routed internally in accordance with instructions for routing plain language incoming messages.

The CWO checks the rough draft of an outgoing classified message for accuracy of contents, originator's initials, releasing officer's signature, precedence, and classification. He then delivers the message to the cryptocenter for encryption. After the message has been encrypted, the CODE copy is passed back to the CWO in the COMM office. He checks and initials the message. It is then passed to supervisor in radio central for transmission. Here the message is processed in the same manner as an unclassified message.

Visual Messages

You no doubt are already familiar with the three types of visual messages: TACTICAL, requiring immediate action; TACTICAL, requiring action at a later time; and ADMINISTRATIVE. A message or signal requiring action other than demanded by the immediate tactical situation is written up and handled as a regular incoming. The signal supervisor assumes first responsibility for the message and the COMM office supervisor is responsible for accuracy of the writeup.

Outgoing visuals are received on the signal bridge either from the OOD or COMM office. Messages for which writeup and routing are desired are first released and sent. They are then written up, using the same procedure as described for outgoing radio traffic.

Class E Traffic

An appreciable number of incoming messages are of a personal nature. Your job is to restrict the routing of such messages to keep them personal. Make sure your men are careful not to discuss with or show any person the text of such messages.

Personal messages are normally received on the broadcast or, if your ship is in port, through shore communication centers. A personal message received via broadcast is typed on a regular message form, using only the original and one copy. It is routed to the COMM officer and addressee only, and the addressee is called to the COMM office to accept delivery. A personal message concerning death, serious illness, or injury is routed to the chaplain BEFORE DELIVERY TO THE ADDRESSEE. If a ship has no chaplain, the message is routed first to the captain or exec.

The originator of an outgoing class E delivers it to the COMM office, where it is written up in proper form. The CWO checks the message and initials it if suitable for release. The originator obtains a release from the COMM officer, exec, or captain. After release the originator takes his message to the commercial traffic clerk, who computes the charges, records the amount paid, and initials the original message. When the message is returned to the COMM office it is processed in similar manner to any other outgoing message. It is assigned DEFERRED precedence except under unusual circumstances and goes out with other traffic in order of DTG.

Abstracting Class E Messages

If, before a class E message gets to its destination, it must be handled by a commercial company, you must collect tolls for the distance the message travels over commercial lines.

ABSTRACTING is the tabulating, reporting, and accounting of such toll messages on the proper forms. A COMMCEN supervisor should make sure he can instruct his men in the details of abstracting.

Class E traffic is abstracted on a printed form, OPNAV 2130–1. Abstracts are submitted monthly; ships must mail them by the 5th day of the month, shore stations by the 10th. All reports must be forwarded to the Officer in Charge, U. S. Navy Regional Accounts Office, Washington 25, D. C.

Check each class E message report to see that it consists of—

1. Abstract, Form OPNAV 2130–1.
2. One copy of each class E handled, showing complete transmission data.
3. Remittance necessary to cover commercial tolls of all class E messages reported. Remittance must be in the form of an exchange-for-cash U. S. Treasury check, U. S. postal money order, or American Express money order. (Cash, postage stamps, or personal checks are not allowed.)
4. Statement of Account, Form OPNAV 2160–3, in duplicate, completely filled in and signed.

The remittance covering class E messages addressed to the continental United States, and refiled for final delivery by the

Western Union Telegraph Company, must be made payable to the order of the Western Union Telegraph Company, Washington, D. C. Forward the remittance to the Officer in Charge, U. S. Navy Regional Accounts Office, Washington 25, D. C. Make sure that only those funds due the Western Union Telegraph Company are included in the check or money order made payable to that company.

At a large shore station, especially one open to commercial traffic, you can expect to handle many class D messages also.

Complete instructions for the accounting and abstracting of ALL classes of messages (A, B, C, D, and E) are found in *Commercial Traffic Regulations* (DNC 26). Be sure you have access to an edition containing the latest effective change.

Security Precautions

A COMM office must be compromise-free. This means security-conscious communicators and a foolproof method of processing traffic. From time to time you and the CWO should go over every step of the procedure for handling traffic to see that it will not betray inexperienced personnel into making errors. Here are a few rules every communicator should follow:

1. Never take the clear (translation) copy of an encrypted message into radio central or onto the signal bridge. This is a safeguard against sending classified information in the clear and the even greater cryptographic error of sending plain a message which has already gone out in encrypted form.
2. Stamp every plain copy of a classified message with its classification in BOLD LETTERS.
3. Check each reference in an unclassified message to find whether the reference was classified and how much, if any, has been quoted.
4. Adhere strictly to established procedures.
5. Give utmost attention to detail.
6. Always be alert.

Remember that you, as supervisor, are responsible to the CWO and COMM officer for enforcing physical security in communication working spaces. Classified files require continuous safeguarding. Unauthorized personnel must not be allowed in communication spaces, particularly the cryptocenter, and are not to have access to communication publications or equipment. Stow encrypted messages apart from their translations. Place all wastepaper in the burn bag.

COMMCEN ASHORE

As was indicated in chapter 2, the COMMCEN (shown in fig. 4–4) is the major activity of a NAVCOMMSTA. Components include the message center (where most traffic is handled), circuit control, cryptocenter, facsimile branch, and tape relay station. In addition, facilities for telephone and teletypewriter conferences are usually provided. With the exception of the tape relay center, operations of each component and facility are discussed here. The tape relay station is described in the next chapter.

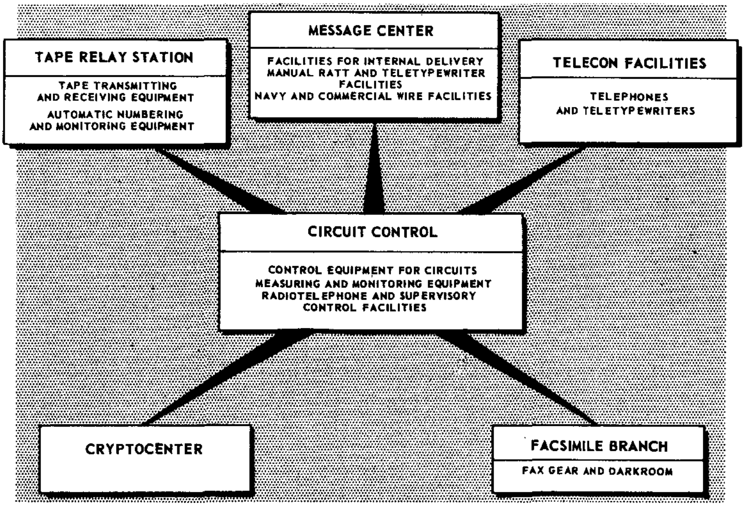


Figure 4–4.—Physical arrangement of COMMCEN.

In a large message center there are many operating positions to supervise because of the diversity of facilities and tremendous volume of traffic. In addition to CW and RATT operators, there are routers, file clerks, delivery clerks, duplicating machine operators, service clerks, and many others. Bear in mind that you are an operator as well as a supervisor, for you are frequently needed to supplement or replace men in certain positions when personnel shortages or heavy traffic dictate.

In any message center the supervisor of the watch—sometimes called chief of the watch—sees that message traffic moves through normal communication channels without undue delay. As direct assistant to the CWO, the supervisor is responsible for all personnel on watch and equipment in use. In the absence of the CWO, he may be designated to act for the CWO insofar as internal routing and delivery of messages are concerned. The supervisor should screen outstanding check copies at least three times each watch to make sure there are no excessive delays in the return of circuit copies. At all times he should keep himself informed of the conditions of radio and NTX circuits to ensure proper message routing. He must also keep posted on alternate routings for all circuits.

Before being relieved, the supervisor should turn over to his relief all special orders, instructions, and other information. He should inform his relief of the radio organization in effect, status of traffic on the nets or circuits in use, and call signs and address groups for which he is responsible.

The traffic checker is another important supervisor in any message center. He is responsible for the complete checking of all incomings and outgoings including those messages received for relay. Here are some of the things he checks:

1. Correct and complete delivery;
2. Breakdown of call signs;
3. Precedence;
4. Circuit routing;
5. Internal routing;
6. TOR and TOD to determine excessive delays;

7. Group count;
8. Legible station serial numbers;
9. Sines;
10. Time stamping;
11. Proper observation of security requirements;
12. Inclusion of all times and dates necessary.

The traffic checker reports all excessive delays to the supervisor or CWO. He informs the party concerned of an error and shows him the correct procedure. The checker must therefore keep up on all COMMCEN directives and memoranda, and be thoroughly familiar with communication procedural publications.

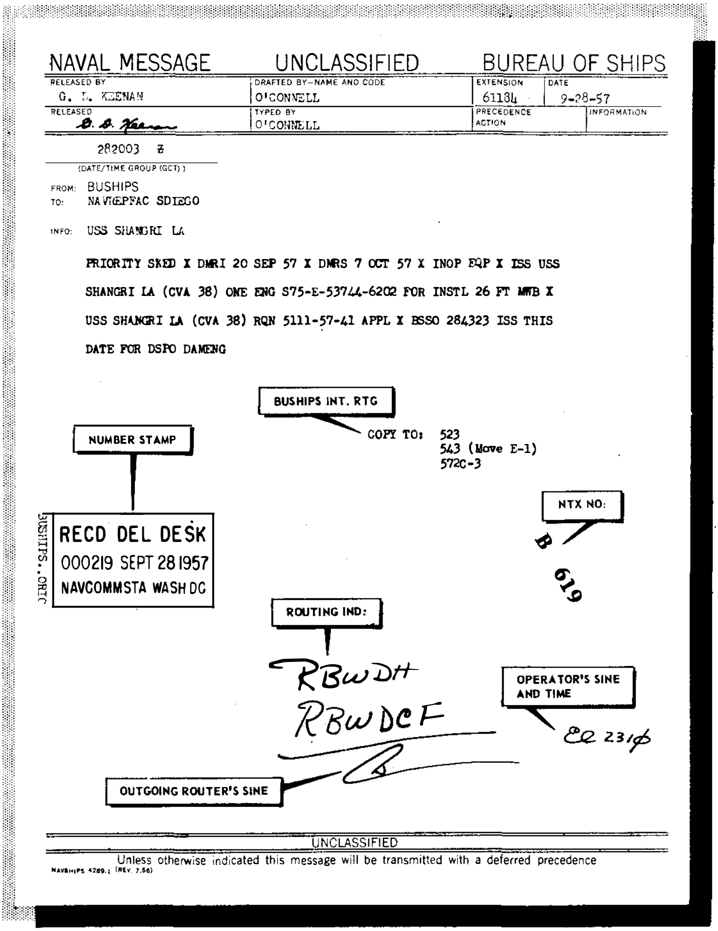
Message Processing

Varying physical arrangements and local conditions at each COMMCEN make it impractical to set forth mandatory procedures for handling traffic. Each command, of course, follows high-level communication directives, but adapts them to fit its particular situation. This section describes, in general, the flow of traffic through the message center of a large COMMCEN. Bear in mind that billet names and some operating practices may differ from those at your command, and that some jobs may be combined due to the ever-present shortage of trained communicators.

Outgoing Traffic

Figure 4–5 shows a message processed by NAVCOMMSTA WASHDC for one of the many activities for which it guards. The message is from the Bureau of Ships to the Naval Repair Facility San Diego, info to the USS *Shangri La.* Note the processing data as well as the general format of the message. Refer to the example as necessary while reading the following description of its handling.

The message is first checked for releasing officer's signature, which is compared with the corresponding one on file at the delivery desk. If a message has no DTG or if the DTG is incorrect, one is assigned. The originating office must always


NAVAL MESSAGE UNCLASSIFIED BUREAU OF SHIPS

RELEASED BY	DRAFTED BY—NAME AND CODE	EXTENSION	DATE
G. L. KEENAN	O'CONNELL	61184	9-28-57

RELEASED	TYPED BY	PRECEDENCE ACTION	INFORMATION
G. L. Keenan	O'CONNELL		

282003 Z

(DATE/TIME GROUP (GCT))

FROM: BUSHIPS

TO: NAVREPFAC SDIEGO

INFO: USS SHANGRI LA

PRIORITY SKED X DMRI 20 SEP 57 X DMRS 7 OCT 57 X INOP EQP X ISS USS SHANGRI LA (CVA 38) ONE ENG S75-E-53744-6202 FOR INSTL 26 FT MWB X USS SHANGRI LA (CVA 38) RQN 5111-57-41 APPL X BSSO 284323 ISS THIS DATE FOR DSPO DAMENG

BUSHIPS INT. RTG

COPY TO: 523
543 (Move E-1)
572C-3

NUMBER STAMP

BUSHIPS. ORIG

RECD DEL DESK
000219 SEPT 28 1957
NAVCOMMSTA WASH DC

NTX NO:

B 619

ROUTING IND:

RBWDH
RBWDCF

OPERATOR'S SINE AND TIME

EQ 2310

OUTGOING ROUTER'S SINE

B

UNCLASSIFIED

Unless otherwise indicated this message will be transmitted with a deferred precedence

NAVSHIPS 4289.1 (REV. 7.56)

Figure 4-5.—Plain language outgoing message.

be informed of the change. It is common practice for an originating office to furnish work copies for transmission, check, and DTG files.

After the initial check, the message is automatically numbered or time stamped, and a copy is returned to BUSHIPS' messenger. If a message is PRIORITY or higher, the original copy is stamped with the precedence. A group count is made, if required, and the proper accounting symbol is added to the message as appropriate.

The outgoing routing clerk checks the message for completeness of address and makes sure there is no classified information in the text. Circuit routing is placed conspicuously at the bottom of the message, underscored, and initialed by the clerk. General message routing cards are used to route general messages as well as service messages. After the message has been routed, the outgoing traffic checker reviews the heading, circuit routing, precedence, classification, and class and type of message. This is also done for service messages.

When the message is ready for transmission over the appropriate circuit, it is inspected by the circuit supervisor for accuracy of routing, heading, and text. The message is then delivered to the correct circuit and placed in the appropriate basket according to its precedence and TOR at circuit. High-precedence messages are passed by hand. After the message is transmitted to the tape relay center, the operator records his initials and time of transmission.

Incoming Traffic

The bulk of incoming traffic is received either from the tape relay center or by direct line from the associated radio receiving station, which brings in ship-shore traffic. Other traffic is received from TWX and commercial facilities circuits.

Incoming messages are time-stamped by the incoming router on the front top center as received and handled in order of precedence. The original is used as a check copy. One copy is used as a transmission copy when relays or refiles are necessary, and the other carbon is placed in the DTG file. The duplicating machine operator then runs off additional copies as needed. The routing given the message (internal or circuit) is placed on the lower right corner above the routing clerk's sign. Messages are relayed to activities for which the message center guards whether or not the activities are indicated in the transmission instructions. Texts are checked for buried addressees, garbles, and irregularities.

Internal Routing

Proper distribution of messages received by the message center for delivery to activities in the area is made by the internal routing clerk. To distribute a message correctly to all interested parties, your router must have a thorough knowledge of the functions of all activities served by the center. He must understand naval terminology, operations, and equipment. Since the internal router acts as a checker for the incoming router, he must also know the NTX system and be familiar with the various ACPS and JANAPS.

Upon receiving the message, the internal router notes the adee(s), determines if the message was received for ACTION or COGNIZANCE (COG), as indicated by the originator, looks up references (if included), and decides on the routing. The subject matter usually presents a concise idea or well-defined air, fleet, or base function. When several subjects are included in one message, familiarity with past and current operations will help the router decide which is the most important idea. References in the text also aid in determining the routing. Standard routing cards for categorized functions and special projects are also available for reference.

After determining the routing, the internal router writes it on the message with a pencil, and places the message in the baskets according to precedence. Navy and commercial messages to individuals are routed to the appropriate office for delivery. Messages to related naval activities in the area are sent via tape relay to their communication offices.

The ditto clerk runs off the necessary number of copies, making certain to reproduce clean, legible copies. He should pay particular attention to see that all circuit numbers appear on all ditto copies. (THIS IS VERY IMPORTANT TO FILE CLERKS.) He should also make sure that no part of the message has been missed from the ditto roll.

Your distribution clerk then checks to make sure enough copies have been run off. He acts as a second check on the incoming and outgoing routing clerks as well as the internal routing clerk. This requires him to have a thorough knowledge of the more common activities and their routings as well as familiarity with the NTX system. He keeps a close check on legibility of copies, making sure that no part of the message runs off the side or end of the sheet. If necessary, he should inform you when the ditto ribbon needs changing. He must watch for relay instructions in the text.

The delivery desk clerk receives messages from the distribution clerk. He numbers each message successively on the top copy, and the numbered copies are placed on file. The delivery desk file is used by the clerk to check on missing messages, to ensure delivery of important messages, and to prepare his daily report of the number of copies delivered to each office.

The clerk inspects heading, text, and internal routing of each message to make sure no interested activity has been omitted or that a disinterested office has been added. Discrepancies must be called to the attention of the appropriate desk and correction made prior to delivery. An adee of an important message is notified by phone so that the message may be picked up at once.

Instructions are constantly received concerning message delivery to certain offices. Some instructions are temporary, others permanent, but the frequency with which they are received requires that the delivery desk clerk check the memo file daily. Most centers also maintain an index card file and CWO hours folder to describe the manner in which important messages are to be handled after office hours. Some are telephoned to duty officers at home or on duty at their offices. Others may be delivered by a COMMCEN messenger. Call the CWO's attention to any message that cannot be delivered promptly.

TWX Traffic

TWX circuits serve naval and other activities for which there is not enough traffic to justify a Navy leased-line circuit. Messages may be sent to and from any office which is also a TWX subscriber. Messages sent by TWX are assigned a channel number as well as a station serial number. In general, the same procedures are used for messages on TWX circuits with naval activities as on NTX circuits. Transmission copies are usually marked and filed in the same manner as tape relay messages. The page copy from the machine is filed in the TWX file. When a message has been sent and receipted for, the control switch of the machine is turned off, breaking the connection.

If necessary to make a tape of the transmission, a reperforator can be connected to the machine by a control switch.

Commercial Traffic

Traffic over lines to commercial telecommunication companies is in either domestic or cable form. Operators and supervisors must therefore have a thorough knowledge of commercial communication procedures. They must also be able to maintain accurate accounts for these messages.

A complete set of domestic and cable tariffs is maintained at each message center with commercial traffic circuits. Messages to any part of the world serviced by commercial companies can be processed. In sending commercial traffic, the cheapest method consistent with traffic precedence and communication procedure should be used. Regulations in the latest edition of DNC 26 must be followed to the letter.

Routing Section

One or more routing clerks work full time to maintain up-to-date circuit routing records for all activities of the Navy, records for control of message accountability, and microfilm records of the message center files. Each clerk must have a good general knowledge of location of cities represented by NTX routing indicators. The associated movement report center (MRC) furnishes the routing section movement reports of all naval commands, ships, and aircraft, and Army, Coast Guard, and Marine Corps movements. These reports are screened carefully to ascertain location of ships and activities and means of delivery of messages in the most expeditious manner. The reports are transferred to a worksheet for convenience and then recorded on routing cards. Cards are kept on file and routings transferred to spindles in the message center. Encrypted movement reports go directly to the cryptocenter for decryption.

Circuit routing records are usually kept in cardex files. The name of each activity or ship is typed on a card, and the tape relay network indicator is entered in pencil. The record card for a ship shows the routing indicator of the COMMCEN whose fleet broadcast the ship copies. Local broadcast letters are entered on the card of a ship in the area, indicating whether it copies CW or RATT. No routing indicator need be entered for a ship with this notation.

There are several different types of card files. One type lists naval activities alphabetically by name, another type by call sign, and still another by hull numbers.

Service Desk

Requests for service on traffic going through the message center are handled by service desk clerks. Their task is to clear up errors made by others.

The service clerk checks each message received for servicing for any other errors in addition to the one noted for which the message was originally referred to the service desk. In this way, all errors can be cleared up with one service. All messages or services of priority precedence or higher must be seen by the CWO, who will decide what final action should be taken.

The DTG file is used to locate any message which the service clerk needs in his work. Having located the message in the DTG file, he then goes to the appropriate incoming or outgoing file and removes the message. He leaves a dummy check with complete identification (channel number, date, DTG, his name, and present location of message) to replace the removed message. If it is necessary to send a message requesting a reference not held in the message center files, the request goes as an official message and is released by the CWO. Normally, a message center sends such requests only when they are desired by activities which are action adees and which do not have a COMM office.

Unanswered service requests more than 24 hours old and messages and services of priority precedence and higher are referred to the CWO. A service message should carry the same precedence as the message to which it refers, except that deferred messages receive routine service.

Make sure your service clerk does not hold up a message from delivery because of a slight error. The test for delivery is whether it is positive that delivery in its present condition would be useless to the adee. Messages should not be held up, for example, because of one garbled adee. Service the call if necessary, but see that the message is also routed. If it has to be relayed further, use the appropriate operating signal in the heading.

Files

Three types of files are generally maintained—outgoing, incoming, and DTG. Outgoing and incoming circuit files are retained for 6 months. After 60 days DTG files are microfilmed and stored for an indefinite period.

The outgoing file clerk must file messages as rapidly as possible to keep current files up to date. Pigeonholes are provided for filing by circuit number all current daily messages awaiting transmission. There are also pigeonholes for check copies of urgent, operational priority, and multiple address messages.

Each check copy contains complete routing and passing instructions. It ensures that all transmissions are complete and all necessary action taken. Check copies and finished transmission copies must be picked up at frequent intervals (never less than once every 2 hours) and placed in appropriate pigeonholes. Check copies are matched with transmission copies. The check copy bears the station serial number of the circuit over which transmitted. The number appears directly opposite the circuit routing as indicated by routing clerks. When all transmissions are complete and copies ready for filing, your outgoing file clerk so indicates by drawing a line across each completely processed message.

The outgoing file clerk obtains messages from the outgoing circuit position and when cleared files them in numerical sequence with respect to station serial numbers. He checks at frequent intervals to ensure continuity of circuit serial numbers. Missing numbers must be obtained as necessary, and there should never be a blank number.

The plain language version of an encrypted message is never placed in the files. If, through an error, your outgoing file clerk receives the plain text copy of an encryption, notify the CWO immediately. Place a dummy in the files until the code copy is obtained.

Your incoming file clerk must have a thorough knowledge of how messages should be routed to various activities, including NTX, in order to save a nondelivery. He operates in the same careful manner as the outgoing file clerk, checking for continuity of circuit numbers, inserting a dummy in the files when a check copy is removed, and making sure he files his traffic as rapidly and accurately as possible. No message should be filed, however, unless it has been cleared, checked, and initialed by the traffic checker.

The date-time group file clerk must keep the DTG file up to the minute for ready reference, for this file is continuously used to locate messages referred to only by DTG.

Each message is filed by the date-time group file clerk chronologically in the appropriate pigeonhole. He places the last two figures of each DTG in the upper left corner of the message and files it in the proper hour box. A message with multiple headings is filed under the DTG of each heading.

Your date-time group file clerk should pay attention to the details on every DTG message copy—breakdown, routing instructions, internal distribution, and other processing information—to help prevent nondeliveries and to qualify him for other duties.

All three file clerks on the day watch should check the previous day's incoming boxed traffic for continuity of circuit and channel numbers. If file clerks are unable to locate missing numbers not listed on the missing number sheet after a thorough search of the message center, the CWO and watch supervisor should be notified so that reruns can be obtained from the relay station.

CIRCUIT CONTROL

Circuit control (sometimes called control center) is the heart of the NAVCOMMSTA. Through this area pass all radio circuits to and from overseas activities as well as landline facilities. Circuits are made normal (balanced, compensated, or matched) throughout their entire length on a continuous basis except when landline casualties occur. In such cases, standby radio facilities are provided.

Communication equipment controlled here covers a wide range of telegraph and telephone application. The teletypewriter is the primary unit of telegraph equipment used at present on both radio and landline circuits. Radiotelegraph operating facilities are available when needed.

In charge of all operations in control is the circuit control supervisor. He keeps thoroughly informed of all current instructions regarding all active circuits and establishment of special circuits. Under his direction, control center watch standers patch circuits to appropriate terminal equipment. Circuit signals are monitored when required and adjustments made to keep signals of optimum quality. Whenever frequency shifts are necessary, operators inform the associated transmitting and receiving stations and the distant stations. Connections for teletypewriter and telephone conferences are also made here and such conferences are monitored in the control center.

In order to utilize equipment to the best possible advantage, the control center supervisor must keep accurate records. Following are some important entries for his records:

1. Transmitter in use and respective frequencies;
2. Changes in transmitter employment, indicating time and nature of change;
3. Casualties and duration;
4. Schedules observed and times;
5. Special circuits and times;

6. Explanation of circuit outages;
7. Time of commencement of watch, absentees, etc.

Equipment in the control center includes devices to control, measure, and monitor both direct-current and tone circuits. In addition there are multichannel and multiplex equipments for high-speed communications, carrier control equipment used with the radio link to the transmitting and receiving stations and certain associated tributaries, and voice terminal equipment for telephone conference calls.

CRYPTOCENTER

The cryptocenter of the COMMCEN is generally located adjacent to the message center. Otherwise, close connection is maintained by means of pneumatic tubes, teletypewriter, and an intercomm system. All of the cryptocenter's traffic is transmitted over tape relay network lines.

Classification of cryptocenter operations prohibits description of billets and details of cryptographic functions. The following section shows you how traffic is generally handled.

Incoming Messages

Messages are received direct from the associated tape relay center. A card file, arranged according to subject matter, is maintained as a guide to routing decrypted traffic. Each card lists those activities interested in a particular subject, and from the appropriate card the router designates the activity or officer who is to take action. Other interested activities are routed for information only. The number of copies, regardless of classification, is governed by the number of copies required by the activity or office routed.

The clerk at the classified delivery desk sees that each message is picked up by a properly authorized messenger from each activity. Carrier authorization cards for messengers are retained on file at the delivery desk and each messenger must present suitable identification. Once identified he signs for and receives copies for his activity. For a secret message, the messenger must sign a receipt indicating the number of copies received. A receipt is required for EACH COPY of a top secret message. Top secret messages are delivered to the top secret control officer of the activity, and a receipt is obtained showing the serial number of his copy of the message. When the message is returned for destruction, this receipt is returned to him. A quarterly inventory reveals all unreturned copies of top secret messages.

Outgoing Messages

For each outgoing message requiring encryption, the originating office delivers a single copy signed by the releasing officer to the cryptocenter. The delivery desk clerk time-stamps originator's copy at the time it is received. This copy is retained in the cryptocenter as evidence of authorization to transmit the message. After the message has been processed by cryptocenter personnel and transmitted, a copy is returned to the originating office. Other copies, as necessary, are routed to local addressees. Local distribution is indicated by the originator at the bottom of the last page of the message.

FACSIMILE BRANCH

The watch stander in the facsimile (FAX) branch of the COMMCEN is responsible to the message center supervisor for proper FAX transmissions and reception. He is usually a Radioman Third or striker and is specially trained in this comparatively new method of telecommunications.

The FAX branch of a primary COMMCEN transmits a primary fleet facsimile broadcast for its designated area, works point-to-point FAX circuits, and receives ship-shore FAX traffic. Continental branches have a drop on the National Facsimile Network, which is a joint facility of the U. S. Weather Bureau, Navy, and Air Force.

Broadcasts

A primary fleet FAX broadcast is transmitted on three frequencies simultaneously. For the most part, it transmits weather maps. Other traffic may include photos, blueprints, drawings, charts, and other graphic material. Facsimile transmissions do not include classified material.

Weather maps on these broadcasts originate in a fleet weather central (FLEWEACEN). (An exception is PRIMCOMMCEN Washington, D. C., whose weather broadcasts originate from the U. S. Weather Bureau.) Transmissions from FLEWEACEN are carried by wire through the FAX branch to its associated radio transmitting station. A line monitor transceiver in the FAX branch copies weather central transmissions, and one of the three broadcast frequencies is monitored off the air by another transceiver in FAX.

Each piece of facsimile carries an identification block in its lower left corner. The block is a modification of the standard message heading format and is described in chapter 7 of the *Radioman 3 and 2* training course. The standard message format for FAX is NOT used when the material introduced into the Naval Communication System is not processed by a naval COMMCEN. An example is the direct retransmission of material from the National Facsimile Network. When such material has been sent, FAX transmits a daily recapitulation sheet containing a list of the day's transmissions. The list shows the time of each transmission and associated serial number.

Incoming Traffic

Incoming point-to-point and ship-shore FAX signals are received from the associated radio receiving station and carried by landwire to the COMMCEN. Weather traffic goes to weather central. A line monitor makes a copy in the FAX branch. Material for activities served by the message center is delivered by the FAX branch supervisor to the incoming routing desk of the message center. Facsimile traffic is handled there in the same manner as other incoming traffic.

CONFERENCE FACILITIES

A number of COMMCENS furnish facilities for telephone and/or teletypewriter conferences (TELECONS). Telephone conference calls are made from the office of the originator much as a regular telephone call is made. After the originator obtains a release for his call, the CWO is notified. He or the watch supervisor notifies the circuit control operator. For example, if the Chief of the Bureau of Ships, Washington, D. C., wishes to confer with the commanding officer of the Naval Shipyard, Pearl Harbor, T. H., Chief, BUSHIPS notifies the message center CWO. The CWO passes the information to the circuit control operator, who handles the call in similar manner as a telephone company long distance operator. When control makes contact with the called party, he connects the telephone of the Chief of BUSHIPS to the voice channel by means of the control telephone switchboard.

In contrast to the lack of security of a telephone conference call, teletypewriter conference circuits afford a high degree of security. The originator of a teletypewriter conference notifies the other party via message, usually at least 24 hours in advance of the time set for the conference. Time of the conference and other details are included in the message. The action adee's COMMCEN as well as any intermediate relay station is an info adee of the message. Arrangements are then made in the COMMCENS concerned. Each CWO notifies his cryptocenter so that personnel may be detailed to operate conference room equipment. The control center is responsible for patching the conference room equipment to the appropriate circuit.

JOINT COMMCENS

In addition to duty in naval COMMCENS you may be attached to a joint operations COMMCEN, working closely with communicators from other United States services and those of allied countries. Procedures such as filing and numbering of messages may vary somewhat from those followed by naval COMMCENS. General operating practices, however, are governed by joint communication directives based on the familiar ACPS and JANAPS you have already studied.

QUIZ

1. Who is senior Radioman in the OR division and in direct charge of all personnel in the division?
2. Why should the Radioman in charge make a thorough inspection of all communication spaces and equipment?
3. Who is primarily responsible for keeping traffic clear and maintaining discipline in radio central?
4. Who coordinates all phases of communications with the Radioman in charge and sees that all equipment is operating properly in radio central and associated spaces?
5. What is the major activity of a NAVCOMMSTA?
6. How do supervisory duties increase on a small ship?
7. Name two important supervisors at a message center ashore.
8. What is the job of the internal router?
9. What activity furnishes the routing section of a message center movement reports of all Naval, Army, Coast Guard, and Marine Corps commands?
10. Who is in charge of circuit control?
11. What is the function of the FAX branch of a message center?

CHAPTER 5

TAPE RELAY STATION

INTRODUCTION

The tape relay station (sometimes called relay center) is a major component of the COMMCEN. As the name implies, its function is to relay teletypewriter messages by tape. To do this, a semiautomatic system is employed at present. Incoming circuits terminate in typing reperforators (reperfs) which automatically perforate and print messages on chadless tapes. Operators transfer tapes to appropriate outgoing circuit transmitters which are keyed automatically by the tapes. Plans are underway to convert primary relay centers to fully automatic operation. A later section of this chapter describes in general the proposed automatic relay system.

The traffic load at each relay station varies in accordance with the number of incoming and outgoing circuits. A primary station, for example, with over 140 circuits, may handle over a million messages per month. At a minor relay center, however, the monthly yield may be only a few thousand.

Because of its key function in the tape relay (NTX) system, the organization and equipments of the primary relay station are presented here. Duties important to you as supervisor are also included, as well as suggestions for indoctrinating new men. No attempt is made to cover tape relay PROCEDURE. Your sources for this subject are ACP 127 and DNC 5.

If you have had no experience in tape relay, be sure to review chapter 10 of the *Radioman 3 and 2* training course. It introduces you to commonly used tape relay terms, many of which are used in the following discussion of the tape relay station.

FLOOR PLAN

The relay station is usually located on the first floor of the COMMCEN terminal building adjacent to the message center and cryptoroom. Relay equipment is arranged to provide fast, accurate distribution of tapes throughout the relay room with a minimum of confusion. Figure 5-1 shows a recommended arrangement. Receiving consoles, sending tables, and monitors are in front of the supervisor's desk. A Mod 14 reperforator and Mod 15 and 28 teletypewriters are located to the left of this desk. (These machines are used as page copy moni-

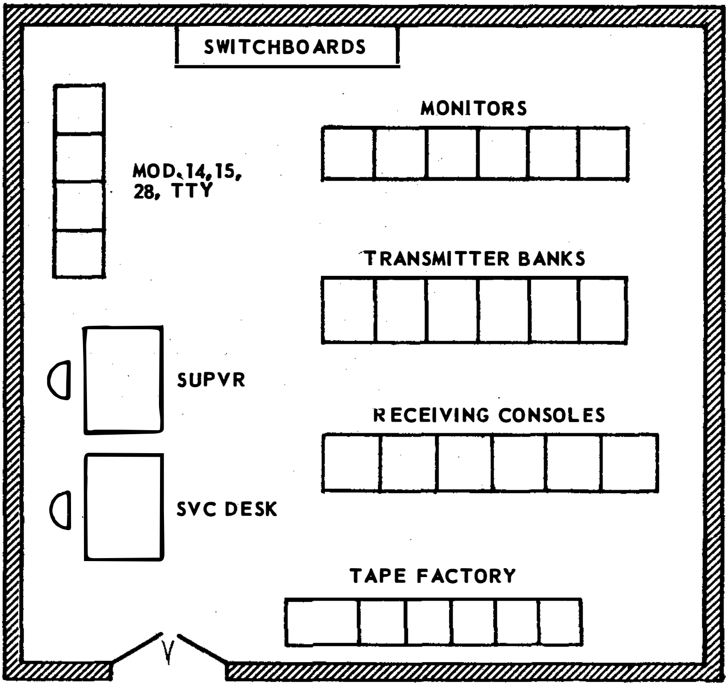


Figure 5-1.—Tape relay station floor plan.

tors and for preparation of service messages.) The tape factory is found near the service desk. Near the bulkhead next to monitors are switchboards and relay frames. Patchboards and test panels are appropriately positioned for patching and testing purposes.

ORGANIZATION

Each primary relay station has an OIC (sometimes called relay officer) who is directly responsible to the communication officer of the NAVCOMMSTA for the proper organization, administration, and supervision of the relay center. The OIC is usually a lieutenant commander. His two principal assistants are the chief in charge of the relay center and a civilian administrative assistant.

In addition to supervision of the operation of tape relay circuits and relay station terminating facilities, the OIC administers a training program for relay personnel, provides adequate control of message accountability, and works with other components of the NAVCOMMSTA and with communication offices of other activities to ensure satisfactory service and operation of the center.

The chief in charge of the relay center is the principal military assistant to the OIC. He prepares the relay station watch bill for approval of the OIC, maintains files, records, and required reports, and supervises the handling of all tracers referred to the relay center. In addition, the chief in charge sees that the station's training program results in constant improvement of personnel operating efficiency. This billet is comparable to that of leading Radioman aboard ship.

At most primary stations a civilian is designated as administrative assistant to the OIC. His civil service title is relay section chief. Under the general supervision of the OIC, the administrative assistant is responsible for operation of the semiautomatic tape relay system, handling of messages, and installation of equipment. He supervises civilian personnel in the relay room, assigns them to watches, and ensures that they are adequately trained and instructed in the latest NTX procedures.

He recommends them for advancement, and assigns their performance ratings. In any supervisory capacity, you will work closely with the man in this billet. The administrative assistant is usually a retired officer with many years of experience in tape relay.

A rated Radioman normally is assigned the full-time job of tracer clerk, for expeditious action must be taken on any message claimed undelivered by the originator. The tracer clerk breaks out monitor rolls of applicable circuits and searches for the message. Results of the search are compiled and a tracer reply is initiated in strict accordance with ACP 127. The outgoing tracer message must be released by the CO of the NAVCOMMSTA.

A supply clerk maintains an up-to-date inventory of supplies and printed forms, makes out stub requisitions, and files boxes for monitor rolls. He is the general utility man in the relay office, assisting the civilian administrative assistant and chief in charge whenever necessary.

WATCH STANDERS

All military watch standers in tape relay centers are Radiomen, TE(RM's), or RM strikers. The relay center in NAVCOMMSTA, Washington, D. C., for example, has 16 men (including strikers) on each watch. Three or 4 are assigned to each peak load watch, assisting regular watch standers during hours of heavy traffic.

Civilian personnel with previous military experience in tape relay stand watches at relay centers in the continental United States and at most overseas stations. In addition to military personnel, 5 or 6 civilians are employed on each regular watch and 3 or 4 on each peak load.

Once you are assigned to a watch in the tape relay center you will work closely with civilian watch standers as well as with lower rated petty officers and strikers. The section which follows describes each supervisory position at a typical primary relay station. Some of these billets may be filled either by military or civilian personnel. Make sure, however, that you know the important duties of each position. Bear in mind that shortages of trained personnel frequently occur. When this happens, your billet may be combined with another, giving you added responsibilities.

Relay Chief of the Watch (RCOW)

The RCOW is an experienced Chief Radioman or Chief Teleman (RM) who is in charge of each watch. He maintains liaison with the CWO of the COMMCEN and keeps him informed of any unusual events of the watch such as excessive outages and delays. When part-time stations are closed, the RCOW screens all traffic and takes appropriate action to deliver all high priority traffic. At some primary stations he is required to refer all ACTION PRIORITY (or higher) messages to the CWO. The RCOW also screens all ROUTINE ACTION and PRIORITY INFO messages, informing the CWO of those pertaining to deaths or injury of personnel, etc. He notes on the hard copy disposition made of each message referred to the CWO and returns it to the relay file.

When final numbers for the day are completed, the RCOW checks each received record card for the previous day to ensure that all encircled and open numbers have been serviced, and initials each card when necessary action has been taken on all messages. He then staples together all the received record cards for the previous day and files them in the received record holders. At some relay centers the RCOW has secondary duties as receiving supervisor.

Receiving Supervisor (ARCOW)

The receiving supervisor is the assistant relay chief of the watch (ARCOW). He ensures that all tapes are promptly removed from receiving consoles and expeditiously distributed. The ARCOW makes half-hourly time endorsements on the received message cards with a colored pencil. Whenever the ARCOW finds that no traffic has been received on a normally busy circuit since the previous endorsement, he immediately investigates conditions on that circuit.

The ARCOW uses a colored pencil to encircle all open numbers on the received record cards, keeping the service desk informed of such numbers so the service desk can request reruns. He supervises the handling of STOP and GO messages, making sure the sending operator inserts or removes holdup tabs in the transmitter of the circuit involved. (A STOP and GO message is a procedure message directing a distant station to either stop transmission or go ahead with transmission on channels as indicated.) The ARCOW also checks handling of number comparisons and is assisted by the sending supervisor as necessary. He must maintain a vigilant watch on all receiving equipment, being particularly alert for reperfs running out of tape and tapes hanging up or jamming in the punch block of the typing reperf.

The ARCOW's duties include ensuring that all information required at the top of each received message card is filled in on both sides, such as the circuit designation and date. He also places all received message cards for temporarily secured circuits upside down in card holders until the circuit is reopened.

He instructs his receiving operators in the following:

1. Separating incoming tapes properly.
2. Checking off channel numbers on received message cards.
3. Routing all multiple address message tapes to tape factory.
4. Routing all outgoing tapes to correct sending position.
5. Inserting tapes in correct order in sending position grids.
6. Giving special handling to OPERATIONAL IMMEDIATE or higher precedence tapes.
7. Routing and identification of TWX tapes.
8. Placing the TOR on the front end of FLASH or EMERGENCY messages and passing these to the supervisor for swift handling.
9. Carrying a maximum of 10 tapes for distribution.

Relay Station Supervisor

At most primary relay stations in the United States an experienced civilian is normally designated relay station supervisor. He works in close coordination with the RCOW, for the relay station supervisor is charged with proper operation of all circuits and equipments, and expeditious movement of message traffic. He cooperates with the RCOW in assigning operating personnel to positions so that the traffic load is handled effectively. He first sees that incoming message tapes are separated and distributed to sending grids in proper order of precedence. Normally, he rotates qualified operators between sending and receiving positions approximately every 2 hours. During heavy peak loads he rotates operators every hour.

The relay station supervisor ensures that used tapes are carefully removed from used-tape bins so that live tapes (those awaiting transmission) are not mixed in. He checks to see that used tapes are placed in burn bags and that full burn bags are ready for disposal at the end of each watch.

When page copy is run off for certain offices at night, the supervisor sees that no garbles, mutilations, or overlines appear in the message copy and that the copy is complete in every respect. For general messages, the supervisor makes sure a checkoff sheet is prepared and attached to a page copy ot all general messages. (The checkoff sheet lists all stations for which the relay center has relay responsibility.) The outgoing circuit channel number and sign of person making the checkoff must be recorded in the appropriate place on the checkoff sheet for each transmission. The relay station supervisor supervises the closing out of channel numbers and preparation of the traffic load study report at 2359 GMT daily.

If no tape factory supervisor is assigned to the watch, the relay station supervisor details a well-qualified person to that position.

Relay Station Sending Supervisor

The relay station sending supervisor is responsible for the proper operation of all sending equipment. He ensures that tapes are transmitted in order of precedence and in order of insertion in the grids. Particular attention must be paid to transmission of reruns to Navy activities, making sure they are sent without picking up a new number.

NOTE.—Air Force and Army sometimes require numbers on reruns.

The sending supervisor sees that all STOP and GO messages are promptly complied with, and that number comparisons are transmitted promptly at designated times. In addition to these responsibilities he assists the relay station supervisor when necessary and is in training for that position.

Relay Station Service Supervisor

The service supervisor (sometimes called service and monitor supervisor) is responsible for all service operations in the relay center. He makes proper disposition of all service messages, initiates service investigations, and operates monitor and automatic numbering equipment. Under careful direction of the service supervisor, service personnel locate and transmit correctly all missent, misrouted, and lost messages, retransmit messages which failed to reach the addressee due to equipment failures, and prepare new message tapes when existing tapes result in faulty transmission.

The service supervisor also sees that service desk personnel clear up garbled or overlined message tapes, make and check numbering tapes, and record and identify all monitor records, including tape file boxes.

Other important duties of the service supervisor are investigation of claims of delay or nondelivery, and correction of automatic numbering equipment failures.

Tape Factory Supervisor

The tape factory supervisor is normally a First Class Radioman with thorough knowledge of NTX routing doctrine and procedure, especially as they apply to transfer of multiple call messages to joint circuits. He must keep fully informed of all local and trunk circuits, both overseas and domestic, which comprise the NTX and joint relay systems, and keep posted on all changes to these systems as they occur.

The tape factory supervisor checks the multiple log frequently for proper checkoff of routing indicators in every multiple call tape. His sign after each routing line indicates the message was routed correctly. He works closely with the service desk correcting and routing properly all tapes with garbled, doubtful, or duplicated routing indicators, retrieving these tapes and passing them to service desk as necessary.

When traffic is light the tape factory supervisor should instruct tape factory operators in the proper method of marking, transmitting, routing, and checking off all multiple call tapes on the multiple log.

Radio Supervisor (Overseas TTY)

The radio supervisor (overseas TTY) is responsible for proper operation of all radio channels. He logs all outages, stating the reasons, and supervises sending and receiving operators in radio section. If high precedence traffic is held up due to circuit outage, he must keep the RCOW and relay station supervisor informed. In close coordination with the control center supervisor in the COMMCEN, the overseas supervisor runs tests on all radio circuits. He also ensures that page copy monitors are changed at 0001Z daily and that a new log is started on all radio channels.

MAINTENANCEMEN

Maintenancemen are needed to repair and maintain relay equipment but generally are not included in the relay station watch bill. Electronics Technicians, Radiomen, and TE (RM's) qualified in teletypewriter repair are designated as maintenancemen. At small relay stations only one man may be required to maintain the equipment. He is available on a round-the-clock basis.

At most relay centers civilians in addition to Radiomen are employed to maintain and repair Navy-owned relay equipment. Equipment leased from commercial telecommunication companies is repaired only by a civilian technician employed by the company.

BREAKING IN NEW MEN

Tape relay stations frequently experience a rapid loss of trained watch standers and consequent influx of new personnel who are, in most cases, completely unfamiliar with tape relay operations. To combat shortages of trained personnel, most relay centers conduct intensive indoctrination courses to qualify a man as a watch stander. The orientation period for a Radioman or TE(RM) petty officer depends, of course, on his background in tape relay and general supervisory qualifications. An experienced petty officer may need only 4 to 6 weeks' instruction. Normally, to train a nonrated man takes from 4 to 6 months. The following procedures, although not standard, will enable you to train a man thoroughly in the shortest possible time.

The first week or two a new man is aboard he should pick up and distribute tapes throughout the relay room to familiarize himself with the physical layout of the relay center. He must, of course, be under strict surveillance to prevent inadvertent misplacement or loss of tapes.

The following week your new man should read all orders, memoranda, and instructions regarding operation of the relay station. Be sure ACP 127, ACP/JANAP 117 series, and other procedural publications are available to him. Get him into the habit of breaking out ACP 127 whenever a question on procedure arises.

During the next few months the new man should break in gradually at each nonsupervisory position. His progress depends on how quickly he picks up duties of each job. A new man should normally spend 3 weeks to a month at each position. The following cycle is recommended:

1. Receive operator (slow bank).
2. Receive operator (fast bank).
3. Send operator (slow bank).
4. Send operator (fast bank).
5. Radio send and receive operator.
6. Tape factory operator.
7. Service desk operator.
8. Comparison operator.

As soon as the new man is checked out at all positions, he is placed on a watch and assigned to the billet for which he is best qualified. The RCOW continues to instruct him, especially during light traffic hours. The relay chief may rotate the new watch stander to make sure he keeps checked out in other positions of the watch.

LOGS AND RECORDS

Relay center logs and records are vitally important to the mission of the station. Their purpose is twofold: to provide traffic analysis data and to ensure up-to-the-minute accountability of every message in process. Remember, properly kept records will enable you, as supervisor, to run a taut watch.

Relay Station Log

All important occurrences of the watch are recorded in the relay station log. It is kept at the relay station supervisor's desk. Typical entries are information on abnormal traffic delays, circuit failures, setting up special circuits, alternate routing of traffic, traffic backlogs, and the opening and closing of all circuits. For convenience, at some stations a separate OUTAGE SHEET (kept by the RCOW) also records the opening and closing of circuits.

Relay Status Report

The RCOW submits a RELAY STATUS REPORT at the end of each watch. In the operational section of the report, he indicates circuit conditions and backlogs, and certifies that all received message records and number comparison sheets (number comps) have been checked. The RCOW also indicates that publications such as ACP 121, ACP 127, and ACP/JANAP 117 series are properly accounted for by a check mark after the appropriate short title.

Listed in the general section of the report are names of watch standers on the binnacle list, those on leave, total number in the crew, and total present.

In the administrative section the RCOW indicates he has submitted the muster report, made routine inspections, and prepared the meals missed list.

Message Accountability Logs

Number comps are sent and received between stations every hour on radio circuits and every other hour on landline circuits to ensure continuity of numbers. These numbers are recorded on the NUMBER COMP SHEET. A number lower than that of the number comp which is still open (not crossed off on the RECEIVED MESSAGE RECORD) must be requested from the sending station through a RERUN REQUEST. The RECEIVED MESSAGE RECORD is a checkoff list of incoming message numbers and contains the operator's sign and time each message was received. This record is kept in a card slot at each receiving console. The RERUN REQUESTS form contains the circuit number of the requested message, reason requested, time rerun was sent, operator's sign, and time the rerun was answered.

A RERUN AND MONITOR RECORD is kept at the service desk. It is a record of all messages rerun to other relay stations at their request. This record contains the following information: message number, reason for rerun, action taken, by whom, and time sent. Reel changes and final numbers (entered in red) are also recorded on the rerun and monitor record.

Figure 5–2 shows the message accountability logs. They are intended for use at all relay stations. If these forms are not available at your station, they may be ordered direct from CNO (DNC). Procedures for ordering are contained in DNC Instruction 5213.1.

Traffic Analysis Records

The relay station supervisor prepares the daily TRAFFIC LOAD STUDY REPORT. This report is signed by the OIC and submitted to the commanding officer of the NAVCOMMSTA with a copy to the duty officer. The report lists each circuit and circuit number and the number of messages sent and received on each circuit that day. The number of service messages is recorded separately at the bottom of the page. Total number of messages sent and received is added to give the grand total.

There are four parts to the TELECOMMUNICATIONS ENGINEERING REPORT (DD Form 280). Each primary relay station sub-

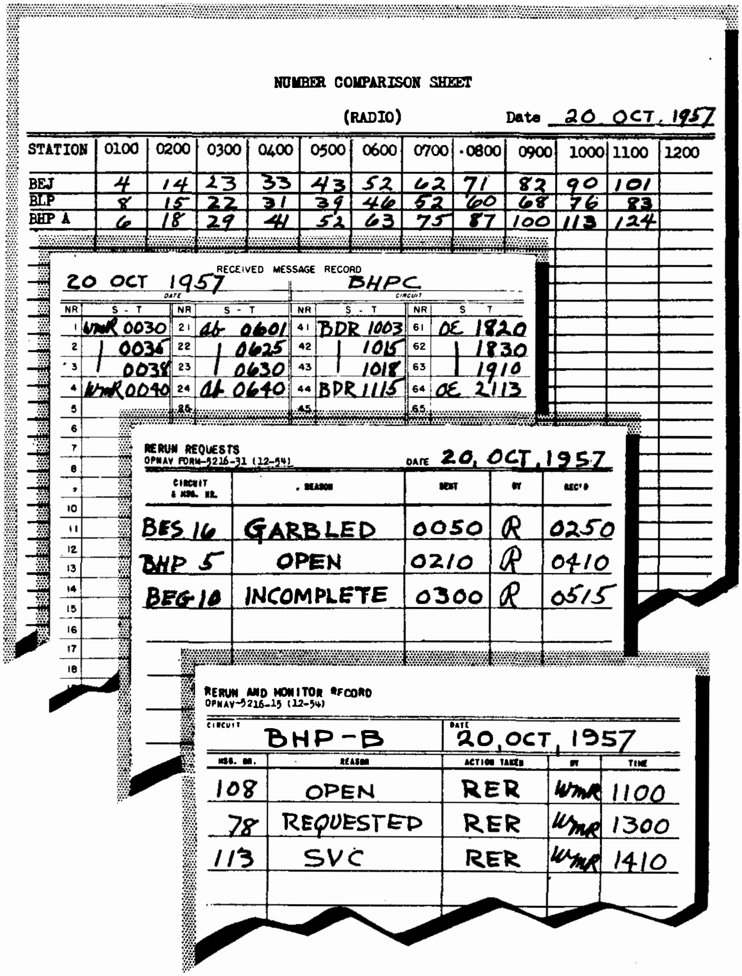


Figure 5-2.—Message accountability logs.

mits part II, the monthly transmitted message load. The smooth report is signed by the commanding officer of each NAVCOMMSTA and submitted to CNO (DNC) quarterly. It is a record of the total of daily incoming and outgoing messages by circuits. A separate columnar entry is made for each channel of every available primary and standby circuit. Each circuit's designation and channel letter (if applicable) are recorded, as well as the type of circuit (RATT, CW, etc.). In addition to the entry of total traffic sent and received, total outages, operating hours of channels and circuits, and model numbers of equipment employed are included on the report. The telecommunications engineering report also includes the average group count, computed once a year in October. It is obtained by measuring a representative number of tapes transmitted and received on each channel during the month.

Permanent Message File

Tape relay stations are not required to keep a permanent file of messages. Each station is required, however, to keep monitor tape or page copy for 24 hours on all INCOMING messages. It is mandatory for relay stations to keep monitor tape or page copy on OUTGOING messages for 60 days.

EQUIPMENT

Most relay stations employ, as major equipment, Navy-owned tape relay equipment formerly used by the Postal Telegraph Company, package units (four-in-one: send, receive, automatic number, and monitor), and A. T. & T. leased equipment. The ex-postal telegraph equipment comprises receiving, sending, automatic numbering, and monitoring units, and is used on both radio and landline circuits. It operates at speeds of 60 wpm on radio circuits and either 65 or 75 wpm on landline circuits. Tape relay equipment is leased from A. T. & T. to terminate heavy traffic load trunk circuits. It also consists of receiving, sending, and automatic numbering and monitoring units, and operates at 75 wpm. Navy-owned package units are normally employed on light traffic load circuits, both radio and landline. Each unit operates at 60 wpm on radio and 65 wpm on landline.

In addition, model 15 teletypewriters are used in relay centers for page copy monitoring. Model 19 and 28 sets are employed by service clerks and supervisory personnel to prepare procedure and service messages.

Following is a description of major tape relay equipment.

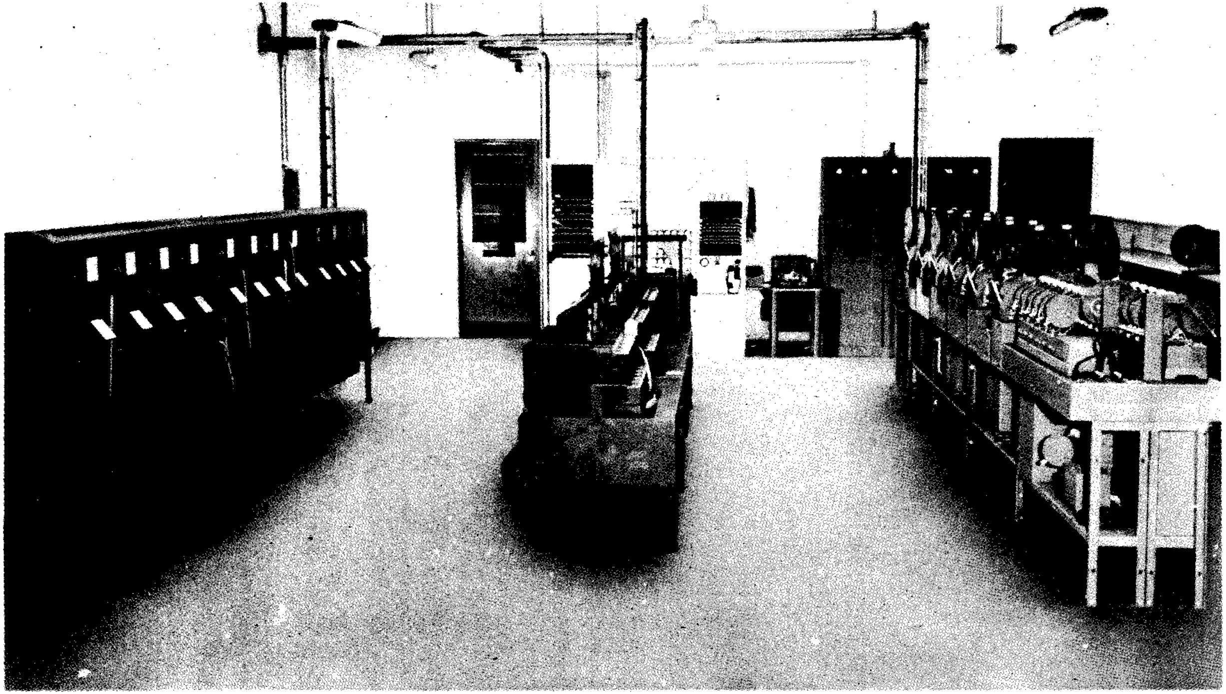


Figure 5-3.—Semiautomatic tape relay installation.

Ex-Postal

Figure 5–3 shows a typical arrangement of semiautomatic equipment. The row of receiving consoles, or cabinets, shown at the left, contains typing reperfs which automatically record incoming messages in the form of perforated tapes on which messages are also printed. These tapes are torn off in message lengths and routed to sending tables, shown near the center of the room. Here the tapes are fed into transmitter-distributors (TD's) associated with the circuits over which the messages are to be sent. At the right of the photograph are automatic numbering equipment and monitor sets associated with the sending circuits. These various equipment units are wired to the group of switchboards and relay frames shown at the far end of the room. The switchboards and relay frames connect the separate units into a complete working terminal.

Duplex and Single Circuits

DUPLEX, as used here, refers to any circuit using separate sending and receiving loops for simultaneously sending and receiving messages. These loops may connect directly to receiving and sending teletypewriter sets at a tributary office, or extend to long line polar duplex or carrier telegraph terminal equipment not part of the semiautomatic equipment. Intra-station sending and receiving circuits are usually operated duplex over separate local line conductors.

SINGLE refers to any circuit arranged for alternate, but not simultaneous, sending and receiving of messages. Such circuits usually extend to tributaries where they are connected to one teletypewriter set used for both sending and receiving. Relays are provided at the relay station to lock receiving equipment during sending and to lock sending equipment during receiving. The tributary can break or interrupt transmission from relay if necessary.

Major Components

RECEIVING CONSOLE.—Typing reperfs used for receiving are mounted in receiving consoles, each of which can contain eight machines (fig. 5–4). The eight typing reperfs are mounted on individual slides (similar to those used with filing cabinet drawers) to provide easy access for maintenance. Eight openings (one for each reperf) are cut in the front of each cabinet for message tapes. A signal lamp and pushbutton release key are mounted above each opening. Holders for received message records and for circuit designation cards are mounted on the front of each cabinet. A built-in panel box in the lower rear section of the table contains motor-control relays, resistors,

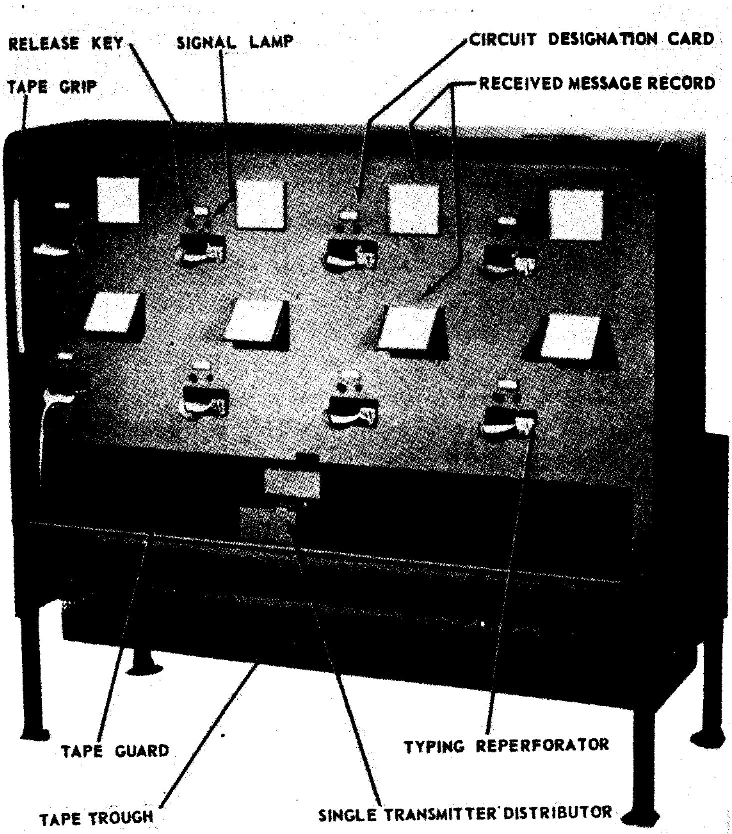


Figure 5–4.—Receiving console.

fuses, and terminal strips for wiring connections. Another compartment in this section of the console may be used for storing rolls of tape.

A single TD is mounted on each receiving console. Each TD is connected to switchboard jacks and can be plugged to the sending side of any duplex or single line circuit. The machine is mounted below the reperfs so that transmission of long message tapes can be started without waiting for the end of the tape to be received.

A TD consists of basic cam-operated units capable of translating perforations in a tape into electrical signal impulses for transmission over one circuit.

Six basic units (called bank transmitters when used as shown in figure 5–5) mounted on a single base with a common motor drive form a multiple TD. Because each unit is connected to a different line circuit, a multiple TD can send messages to six circuits at the same time. This equipment is also used for numbering messages automatically.

A letters-sensing mechanism is added to each unit. This stops the transmitter automatically upon sensing the letters signal perforations located in the number tape immediately after each message number.

Some TD's are mounted on separate bases with individual motors. These are used to handle unusually long tapes and are also used on tape patching and switchboard monitor sets. Single TD's equipped with letters-sensing mechanisms are used as spare number transmitters. In this case they are equipped with reel stands.

Sending Table.—A sending table is used to mount two multiple transmitter distributors of six TD's each, thus providing a bank of transmitters for sending to a maximum of 12 circuits or channels. A tape basket, attached to the back of each table, has six perforated metal compartments for holding tapes that have passed through the transmitters. Six tape holders are mounted on a tape holder bracket on the top of the tape basket. A designation card holder strip is fastened to the front of each multiple TD to designate circuits to which each basic transmitter unit is connected.

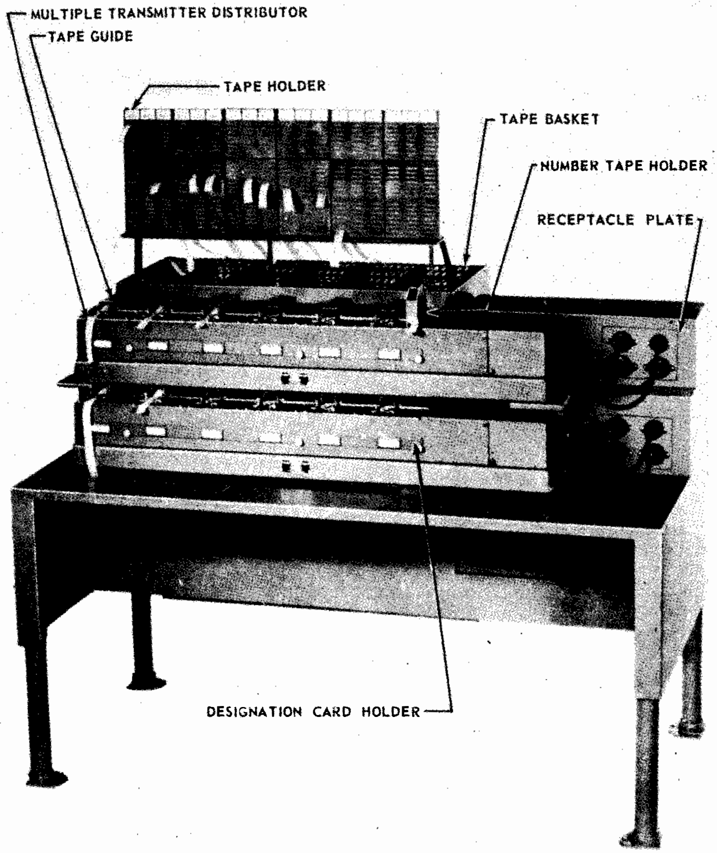


Figure 5-5.—Sending table.

The sending table has a rear compartment with a hinged door which contains a terminal shelf. This is a metal framework to which is attached all wiring required for the table. The shelf has fuse compartments, terminal strips for outside wiring connections, and two receptacle plates. The power and operating circuit cords of the TD's are plugged into these receptacles. Each shelf is arranged to mount two detachable relay boxes when required. Spring connectors, known as frame jacks, make connection with relay circuits. Switches are provided as part of the shelf for disabling the transmitter and relay circuits whenever a multiple transmitter or relay box needs to be removed for maintenance.

In some cases an upper transmitter unit and corresponding lower transmitter unit are arranged to send alternately to the same circuit. This is known as tandem operation and requires relays to lock each transmitter unit while the other one is operating. Relay boxes must then be added to the terminal shelf to provide lockout relays. By making suitable connections, some of the transmitters can be operated singly, and others tandem. If all transmitters are operated singly, no relay boxes are required.

AUTOMATIC NUMBERING EQUIPMENT.—The multiple TD, consisting of six individual TD units, is mounted on a chassis that includes a mounting assembly for six reel arms which hold the number tapes. The assembly includes a small induction motor geared to a long shaft.

MONITOR SETS.—Typing reperfs mounted on special chassis give a continuous monitor record of all messages transmitted over each sending circuit equipped for automatic numbering. A monitor set for wire circuits consists of a trunk chassis, tape winder, typing reperf, and relay box. A stand supports two complete sets.

LINE FINDER.—A line finder is a floor-mounted frame with groups of relays and step-by-step automatic rotary switches. A complete line finder has a capacity of 50 lines and 16 receiving reperfs but usually is arranged for only 24 lines and 8 reperfs. The line finder is used on short lines where incoming traffic per line is light and one reperforator can serve several lines. When an incoming call is received from any of the 24 lines, the line finder will automatically connect it to an idle reperf.

SWITCHBOARDS AND RELAY FRAMES.—Figure 5-6 shows a group of switchboards and relay mounting frames. The group consists of a main switchboard, receiving frame, sending frame, and a testing and monitoring switchboard. The relays on the receiving and sending frames are required for proper function-

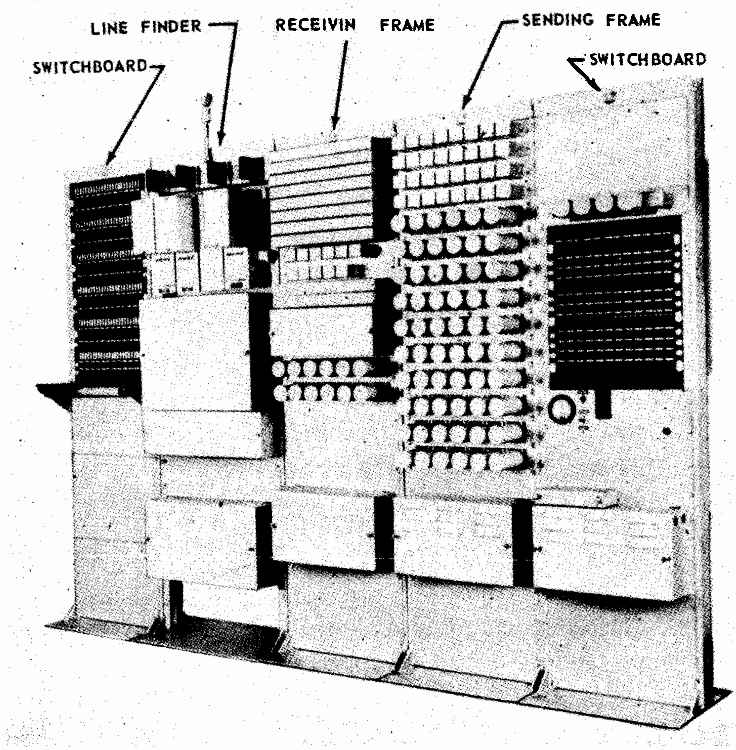


Figure 5-6.—Switchboards and frames.

ing of the circuits, and the switchboards are used for testing, monitoring, and making temporary rearrangements of circuits. A line finder is provided when required.

The switchboards and sending frame may be supplied either fully equipped or half-equipped. A fully equipped switchboard and frames can accommodate a total of 72 line circuits; a half-equipped switchboard, 48. A fully equipped switchboard also has double the number of jacks contained in the half-equipped switchboard.

Switchboards and relay frames each have two long terminal strips mounted on the back. These terminal strips are used to terminate cables to outside line circuits and to various operating tables, monitor sets, etc. The operating units are interconnected by cross-connections or jumper wires run through jumper rings and over brackets. This provides an intermediate distributing frame and permits flexibility in assigning circuits to various operating units.

MAIN SWITCHBOARD.—Outside line or loop conductors are connected to the switchboard usually through a separate cable box which serves as a main distributing frame. For each loop circuit, this switchboard has two series or looping jacks and a set jack. A fully equipped switchboard has jacks for 120-loop circuits, and 48 jacks for miscellaneous use. In small relay centers a half-equipped switchboard is used. It has jacks for 72-loop circuits and 24 jacks for miscellaneous use. The switchboard is completely wired so that jacks can be added readily to expand it to the capacity of the fully equipped switchboard. Below the jack field is a writing shelf with a logbook compartment.

RECEIVING FRAME.—The receiving frame mounts relays associated with the receiving circuits. At the top are 40 pairs of tape feedout relays operated by the pushbutton release keys on the receiving tables. Below these are single circuit control relays for locking the reperf during transmission, and locking the transmitter during reception. These relays also allow the outside station to break or interrupt transmissions from the bank transmitter. Relays (including polar receiving relays) are provided for 12 single circuits. The lower part of the frame includes a power panel for power fuses and current-limiting resistors. A similar panel is located on the line finder and each of the other frames, except on the main switchboard.

SENDING FRAME.—A sending frame mounts 60 polar relays with associated spark suppressors and bias resistors. The first 48 of these relays are used as sending relays. The last 12 are available for miscellaneous purposes. On half-equipped frames the first 24 sending relays and last 6 miscellaneous relays are omitted, together with their associated spark suppressors and resistors.

TESTING AND MONITORING SWITCHBOARD.—This type of switchboard is for testing, monitoring, and making temporary rearrangements of the semiautomatic operating equipment. A fully equipped switchboard has a lock key, line jack, and transmitter jack for 48 bank transmitter circuits, and series reperf jacks for 48 receiving reperfs. On half-equipped switchboards, the first 24 of the 48 sets of lock keys and jacks are omitted. In small relay centers, certain other jacks are omitted. The lock keys lock the bank transmitters on circuits not in use or temporarily closed down. Jacks are used for monitoring and for plugging in spare transmitters and reperfs. A broadcast repeater on the switchboard may be plugged into any 6-line jacks so that the same message can be sent simultaneously over 6 circuits. Break signal lamps for the 12 single circuits are mounted on the switchboard, as are jacks for spare reperfs, transmitters, and for the single TD's under the receiving tables. Jacks are provided for the lines and reperfs associated with the line finder (if installed). The switchboard also has a control panel, including a test circuit with a milliammeter, two relays, and a cord and plug, associated with the switchboard monitor set. This set is used to monitor line signals.

AN/FGC-6

Other Navy-owned tape relay equipment in use at some stations includes such teletypewriter sets as the AN/FGC-38, -38X, -39, and AN/FGC-6. Major components of the AN/FGC-6 are described below.

RECEIVING CABINET.—This cabinet or console normally contains four receiving units (typing reperfs) mounted on two upper shelves. Space is available on the lower shelf for two additional typing reperfs, which makes the unit adaptable as a tape factory. When used as a receiving unit, three of the typing reperfs are for circuit terminations and the fourth for a spare.

SENDING CABINET.—The sending cabinet is different from leased equipment mainly in design of tape bins. Bins for live tapes are built permanently into the cabinet, both front and rear. A separate used tape bin is provided for each circuit.

Tapes may be removed from the front of the sending cabinet with no danger of mixing them with live tapes.

The TD's are arranged in banks of three, with two banks per sending cabinet for tandem transmission. Automatic numbering transmitters are installed in a rear compartment of the sending cabinet. Transmitters are equipped with number delete buttons and open circuit or busy circuit warning lights.

Monitor Cabinet.—In the monitor cabinet, the monitoring typing reperf and associated tape winder are mounted together on the same shelf. Three such units are mounted in each cabinet, and the bottom shelf is used for tape stowage. A throw switch controls sending by the sending operator so that the monitor operator can seize control of the circuit and make reruns directly from the monitor. A small plug board or control panel at the base of the monitor cabinet provides for plugging in a portable transmitter for making reruns.

AN/TGC-1 and AN/TGC-1A

The AN/TGC-1 and AN/TGC-1A teletypewriter sets (fig. 5-7) include facilities for sending, receiving, and monitoring teletype messages on perforated tape on which the message is also typed. Sending, receiving, and monitoring facilities are furnished by a multiple TD (for sending) and two typing reperfs (for receiving and monitoring). These sets are electrically and mechanically similar, the only differences being methods used to increase speed of operation.

The multiple transmitter distributor and typing reperfs of these package sets function in similar manner to the semi-automatic ex-postal gear previously described. They may be used singly in a small relay center, or a number of sets may be set up side by side to provide facilities for handling traffic in large primary stations.

With appropriate wiring and switching changes, the equipment may be operated neutral over one or two half-duplex (single) circuits, and neutral or polar over one or two full duplex circuits. Operation over one full duplex circuit (two external circuits, each consisting of two wires or single wire

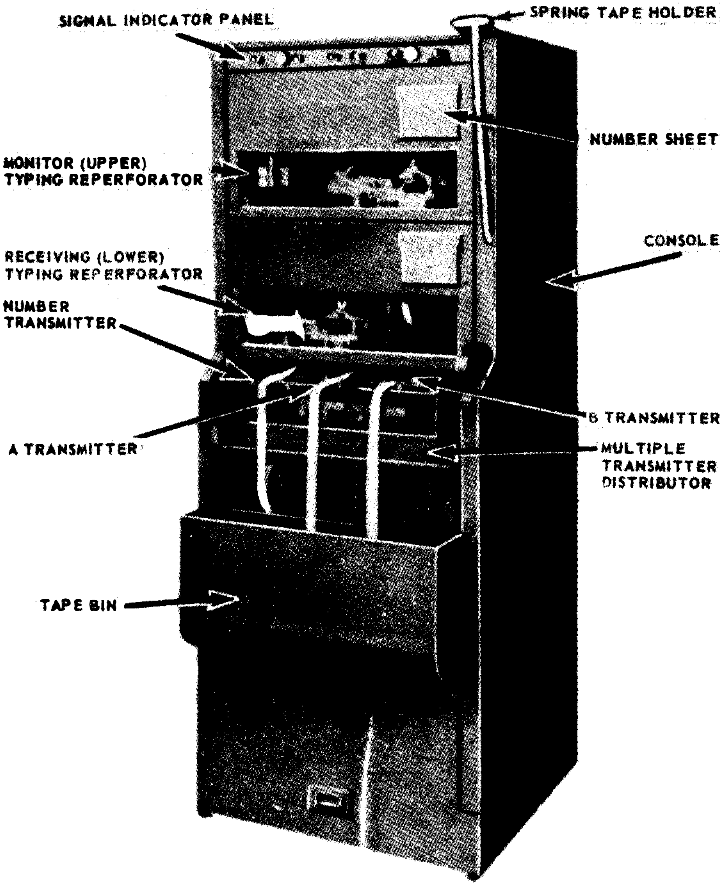


Figure 5-7.—Teletypewriter Set AN/TGC-1 or AN/TGC-1A.

with ground return) or one half-duplex (single) circuit is designated NORMAL. Operation over two full duplex circuits (four external circuits) or two half-duplex (single) circuits is designated SPLIT.

Power for both sets is furnished by series-governed motors adapted for 110-volt a-c or d-c operation. However, power for the typing reperf of the AN/TGC-1 is furnished by a synchronous motor adapted for 60-cycle, 110-volt a-c operation; the AN/TGC–1A typing reperf receives its power from a series-governed motor adapted for 110-volt a-c or d-c operation. This motor is also replacing the synchronous type in the AN/TGC–1.

Each set contains a rectifier to provide a source of d-c (signaling battery) when the external power source is a-c. Tape winder motors are induction-type and operate from a 115-volt, 60-cycle a-c source.

Leased Equipment

Double-Deck Transmitting Consoles.—Each transmitting position consists of one or more double-deck consoles mounting two triple-gate TD's. Since two transmitters may be used alternately on each circuit, transmitter gates in the same relative position on both upper and lower levels of the console are associated with the same working or spare circuit. For example, an upper-level gate for Pearl Harbor send traffic is labeled the BHP (Alfa) channel. The lower-level gate in the same relative position is associated with the same Pearl Harbor circuit. Its channel designation is also BHP (Alfa). One console serves a maximum of three working or spare circuits.

Three sets of control lamps and keys are mounted in each console panel. One set is associated with each pair of alternate transmitter gates. These controls are the no-number key, seize lamp, and tape stop key.

The no-number key is a nonlocking pushbutton which permits sending a message tape from a transmitting position without prefixing the channel identification and next consecutive channel number. When lighted, the seize lamp indicates that the control position has seized a circuit for supervisory functions. Until seize lamp is extinguished by control, the transmitter gates will be inoperative.

When changing number tape reels and servicing torn tape, the number alarm lamp lights, indicating a message transmitted at this time will not have the channel identification and next consecutive channel prefixed.

NOTE.—This lamp will flicker as the numbering transmitter scans the letters character following transmission of channel number. The flicker at this instant indicates that the channel number has been transmitted.

The tape stop key is a locking twist-type key which stops either of the two transmitters with which it is associated, permitting tape removal for servicing with loss of circuit seizure to the alternate transmitter.

AUTOMATIC CHANNEL NUMBERING EQUIPMENT.—One or more reperf cabinets are employed, each mounting one, two, or three triple-gate transmitter assemblies. Each gate of each transmitter assembly is associated with one working or spare circuit. Supply and takeup reels are mounted above and below each gate. Number tapes used on the circuits may be transferred to these reels. Operation of the leased numbering transmitters is identical to operation of Navy-owned (ex-postal) equipment.

MONITORS.—Monitors consist of one or more reperf cabinets each mounting three receiving only typing reperforators. One reperf is associated with the sending side of each full duplex circuit. Three motor-driven tape-winding reels are installed in the base of each cabinet to collect the monitor tape in reel form. A control panel is mounted in the face of each cabinet just below the top edge. Each panel consists of a tape feed-out key (nonlocking pushbutton) for each reperf, a tape alarm lamp, and an audible alarm release key (nonlocking push-button).

RECEIVING CONSOLES.—Receiving consoles are identical to monitors with two exceptions:

1. One receive only typing reperf is associated with the incoming side of each full duplex circuit.
2. Received copy tape is fed through tape slots to the outside of the cabinets, where it is torn off by the operator. All other features, including the control panel and noninterfering tape feedout are as described under monitors.

EQUIPMENT AT CONTROL POSITION.—An automatic transmitter and a keyboard typing reperf are located at the control position on a table arranged for a standup operation. In addition, a small patchboard is mounted at the rear of the table with the jack bay facing the operator.

At large primary stations, two control positions, designated control A and control B, are needed. The equipment and the functioning of control B position are identical to control A position previously described, except that no patchboard is mounted on the control B position. All patches for both positions are made at the jack panel mounted on control A table. A second control position jack associated with control B is wired in this jack field. A second patch cord is provided, and at anytime either or both tables may be used as desired for supervisory functions.

Spare Equipment.—With the exception of equipment at the control position, leased equipment at each position is backed up with spares of similar type. In addition to spare reperfs, both receiving and monitoring, there are spare banks at both sending and numbering positions. Spare equipment ensures against loss of communications due to failure of any or all component units. In addition, it facilitates replacement of tape and ribbon without disrupting service.

Channel Outage Indicator and Bank Control System

The outage indicator and bank control system is used with overseas (radio) send and receive channels. It furnishes the relay station supervisor and the radio control board supervisor in the COMMCEN a visual reminder when a channel is out due to equipment or circuit difficulties. It also provides the relay station supervisor with a certain amount of remote control over the sending and receiving teletypewriter equipment in the tape relay station.

The system consists of two units approximately the size of ordinary intercom sets. One unit, for indicating purposes only, is located on the radio control board supervisor's desk. It contains 30 switchboard lamps and designation strips. One lamp is assigned to each channel. The controlling unit, located in the tape relay station adjacent to the supervisor's desk, contains 30 switchboard lamps and 30 jack switches. Designation strips assign a lamp and a switch to each channel.

Installation and operation of the system require no modification to existing equipment or wiring. Normal communication cable pairs are used between the radio control board and the tape relay station. The bank control circuits are cabled to spare terminal strips in the relay station distribution frame and cross-connected to appropriate points.

AUTOMATIC RELAY

Plans are underway to convert primary relay centers to fully automatic operation. The automatic relay center is fundamentally a relay point and is not intended to be an originating or terminating station. It is designed to receive messages from many points, to determine where the messages go, and to transmit them expeditiously.

The relay center commences action upon a message almost as soon as it is received. It is capable of routing the message to an outgoing circuit within 15 or 20 seconds. The need for waiting until the entire message is received before beginning outgoing transmission, as in the case of semiautomatic operation, is eliminated.

Equipment breakdowns are brought to the operator's attention immediately by an extensive alarm system. If the center receives a message with a garbled or nonexistent routing indicator, or with an incorrect precedence indicator, the message is routed automatically to an intercept position. Here the operator handles the transmission manually.

Outgoing messages are handled in descending order of precedence. High-precedence traffic gets immediate handling, and signal lamps indicate that such a message is in the center. Messages of the same precedence destined for a particular channel are normally handled on a first-come, first-served basis. Those of the top three degrees of precedence—FLASH, EMERGENCY, and OPERATIONAL IMMEDIATE—automatically interrupt outgoing messages of lower precedence. Audible and visual alarms indicate to the operators that such a cancellation has taken place. Thus high-precedence traffic in most cases is relayed within a few seconds of receipt.

When a multiple address message is to be transmitted on more than one channel, the equipment sends the message to those channels which are available. Because of the storing operation, special handling is not required for multiple address messages, some of which may be destined for channels which are out of service, shut down for the night, or busy with other traffic.

In many cases a light traffic load between the automatic relay center and various tributaries does not warrant a channel for each tributary. In such cases, a multipoint or party line system proves adequate. Transmission to and from stations on a party line is handled without affecting other stations on the same line.

Equipment for automatic relay is designed for use both on landlines and radio circuits. When used with radio circuits, or when heavily loaded trunks are utilized, more than one channel is often necessary for a particular destination. Traffic is automatically distributed evenly over the channels within the multichannel groups.

During light traffic hours and on weekends, messages normally are held in storage until the channel reopens. With high-priority messages, however, an operator throws a toggle-switch to route such traffic to an intercept position where the message may be examined by an operator.

When a particular channel is shut down for the night, or is out of service, alternative routing is accomplished at an alternative route patch panel with ordinary patch cords.

The relay station watch stander will be replaced to some extent by the automatic equipment. However, many highly trained Radioman supervisors and operators will still be needed to control the system and maintain the equipment.

QUIZ

1. What is the function of a tape relay station?
2. Who are the two principal assistants to the OIC of a tape relay center?
3. Name some important duties of the RCOW.
4. What is a STOP and GO message?
5. What is the principal responsibility of the relay station supervisor?
6. Why do tape relay stations conduct intensive indoctrination courses?
7. What items are indicated in the operational section of the relay status report?
8. Name the four standard message accountability logs.
9. As referred to in the discussion of ex-postal relay equipment, what is a DUPLEX circuit?
10. What is the function of the channel outage indicator and bank control system?

CHAPTER 6

RADIO RECEIVING AND TRANSMITTING STATIONS

INTRODUCTION

Radio receiving and transmitting stations at NAVCOMMSTAS provide vital receiving, transmitting, and radio link relay functions. A receiving station accepts traffic on ship-shore radiotelegraph or teletypewriter circuits and relays the intelligence to circuit control at the associated NAVCOMMSTA. At the transmitting station traffic is sent on frequencies designated by circuit control to ships at sea and to shore activities in all parts of the world.

The control center directs frequency shifts, patches circuits to appropriate terminal equipment, monitors signals, and makes adjustments to ensure maximum use of all channels. Orders and information are exchanged with the receiving and transmitting station via telegraph order lines, manual telephones, FM radiotelephones, and teletypewriters.

TRANSMISSION SYSTEMS

Landlines and radio links are the principal methods of linking shore communication stations. (See fig. 6–1.) At NAVCOMMSTA Washington, D. C., for example, traffic is exchanged primarily by landline (Navy-owned, -leased, or commercial). Radio link is the secondary or alternate means. Intelligence is relayed at NAVCOMMSTA Pearl, T. H., however, primarily via radio link. The microwave radio link

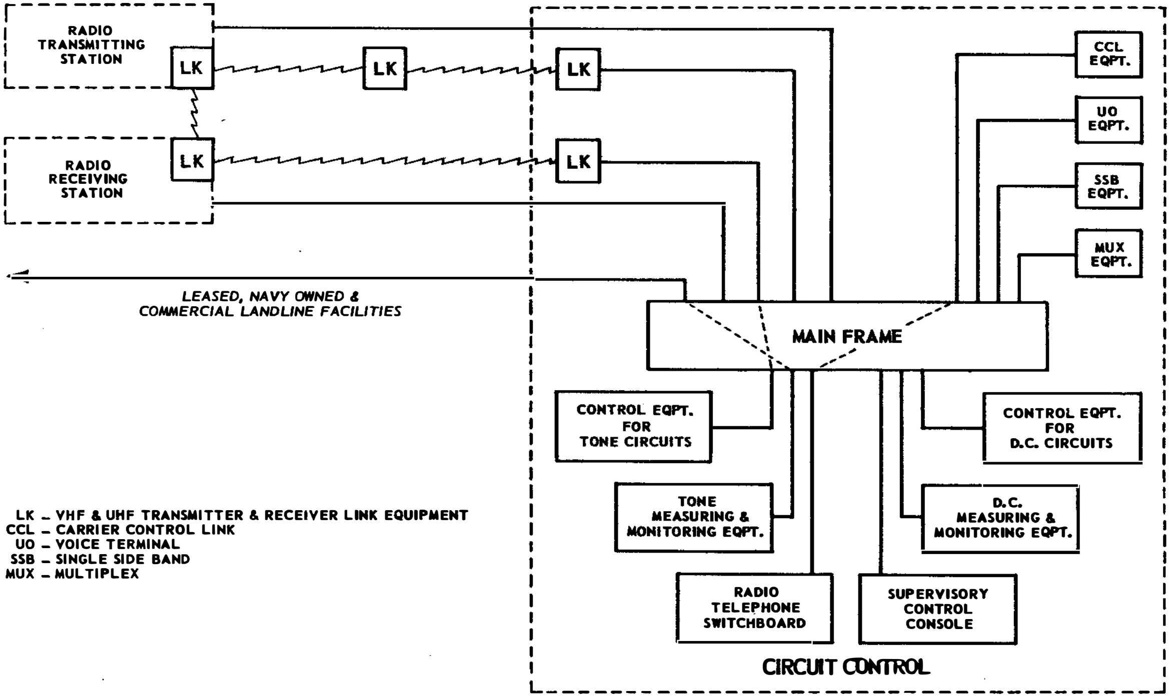


Figure 6-1.—Interstation linkage.

method (newer than landline) is built on the basis of actual traffic demands but can be expanded easily. Repeaters, placed several miles apart, receive, amplify, and retransmit the original signal.

POINT-TO-POINT CIRCUITS

Most traffic on point-to-point circuits (one shore station to another) is sent on teletypewriter circuits. Radiotelephone and CW also are used, but teletypewriter gives faster message-handling time than other methods. Teletypewriter signals are generated by two principal modes of emission: single sideband (SSB), and electronic time division multiplex (MUX). Descriptions of each method follow. Read them carefully, for they will give you the background for understanding operations and equipments at both receiving and transmitting stations.

SINGLE SIDEBAND

In conventional radiotelephone communications the carrier provides a means of transporting desired voice intelligence to the receiver where the usable, audible intelligence is separated from the carrier. The carrier is an oscillating wave of radio energy that has a frequency corresponding to the station's transmitting frequency.

Modulation

The technique by which voice intelligence is superimposed on the carrier is called modulation. Without modulation, the carrier or continuous wave (CW) signal occupies no bandwidth in the frequency spectrum. The signal can be visualized as an infinitely thin line drawn at a specific frequency when a plot of frequency along a horizontal axis is one dimension. Height of the carrier is merely a measure of its amplitude or signal strength. (See fig. 6–2.)

When modulation is placed upon the carrier, the carrier will be present at its original frequency. There would be two other radio-frequency signals present at the output of the transmitter when viewed on an oscilloscope, however. The width of the two radio frequencies appearing on each side of the carrier de-

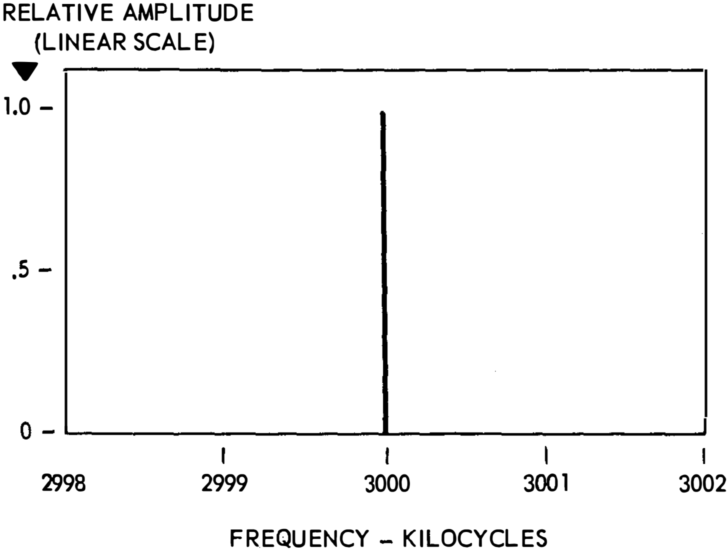


Figure 6–2.—Unmodulated carrier.

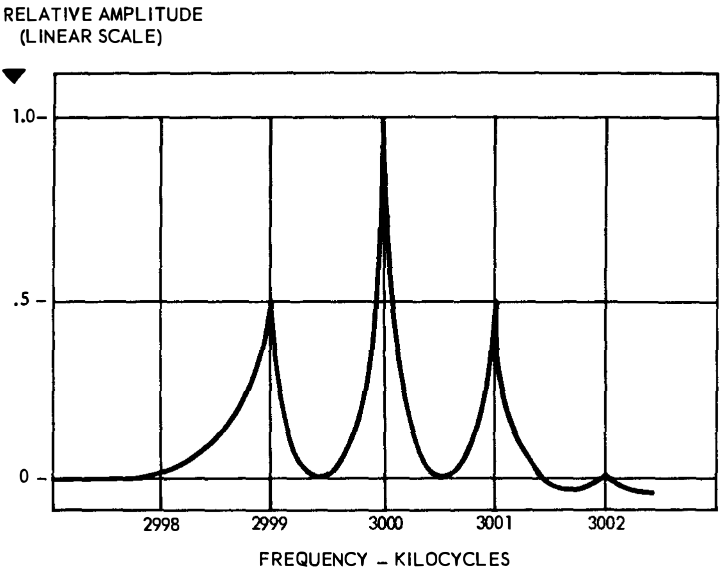


Figure 6–3.—Upper and lower carrier on either side of DSB carrier.

pends upon the audio modulation frequency fed into the transmitter either by a controlled audio source or by voice. If the audio frequency fed into the transmitter is 1000 cycles per second, the two additional signals present at the transmitter output would be exactly 1000 cycles on each side of the carrier frequency. (See fig. 6–3.) If the audio tone fed into the transmitter is 300 or 3000 cycles, the two additional signals would move, respectively, closer to or farther from the carrier. Thus, for each single audio frequency fed into the microphone of an amplitude-modulated transmitter, there are two sideband signals present at the output of the transmitter, each carrying the same intelligence.

Modulation of the carrier produces a complex signal consisting of three individual waves: the original carrier, plus two identical sidebands each carrying the same intelligence described above. This is known as amplitude modulation (AM) or, as usually is indicated in frequency plans, A–3 or voice. This type of modulation sometimes is referred to as double sideband (DSB) to distinguish it from single sideband.

Bandwidth

The amount of radio spectrum required to transmit the desired intelligence is called BANDWIDTH. For conventional DSB voice transmission, a bandwidth of 6–7 kc, plus an adjoining band on either side to prevent interference from adjacent channels, normally is required.

When the DSB signal appears at the second detector of the communication receivers, the carrier frequency is heterodyning with the two sidebands. The two separate (but identical) audio signals are recovered and combined into the audio system of the receiver. In principle, these two sidebands add in phase to produce usable audio intelligence at the speaker or headphones.

Suppressed Carrier

Elimination of the carrier is accomplished by using a balanced modulator in one of the early radio-frequency stages of the transmitter so that sidebands are produced but NO PILOT

CARRIER WILL BE PRESENT. This is sometimes the most difficult aspect in understanding SSB suppressed carrier. In SSB suppressed carrier, THERE IS NO CARRIER UNDER MODULATION CONDITIONS IN A PROPERLY DESIGNED SYSTEM. That is, when speech is fed into the SSB transmitter, the carrier itself does not appear. What is heard or seen on a scope is radio-frequency energy appearing at the transmitter output as sideband energy or talk power.

Transmission Efficiency

If one of the two sidebands is filtered or phased out before it reaches the transmitter power amplifier, the same intelligence can be transmitted on the remaining single sideband. All the power then is transmitted on one sideband, rather than divided between the carrier and both sidebands as in DSB. This higher transmission efficiency amounts to a power gain of 4 to 6 decibels for the wanted single sideband. Equally important, the bandwidth required for SSB voice circuit is approximately half that needed for DSB. (See fig. 6–4.)

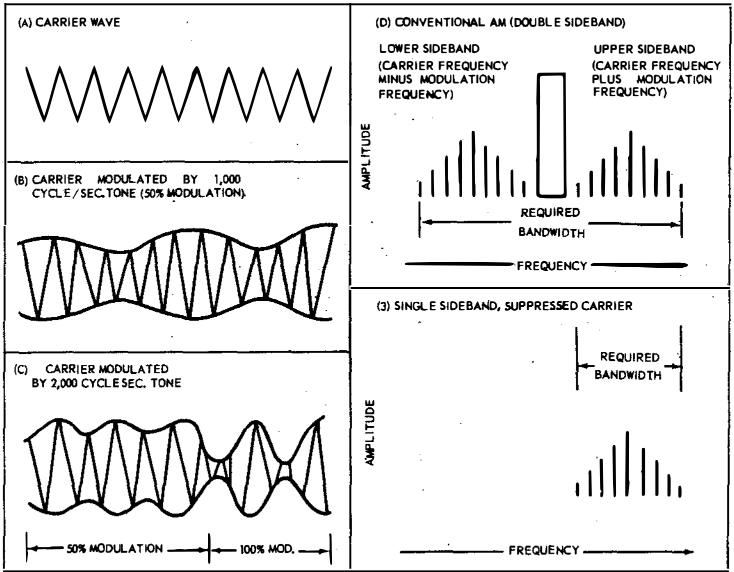


Figure 6–4.—Comparison of SSB and DSB.

Receiving Single Sideband

SSB demands a receiver with rigid frequency stability, because the reception of SSB signals is not as simple as that of DSB or AM signals. The receiving station has the problem of furnishing an artificial carrier, since the SSB signal no longer has a carrier against which the sideband signals can be heterodyned in the receiver to demodulate the sideband and produce useful audio signals. Normally, the artificial carrier is furnished by the beat-frequency oscillator in the receiver. It is mandatory that the SSB transmitter have the same high order of stability as the receiver. The transmitter and receiver must not drift apart more than a total of 50 cycles for quality voice reception.

Advantages of Single Sideband

It has been pointed out that in DSB there are two sidebands heterodyned in the receiver to produce a single audio signal that carries voice intelligence heard in a speaker or headset. If these sidebands are not received in phase (usually because of multipath skywave propagation conditions), the signal heard is fuzzy, distorted, and possibly quite loud. You no doubt have heard the report "loud but distorted." One sideband may experience a slight phase shift due to multipath transmission, thereby nearly canceling the other sideband. This produces distortion and loss of intelligibility. Fading or slight phase shift of the carrier can produce similar results. However, with the suppressed carrier type of SSB, these problems are rare.

Other advantages of suppressed carrier SSB are—

1. Increase in effective power. In a conventional DSB system, approximately two-thirds of the transmitter's power goes into the carrier and the remaining third is divided equally between the two sidebands. However, with the suppressed carrier SSB, all this power goes into the single sideband which carries the useful voice intelligence.
2. Double the number of channels. In the simplest system of SSB suppressed carrier, the number of voice channels utilizing the same frequency in the radio spectrum is doubled.

3. Reduction of interference. In normal radiotelephone DSB communication systems, the carrier of the transmitting station remains on the air until the transmitter is turned off. If another station transmits while the carrier of the first station is on, squeals and howls result. These are caused by the heterodyning of two or more signals transmitting at the same time. In SSB, with voice break-in, as soon as the operator stops speaking into the microphone, talk power in the single sideband leaves the air and the receiver is automatically reenergized. A station may enter the network as soon as the talk power leaves the air.

Even though two stations may transmit at the same time, it is possible for a receiving station to read through the interfering station the same way we are able to listen to more than one conversation around a table.

ELECTRONIC TIME DIVISION MULTIPLEX

One way to transmit several teletypewriter (TTY) circuits at once over a typical transmitter capable of F1 transmission is to key the transmitter at a faster rate than the normal TTY keying speed. By keying fast enough, the transmitter can keep up with four normal-speed TTY circuits, provided circuits are available to store up or "remember" information coming in while each TTY channel awaits its turn to have its information transmitted. A similar requirement exists at the receiving end. Here, the rapidly arriving information must be stored for each circuit until the TTY relay equipment can send it on at the normal speed of transmission to printers.

Electronic multiplex (MUX) performs these tasks: (1) storage of incoming signals; (2) high-speed automatic transmission in proper sequence of the signals from each TTY circuit; (3) storage of high-speed incoming signals at the receiving end, and (4) transmission of stored high-speed signals to the separate TTY circuit at normal TTY speed.

In the sequence of transmission, one character is sent for each TTY circuit in turn, then the second character from each TTY circuit in turn, etc. The TTY code used in MUX high-speed transmissions differs from that used in start-stop teletype transmissions because of the extremely good synchronization achieved between electronic multiplex transmitting and receiving equipments. It is possible to omit some of the pulses used in start-stop teletype, so that the telegraph signal unit does not have to be one-fourth the normal duration to transmit four circuits. The signal unit or band length normally used with MUX transmission is 6.67 milliseconds compared with 22.6 milliseconds for conventional teletype circuits.

MUX equipment consists of a send telegraph terminal and a receive terminal. The send terminal accepts four standard 7-element d-c teletype signals nonsynchronous to each other. By time division, the terminal changes the length of the individual signal elements to allow four separate TTY channels to be transmitted in the same length of time required for ONE channel of normal teletype. This multiplexed signal is then placed on the radio path by frequency shift transmission occupying approximately a 2.85-kc segment of the frequency spectrum. In frequency shift transmission, the transmitter operates specified frequencies separated by a nominal 850 cycles—one frequency called mark (key closed condition), the other called space (key open condition). The assigned operating frequency is midway between mark and space frequencies and is not used in transmissions.

The receive telegraph terminal accepts the multiplexed signal from the receiver and associated equipment, which converts the received signal to d-c, and reconstitutes the original 7-element d-c TTY signal for delivery to four separate teletypewriters.

A recent version of 4-channel MUX is the AN/UGC-1. It is completely transistorized, is approximately one-fourth the size of earlier models, and uses about 90 percent less power.

SSB v. MUX

SSB emissions are unique in that, as we have seen, the carrier is suppressed greatly at the transmitter to utilize the maximum power available in the sideband. SSB terminal equipment such as the AN/FCC-3 provides for transmission and reception of eight individual teletype signals as compared to the 4-channel MUX. The normal frequency spectrum used for SSB transmission is 10 kc as compared to 2.85 kc for multiplex. Shore communication stations use SSB on most circuits, reserving MUX as an alternate or standby mode of emission.

NAVRADSTA (R)

Site

To obtain optimum radio reception, a NAVRADSTA (R) usually is located in flat country or on long, easy slopes, and is isolated to minimize radio interference from urban areas, power lines, aviation and navigation aids, and similar sources. Of secondary consideration is the station's accessibility to good highways, electrical power, telephone, and other utilities.

Plant

Ability to receive a radio signal depends on the ratio of desired signal strength to the strength of undesired noise in the system. The antenna area and buildings are laid out to minimize noise and increase effective signals. Usually the antenna area is near the center of the station away from structures other than the receiver building and utility connections, and connections are normally underground.

The receiver building is the heart of the station. At most stations it usually is designated building No. 1. It is made of masonry or reinforced concrete and is generally rectangular in shape. The building is located near the center of the antenna area to reduce length of transmission lines. (The transmission line is 70-ohm solid dielectric coaxial cable, properly terminated, and is buried to reduce noise pickup usually caused by exposure.)

All other station buildings and the service area are near the station boundary to provide the greatest antenna area and the best noise and interference surveillance of the station. To suppress interference, metal in the various buildings is thoroughly bonded and grounded.

Buildings and facilities for maintenance and repair of station equipment are located in the service area. Included are maintenance and repair shops, storage facilities, garage, firehouse, antenna and cable storage, and a small administration building.

The administration building is usually close to the junction of the maintenance and storage area and the area for personnel. Location of personnel and housing areas provides accessibility to and from the main gate without crossing antenna or maintenance areas.

ANTENNA SYSTEM

Special consideration is given to the antenna layout because of its importance to the mission of a receiving station. Antennas are grouped about the area conforming to a pattern which gives maximum signal strength. They are connected to the main receiver building by buried coaxial cables or surface air-filled coaxial lines. Primarily rhombic or fishbone types, the antennas are located in bearing to give optimum reception from almost any part of the world. There are several antennas of other types, such as long wires, doublets, and special types for VHF/UHF and microwave. Figure 6–5 shows a rhombic antenna.

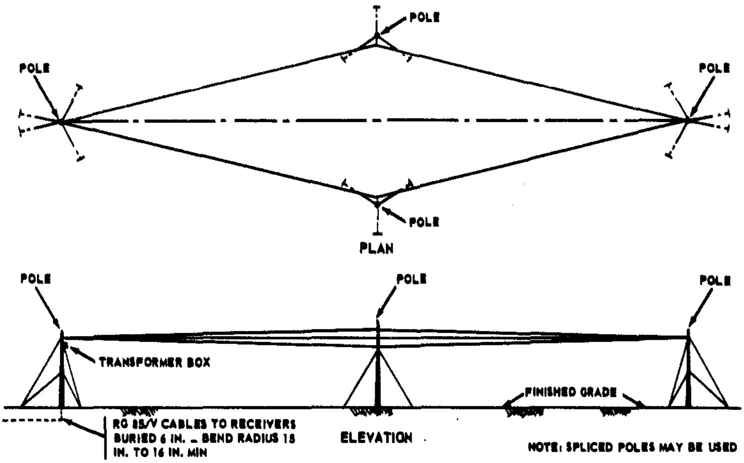


Figure 6–5.—Rhombic antenna—receiving.

Multicouplers are important to the antenna system because they eliminate interaction between various receivers on the same antenna. Multicouplers normally are located in the basement of the main receiver building and are used to provide four outputs from each antenna.

Another component of the antenna system is the antenna patchboard, located in the main operating room of the receiver building. At this board any antenna can be patched to the desired receiver.

ORGANIZATION

Typical organization of a NAVRADSTA (R) is shown in figure 6–6. Note the two operating departments—communications and security group. They perform the mission of the station and are supported logistically by the administrative and public works departments.

The communication department normally is allowed 2 officers and 55 to 60 enlisted men. The department contains two divisions: operations and maintenance. You no doubt will be assigned to operations. The division normally has 40 to 45 Radiomen and strikers. The maintenance force numbers approximately 12, all of whom are Electronics Technicians.

The communication department is responsible for the operation and maintenance of—

1. Receiver facilities for RATT, MUX, and FAX.
2. Landlines and CCL (communication control links: VHF, UHF, microwave relay, etc.).
3. Ship-shore radio circuits.
4. Terminal and subsidiary equipment for above functions.
5. Communication security functions.

Head of the communication department is the communication officer, usually a lieutenant commander. The COMM officer is responsible to the communication officer of the parent NAVCOMMSTA for operational matters, and reports to the electronics material officer of the NAVCOMMSTA concerning maintenance and repair of all electronic equipments. As shown on the organizational chart, the COMM officer of the receiving station is responsible to the officer in charge (OIC) of the sta-

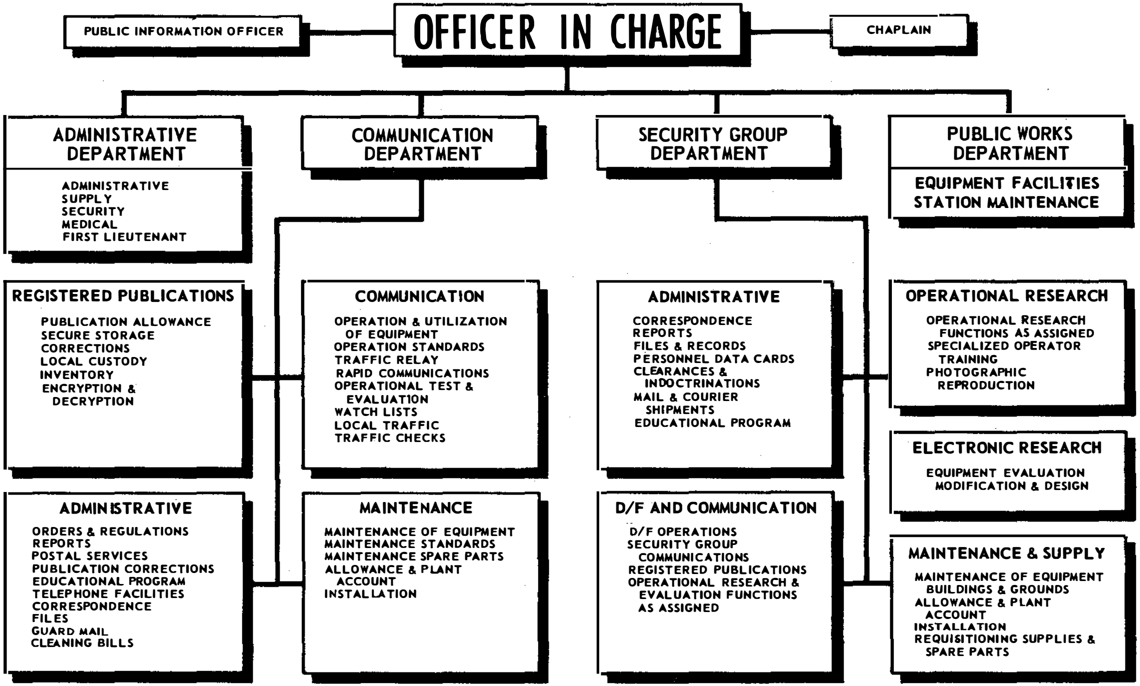


Figure 6-6.—NAVRADSTA (R) organization.

tion for administrative and military matters, and keeps that officer informed on current operating practices and plans.

The COMM officer's principal assistant is a Warrant Electronics Technician. This officer ensures that electronics maintenance and repair programs are efficiently administered. His principal assistants are the electronics chief and the special equipment supervisor, both of whom are Chief Electronics Technicians.

At some large receiving stations the COMM officer has an officer administrative assistant. He is in charge of the communication office, oversees preparation of required reports, and maintains liaison with other departments. The administrative assistant is sometimes designated custodian of registered publications.

Chief Supervisor

The job of chief supervisor is the most important petty officer billet in the communication department. He is a Chief Radioman with considerable experience at shore communication stations. His duties may be compared to those of the leading chief in RADIO CENTRAL aboard ship. The chief supervisor is the petty officer in charge of operations, supervising all operational personnel. He must have thorough knowledge of all plant equipment to ensure coordination of circuits and equipment. The supervisor also maintains liaison with senior enlisted personnel of related activities at the NAVCOMMSTA and the local transmitting station.

Administrative Chief

Another important day job in the communication office is that of administrative chief. He is the Chief Radioman in charge of the communication office. His duties correspond to those of the traffic chief aboard a large ship or at a NAVCOMMSTA. He makes a daily check of traffic files and logs (daily summary, supervisor's log, etc.) and prepares daily summaries of traffic and circuit conditions. Supervision of local traffic handling is an important duty of the administrative chief. The administrative chief is in training for chief supervisor and, in the absence of the chief supervisor, assumes his duties.

Radio Watch Supervisor

Watches are stood at either receiver control or on ship-shore (NERK) circuits. As radio watch supervisor, you have direct supervision of the 10 or 12 watch standers in your crew, including control of ship-shore personnel through the ship-shore supervisor. You are responsible for handling local traffic, and for keeping required records such as the supervisor's log and radio log. You must be thoroughly familiar with single sideband, MUX, and other electronics receiver equipment. The supervisor's status board must be kept up to date, and a watch-to-watch inventory of classified publications must be conducted. After working hours and on weekends the radio watch supervisor represents the COMM officer and keeps him informed of unusual conditions such as outages and circuit breakdowns. At some receiving stations the radio watch supervisor is referred to as the circuit control watch officer.

First Floorman

The first floorman is a Radioman First Class. He must be thoroughly familiar with all normal and emergency circuits at circuit control. He sees that converters such as the URA–8, single sideband receivers, and microwave equipment are in A1 operating condition. He is, in effect, the right arm of the radio watch supervisor. He should be capable of taking over as radio watch supervisor at any time. The second floorman is a Radioman Second Class and is in training for duties of first floorman.

Ship-Shore Supervisor

The ship-shore supervisor on each watch is an RM1 and reports directly to the radio watch supervisor. In addition to control of ship-shore operations, the ship-shore supervisor spends as much time as possible monitoring transmissions. He can then correct poor operating habits of his operators.

Ship-Shore Operators

Four Radiomen Second or Third Class are assigned to each watch as ship-shore operators. They must know standard operating procedures, including current authentication systems.

Knowledge of frequency meters, antenna patching, teletypewriter operation, and equipment maintenance is vital to the job. Ship-shore operators man special circuits in connection with fleet exercises when necessary.

TECHNICIANS

Electronics equipment worth many millions of dollars is installed at every receiving station. Keeping this complex gear in first-class operating condition is the responsibility of the maintenance division. Although a Chief or First Class Radioman is not ordinarily assigned to this section, he should be familiar with the duties and problems of the Electronics Technician.

The petty officer in charge of the maintenance division is designated electronics chief. He supervises all maintenance, records, test practices, and training of electronics personnel. In addition to thorough knowledge of all electronics equipment, he prepares and keeps in effect a preventive maintenance program, and supervises operation of the electronic shop.

The maintenance chief is an assistant to the electronics chief. He supervises preparation of electronic reports, coordinates the training program, and recommends changes to existing maintenance schedules.

Other key electronics personnel are the supervisors for special equipment (SSB, MUX, and FAX), line equipment (receivers and associated converters), and communication control link and landline equipment.

LOGS AND RECORDS

Each receiving station uses locally prepared mimeographed forms similar to those kept in radio central aboard ship. The type of information is different, but the purpose of the records is the same: to provide accurate summaries of the happenings on each watch.

Supervisor's Log.—This log shows the frequency to which each receiver is tuned and the station originating the transmission. There are columns for type of emission, hours of operation, time up, outages, and remarks. The log shows, for example, that receiver REA6 is tuned to frequency 16150 and is receiving NPM Honolulu on SSB.

RADIO LOG.—Information recorded in the radio log includes frequency shifts, receivers unable to hold signal, orders from the control center, and receiver shifts. A radio log is kept both at receiver control and in ship-shore spaces. The radio watch supervisor is responsible for the accuracy of both radio logs in addition to the supervisor's log.

DAILY SUMMARY.—The daily summary of circuit and equipment conditions is submitted to the communication officer. The summary normally is divided into three sections as follows:

SHIP-TO-SHORE—This section shows the number of ships contacted on each frequency, total number of messages and total word count. Recorded herein is also total messages and words relayed to the control center of the NAVCOMMSTA.

POINT-TO-POINT (RATT, MUX, SSB)—This section contains the following information: station, equipment, conditions, number of shifts, outages, and remarks. Information is compiled from radio watch supervisors' logs.

SPECIAL CIRCUITS AND FACSIMILE—The facsimile transmitting station, equipment in use, and control designations are recorded in this section of the daily summary. When the receiving station is up on special circuits designated for fleet exercises, such information is recorded here.

EQUIPMENT

Over a hundred receivers are needed to cover all the circuits which a large radio receiving station works. Some of these are the familiar RBA, RBB, and RBC types found aboard ship. Others are those especially adapted to shore communications: single sideband, point-to-point diversity, and control link equipment. Some representative types are described below.

REA SSB Receiver

The REA radio receiver is a high-frequency single sideband receiver designed to operate in the frequency range from 4000 to 22,000 kilocycles. It provides for reception of either one or both telephone channels arranged as a twin-channel system.

For Navy use, one channel has been converted as a carrier system for six separate teletype signals. This teletype intelligence is usually referred to as the ALFA channel or side; the voice channel is termed the BRAVO channel or side. Here is how this twin-channel system works:

The radio transmitter and receiver provide two independent transmission bands extending from 100 to 6000 cycles on opposite sides of a common reduced carrier. The two channels, one telephone or voice and the other teletype intelligence, are about 5000 cycles wide. These channels are positioned in the transmission bands by modulators in the terminal equipment at the control center. The ALFA channel has 26 individual tones, 2 tones for each marking pulse and 2 for each spacing pulse. Thus for each teletype channel there are 4 separate tones, 2 for each marking pulse transmitted by teletype printer and 2 for each spacing pulse. Therefore, with 6 different teletype channels on the ALFA side, there are 24 tones. The 2 extra tones are for local interstation communications.

AN/FRR-10 SSB Diversity Receiver

The radio receiving set AN/FRR-10 is a double-conversion superheterodyne-type diversity receiver contained in three rack cabinets. The complete receiving equipment consists of two radio receivers together with the switching, comparing, and filtering circuits necessary to receive the following signals in single-channel or space dual-diversity operation:

1. Double sideband radiotelephone;
2. Single sideband radiotelephone and teletype;
3. Single sideband suppressed carrier and radiotelephone or teletype (carrier suppression up to 26 decibels).

The AN/FRR-10 covers the frequency range of 2.0 to 32.0 megacycles in four tuning bands.

AN/FCC-3 Carrier Telegraph Equipment

The AN/FCC-3 is a d-c to audio tone converter (send) and an audio tone to d-c converter (receive).

The FCC-3 send terminal accepts 12 standard TTY signals, converts the signals to audio tones that vary in accordance with

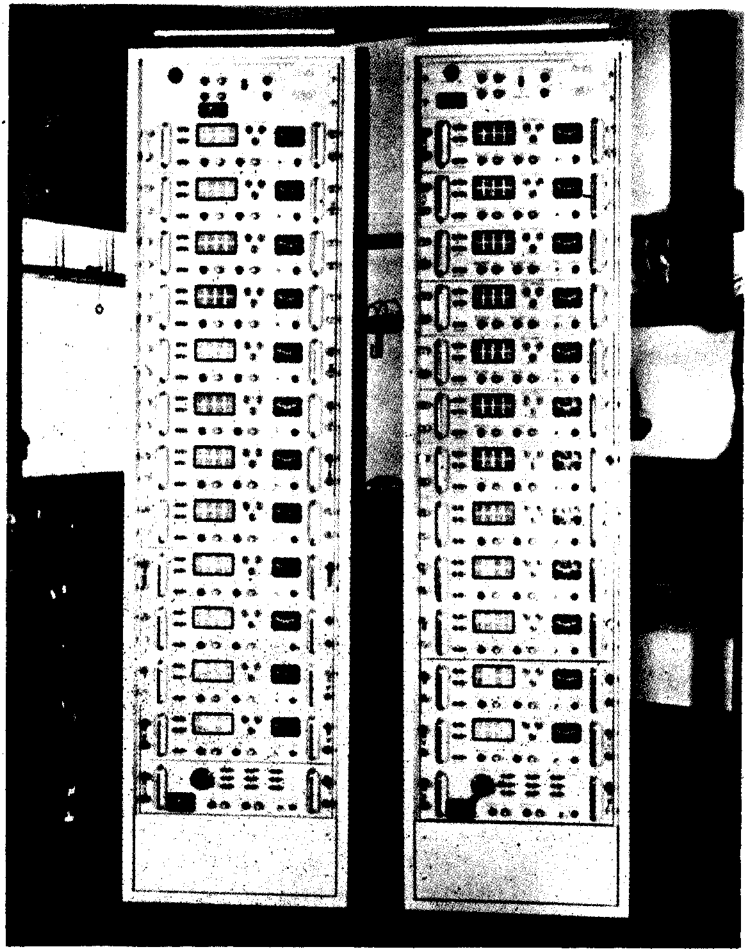


Figure 6-7.—AN/FCC-3 carrier telegraph equipment.

the input d-c signal. It then combines the 12 separate tones for transmission to the receiver.

The FCC–3 receive terminal receives the combined audio tones, and separates the tones into companion channels by selective audio filters. The terminal then reconstitutes the d-c keying signal that was inserted at the companion channel on the send side.

Channels 1 through 8 are classed as narrow-band channels since they are suitable for transmission of single-channel TTY (or CW keying) signals only. Channels 9 through 12 are wide-band channels and are used for faster keying speeds such as MUX and RATT. The frequency shift of the four wide-band channels is twice as much as the narrow-band. Their frequency is shifted 170 cycles, 85 cycles below the channel frequency and 85 cycles above.

AN/FRC–24 (UQ) Microwave

The Navy model AN/FRC–24 is a microwave link between transmitting and receiving stations. There are two transmitters and two receivers. A 23-channel system is used, operating in the frequency range of 1700 to 1850 megacycles. Automatic switchover units for transmitter and receiver operate independently of each other. Any pair of transmitters and receivers can be selected for normal use; the other pair becomes a standby.

Each of the 23 channels is designed primarily for radiotelephone communication, but can be used to provide other types of communication within the limits of its bandwidth. By adopting appropriate terminating equipment, for example, the same channel can be used to transmit speech and other signals simultaneously, limiting actual speech frequencies to those below 2500 cps, and utilizing the region between 2500 and 3400 cps for other signals. If the entire channel is used for a number of carriers modulated by low-frequency signals, such as voice frequency telegraph, one channel can be used to transmit many different signals simultaneously. In addition, the system is readily adaptable for tie-in to intermediate points. All channels can be terminated on a 2-wire basis suitable for telephone sets and conventional switching, ringing, or dialing systems.

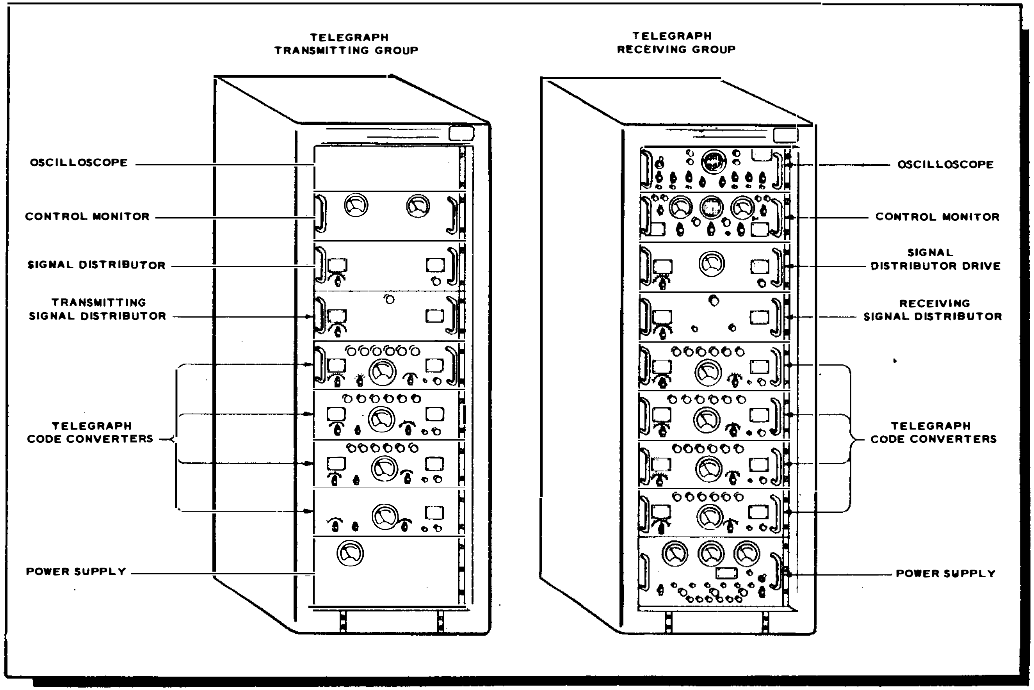


Figure 6-8.—AN/FGC-5 MUX equipment.

AN/FGC-5 Multiplex Terminal Equipment

As seen in figure 6-8, the AN/FGC-5 MUX equipments consist of a transmitting group and a receiving group. Together they comprise a complete send-receive electronic time division multiplex telegraph terminal.

The telegraph transmitting group accepts on-off direct-current start-stop signals from transmitting circuits. Adequate samples of each signal are taken and applied to the MUX circuit channel by channel. The MUX circuit is connected by landline or radio link to the radio transmitting station.

Incoming signals from the radio receiving station are carried either by landline or radio link to the telegraph receiving group which converts the MUX signals (signal samples) to on-off d-c signals and passes them to local TTY equipment.

NAVRADSTA (T)

Location

A transmitting station is located in an isolated area several miles from the receiving station and parent NAVCOMMSTA. This site prevents obstructions to transmission and interference to radio and facsimile reception. As is the case with receiving stations, accessibility to transportation, electrical power, telephone, and other facilities is of secondary consideration. The terrain is mostly flat or rolling with no sudden rises or descents. Soil is highly conductive to provide good conductivity for VLF, LF, and MF transmissions.

TRANSMITTER BUILDING

The transmitter building is the terminal part of open-wire transmission lines and is located near the center of the antenna park. (Transmission lines transfer radio-frequency energy from transmitter to antenna.) The building is blast-resistant and steel reinforced. It is completely bonded together and grounded to prevent excessive heating and losses in the presence of high-intensity radio-frequency (r-f) fields.

The main floor contains transmitter room, shop and storage spaces, communication control link equipment, and, at some transmitting stations, administrative spaces. A full basement contains tray and cable distribution floor sleeves under rows of equipment and also houses air-conditioning equipment.

Station buildings, such as maintenance, storage, and housing, are grouped about the station boundary in the same manner as corresponding structures at a receiving station.

ANTENNA PARK

The antenna park is as near the center of the station as topography will allow. This permits expansion of the area and easier observation of required clearances. The more common types of transmitting antennas are the Marconi, rhombic, and doublet.

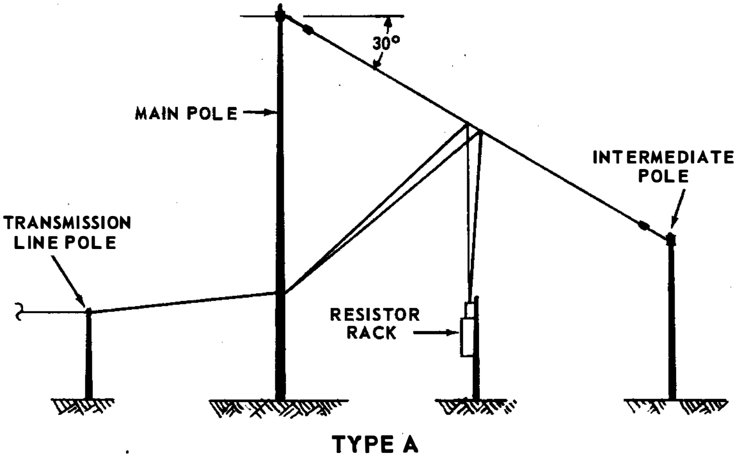
Transmitting antennas of the low-frequency type are provided with electronic tuning devices, including coils (helices) and variometers. (A variometer is a variable inductor used as a fine tuning coil to resonate antenna.) For high-power LF or VLF antennas 50 kw or higher, tuning equipments are installed in a helix house. This structure is located near and below its particular antennas.

At most stations, a Marconi antenna is designated by the letters MA followed by one or more numerals indicating length of the antenna. The last numeral of the antenna length is dropped. MA 11, for example, designates a Marconi antenna 110 feet long.

A doublet antenna is termed DA followed by numerals indicating frequency to which the antenna is tuned. DA 4235, for example, designates a doublet tuned to 4235 kilocycles. A special two-frequency doublet carries the letters DA followed by two sets of numerals indicating frequencies to which the antenna is tuned.

Special designations are also given to a rhombic, or directional, antenna. The letters RA are used, followed by numerals showing true compass direction in which the directivity pattern points. Thus RA 40 indicates a rhombic directed to 40 true.

Any antenna can be connected to the desired transmitter through switching stations located adjacent to the transmitter



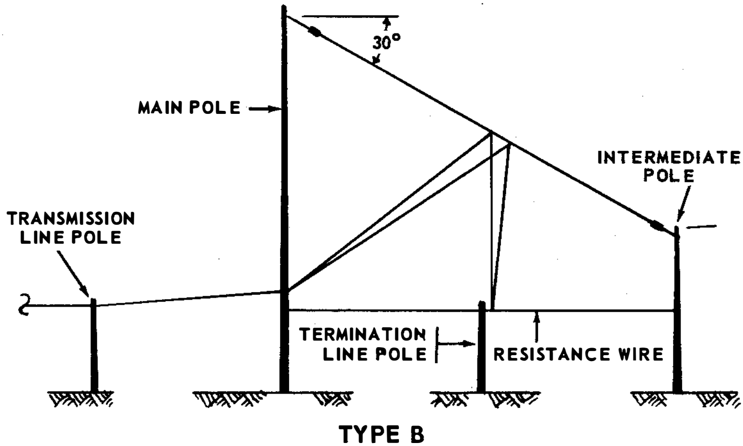


Figure 6-9.—Wire band doublet transmitting antenna.

building. Antenna cards on each transmitter indicate the antenna to which the transmitter is connected. These cards must be changed each time a switch is made.

Antennas are supported by towers (self-supporting or guyed) and vertical radiators which range in height from 300 to 600 feet. Towers are electrically grounded as a protection against lightning and accumulation of static charges. A spark gap for insulated towers and vertical radiators serves the same purpose.

GROUND SYSTEM

Many structures at a transmitting station such as the transmitter building and helix houses require a comprehensive and intricate ground system. The ground system consists of a No. 6 bare copper wire mat with wires on 10-foot centers in each direction brazed together at each intersection and to the marginal wire. Copper ground rods are driven at all corners.

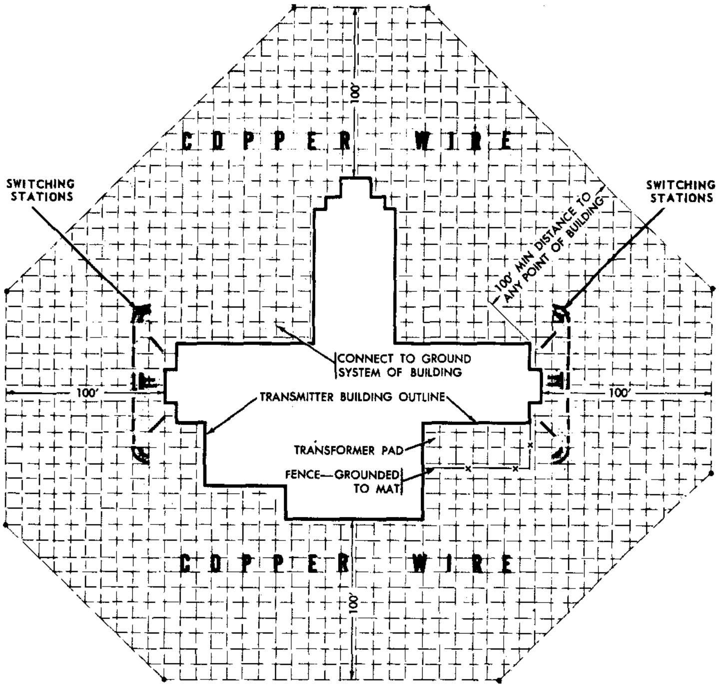


Figure 6-10.—Transmitter building showing switching stations and ground area.

ORGANIZATION

The number of officers and men at a transmitting station varies greatly, even between those which serve primary COMMCENS. The complement is normally not as large as that for a receiving station. The OIC is usually a commander, with two officer assistants. Radiomen comprise approximately 60 percent of the enlisted complement. Other personnel are Electronics Technicians and strikers, and administrative ratings such as Yeomen and Storekeepers. Civilians include an electronics engineer and several riggers. Typical organization of a transmitting station is shown in figure 6–11. The electronics and operations officer serves also as maintenance officer.

The OIC executes general policies of the commanding officer of the parent NAVCOMMSTA. He is, in effect, the opposite number of the OIC of the associated receiving station, directing and coordinating all work and operations of the transmitting station. The electronics and operations officer directs installation, operation, and maintenance of all electronic equipment. He is also responsible for upkeep of plant account property records, and records on spare parts and tube allowances for electronic equipment. The administrative officer assists the OIC in the general administration of the station, and is usually designated security officer and custodian of registered publications.

Each transmitter building, helix house, and auxiliary transmitter building is supervised by a chief in charge, usually a Chief Electronics Technician. He is responsible to the electronics officer for proper installation, operation, and maintenance of all electronic equipment in his building.

In the main transmitter building the chief in charge is assisted by the day supervisor, who trains and instructs watch standers and new men. His duties are similar to those of the leading Radioman in radio central aboard ship.

Another important billet for a Chief Electronics Technician is that of maintenance chief. He supervises and works with civilian riggers and overseas repair of electrical and plumbing fixtures.

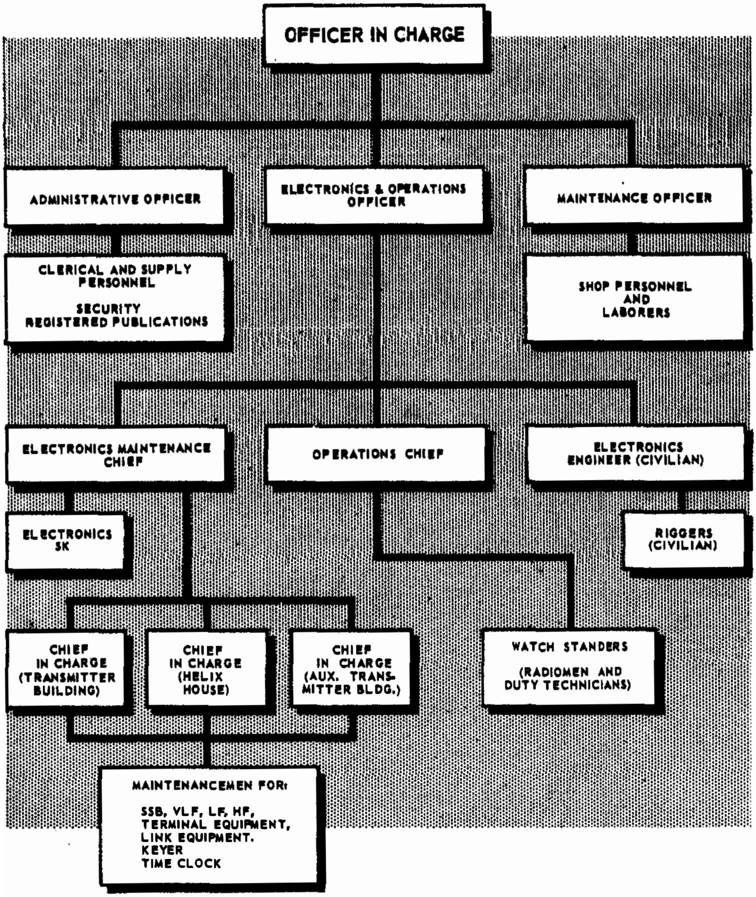


Figure 6-11.—NAVRADSTA (T) organization.

Second and Third Class Electronics Technicians overhaul, inspect, and make major operational repairs and alterations to electronics equipment. Each maintenanceman specializes in a particular type of equipment. Those assigned to a helix house, for example, are experts on VLF transmitters and associated equipment. Others specialize in single sideband, terminal, or time clock equipment.

OPERATING SPACES

Watches are stood in the transmitter room, the most important operating space on the station. In addition to housing various transmitters, the area contains a control board or console, frequency measuring and monitor set, spare tube racks, rolling test carts and workbenches, and other standard equipment for testing and maintaining transmitters.

The control console gives the operator access to all transmitter keying lines, interstation and intrastation lines, and necessary keyers, amplifiers, and adapters for all equipment. (See fig. 6-12.) At the frequency measuring and monitor set, operators check frequencies and keying, monitor transmitter output by a receiver, and carefully watch water system alarm indicators.

A transmitter status board is normally mounted directly in front of the control console. On this board is recorded com-

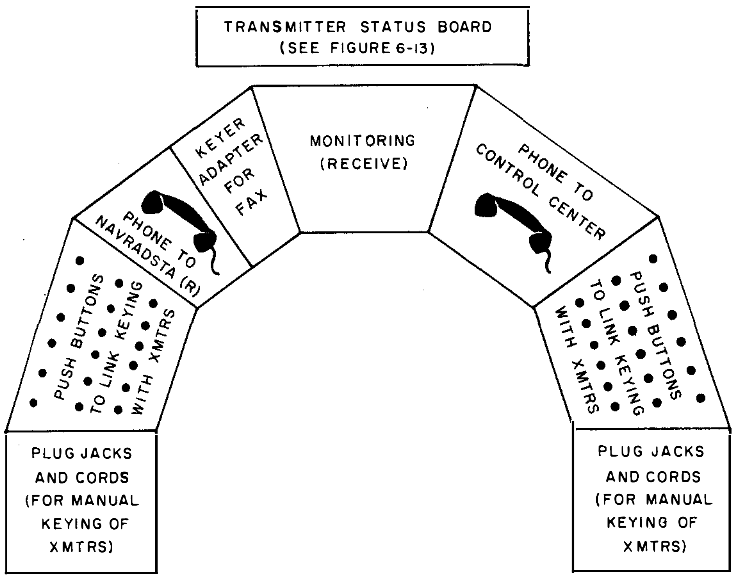


Figure 6-12.—Transmitter control console.

plete, up-to-the-minute status of each transmitter and antenna on the station. The board is shown in figure 6–13.

Safety precautions are posted conspicuously in the transmitter area, along with the watch bill, station regulations, and instructions.

Just outside the transmitter room are the water tanks of the water-cooling system. These units supply cool water to the water-cooled tubes of high-power transmitters at 35 pounds' pressure. Water pumps are located in the basement of the transmitter building.

Equipment is tested and serviced in the laboratory, located adjacent to the transmitter room. The laboratory is equipped with voltmeters, ohmmeters, capacity testers, radio-frequency generators, and other electronics testing and servicing equipment. New men are instructed in this shop by the day supervisor.

Space for tube storage is provided next to the laboratory.

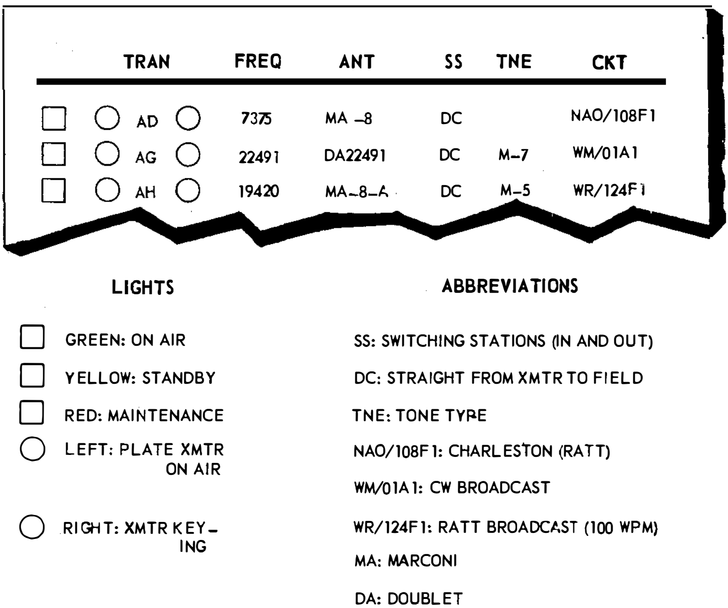


Figure 6–13.—Transmitter status board.

TRANSMITTER DESIGNATIONS

To identify each transmitter on the station quickly and easily, a system of designation is used. Systems vary, but following is a typical method:

A low-frequency transmitter is designated by a single letter. High-power, low-frequency transmitters are designated by letters at the beginning of the alphabet. For example, the "A" set is the TBJ with an output of 500,000 watts. Low-power, low-frequency transmitters are given letters at the end of the alphabet, as the "Y" set with an output of 2000 watts.

High-frequency transmitters are designated by a 2-letter system. The first letter is the last letter of the transmitter type. The second letter is given alphabetically to the transmitters as they are installed. Thus "CA" indicates a TBC, the first to be installed; "AC" designates a TBA transmitter, the third to be installed.

HELIX HOUSE

Because of the tremendous size of LF transmitters such as the TBJ and TAW, transmitting stations where such equipment is installed need separate helix houses for the transmitter's tuning coils. These structures contain spiral-shaped (hence helix) antenna tuning coils and a variometer.

Flexible leads of Litz cable are used to hook the desired number of loading coils in the antenna circuit to permit tuning antenna to the operating frequency (15–34 kcs).

WATCH STANDERS

There is usually a crew of 4 Radiomen on each watch, plus 2 duty technicians. Watch supervisor is a Radioman First or Chief assisted by lower rated Radiomen designated as first, second, and third operators. Strikers are assigned to watches for training and may, when qualified, become second or third operators. It normally takes 3 to 6 months to check out a new man.

Duty technicians stand by in case major equipment troubles occur. Responsibility for proper operating procedures and routine equipment upkeep still rests with the Radioman supervisor.

Important duties of each watch stander follow. Once you qualify as supervisor, keep a checklist for each man. List each piece of equipment, and record the date the watch stander qualifies to operate it properly.

Supervisor or First Operator

As supervisor or first operator you must be checked out on transmitter tuning and know the frequency ranges and output of all equipment. You should also know VHF, microwave, single sideband, and multiplex theories; and be familiar with facsimile transmitters, keyers, and adapters, as well as the various types of antennas in use.

First Operator

A working knowledge of all equipments in the transmitter building, including power lines and methods of shifting them, is essential for the first operator. He must know the location of water-cooling systems, and how to secure water to individual transmitters before changing tubes. His maintenance duties include ability to locate and fix minor trouble on equipment. He must be proficient in the use of tone link equipment, and patch panels. The first operator makes an hourly inspection of the building to catch minor discrepancies before they become major breakdowns.

Second Operator

Your second operator should know how each transmitter normally is used; also its frequency range, output, and its associated antenna. He must have some knowledge of FCC–3 tone link system. The second operator is under instruction by first operator in the use of patch panels, link systems, time clocks, shifting of power, and noting and repairing minor troubles on all equipment.

Third Operator

The third operator must know the location of all transmitters and how to tune them. He should be able to use a frequency meter efficiently, and be able to tune photo-adapted and FSA keyers. Operation of the teletypewriter is also his job. It is especially important that you check out the third operator on safety precautions, including treatment for electric shock.

WATCH STANDING ROUTINE

In general, during the course of your watch, you supervise energizing or securing transmitters, tuning and adjusting equipment, and frequency shifts as directed by the control station. You must keep a constant check on equipment to ensure that it functions normally, is on frequency, and operates at its designated power output.

Be sure to check frequencies of equipment in use every hour or at any time you suspect the equipment is not within frequency tolerance. Keep a constant check on equipment to ensure it is radiating the desired power. Watch your indicator lights and receivers for signs of trouble.

Inspect rotating machinery every hour. Be especially alert for signs of arcing, excessive heat, unusual noise, or any other abnormal condition. When bringing up transmitters for regular schedules, start early enough so that troubles encountered can be remedied before the circuit is due on the air.

Keep your transmitter status board up to date. Remember to have an operator change this board immediately after each frequency or antenna shift. Keep the control station fully informed of status of all transmitters and any changes in status.

Relieving the Watch

Before relieving the watch, inspect the status of each transmitter and then read all orders issued since the last watch. Check the control board to determine which control lines, link circuits, and patch cords are in use. Ensure that all important information has been recorded on outstanding trouble reports.

Be sure to ascertain all frequencies and spreads in use, and make a personal check of powerline feeders utilized. Availability of keys for interlocks should also be checked.

Weather Conditions

Except for transmitting stations in tropical zones, watch standers must be particularly alert to outside temperatures. Sleet or ice on antennas used with LF transmitters causes leakage over insulators, increases the loss resistance of antennas, and make antennas difficult to tune. In the helix house, when the temperature drops below 40°, inform the station maintenance man to turn on the heat immediately. If the outside temperature is 34°, and it is hailing, snowing, or sleeting, keep a dotter on the transmitter when it is not being keyed by the control center at the COMMCEN. (A dotter is an automatic keyer which transmits a series of dots.)

At the main transmitter building, when the outside temperature drops below 34°, and it is hailing, snowing, or sleeting, put a dotter on the weather sets when they are not being keyed by the control station.

During freezing weather the supervisor must keep a close check on all transmitters. They must be retuned as necessary. Water-cooling houses should also be checked to make sure strip heaters are ON and louvers closed.

Some orders concerning frequency shifts and other operations may be received from control center in the COMMCEN by telephone. Be sure you receive the order by teletypewriter page printer before executing it. In other words, get it in writing!

Have an hourly inspection made of all equipment, entire building, grounds within the building's security fence (during night watches only), switching stations, etc. Be sure your operator carefully observes meters on equipment in use to detect malfunctioning of rotating equipment. He should also watch for possible arcing of antennas, broken insulators, and burned-out tower lights. A taut watch means proper operation and safety of building and equipment.

Equipment Failures

When an equipment failure occurs, resume service as quickly as possible by bringing up other equipment or restoring equipment to operation after minor repairs and/or adjustments.

Such minor breakdowns include replacing defective tubes and blown fuses; changing tones, lines, demodulators, and other control equipment; and tuning and adjusting transmitters, oscillators, and frequency meters.

Restore service on the following priority: (1) broadcast circuits, (2) point-to-point circuits, and (3) other circuits. If you doubt whether service can be restored immediately, notify the electronics duty section, but keep working on the equipment. In the meantime, bring up another transmitter.

In case of fire, an electrical surge which knocks down several transmitters, circuit outage exceeding 1 hour, or icing of the large VLF antennas, call the duty officer.

SAFETY PRECAUTIONS

At both transmitting and receiving stations, you work with voltages which could render you or your men unconscious or could kill you in a matter of seconds. Before you begin standing watches, carefully review the following material: chapter 18 of *United States Navy Safety Precautions*, and applicable sections of chapter 67 of the *Bureau of Ships Manual*.

When working with transmitters, keep these points in mind:

Do not rely on interlocks to remove high voltages. Grounding rods are provided with all transmitters for making contact between transmitter frame and the part to be worked on. USE THEM! When major work is to be done, obtain a red tag from the operator's desk, throw the switch on the deenergize panel or front auxiliary panels associated with the equipment under repair. Then secure the red tag to the handle of the switch. No one should touch the switch as long as the tag is there. The tag contains the following legend:

> This circuit was ordered open for repairs and shall not be closed except by direct order of ______.

The reverse side of the tag is inscribed: SAFETY FIRST.

LOGS AND RECORDS

OPERATOR'S LOG.—All happenings on the watch are recorded in the operator's log. Types of entries include equipment failures, frequency shifts and equipment shifts, hourly temperatures, report of time test, time tick, building inspection, and frequency checks. The time that weather, mercast, hydro, and press circuits are ordered up or down by control must also be entered. When frequencies and/or transmitters are shifted, this information is logged also in a separate transmitter shift record. This record is a part of the operator's log and is filed with it.

FREQUENCY MEASUREMENT LOG.—A frequency measurement log lists all transmitters in the first column. Actual measured frequency and spread are recorded in the second and third columns, followed by the corrected frequency and/or spread. An entry must be made in the log every 4 hours for each frequency in use during day or mid watches. On the evening watch, entries are made every 2 hours.

DAILY ANTENNA CHECKOFF LIST.—The checkoff list shows each transmitter and the antenna to which it is tuned. There is also a column for new antenna shifts. Information on the antenna checkoff list must agree with that on the status board.

TELETYPEWRITER LOG.—The teletypewriter log is a record of all communications sent and received on the teletypewriter and recorded on the page printer. Time of each transmission and operator's sign are included. Orders from control and information from the local receiving station are received via page printer.

Logs are also needed in transmitter buildings housing LF transmitters such as the TBJ. In addition to the operator's log, teletypewriter log, and frequency measurement log, a TBJ meter and inspection report is kept. Entries are made in this log hourly during normal keying of schedules, except for the water flow, temperature, and pressure report; these are logged every 2 hours.

TROUBLE REPORT.—Information on malfunctioning and failure of equipment is entered in the trouble report. Care must be taken to fill in the exact cause of failure and action taken to remedy it. On electronic tube failures, the following data must be included: tube serial number, socket, and tube

TROUBLE REPORT — U. S. NAVAL RADIO STATION (T)

DATE 3 Aug 1957

T. R. NUMBER	EQUIPMENT MODEL	SERIAL NUMBER	CIRCUIT
1006	TEB(BG)	46	P-54

STATE HOW YOU KNEW THERE WAS TROUBLE
Transmitter off air. No reading on front PA filament.

STATE WHAT ACTION WAS TAKEN Changed front PA tube but could not bring up circuit. Further trouble in 3 KV relay. No 3KV readings. Shifted circuit to another XMTR BG.

WHAT WAS THE CAUSE OF TROUBLE?
Shorted PA tube.

SUGGESTIONS TO PREVENT RECURRENCE
None

FIRST OPERATOR (Signature)	SECOND OPERATOR (Signature)	THIRD OPERATOR (Signature)
Boles, RM1	Conrad RM3	Barnhardt RMSN

ACTION TAKEN BY MAINTENANCE PERSONNEL

Replaced contact on PA overload relay. Visual inspection showed bad contact K-115.

Circuit up normally.

SIGNATURES OF MAINTENANCE PERSONNEL

WORK DONE BY Day crew — P. O. IN CHARGE Thiese THIESE ETC

~~VACUUM~~ TUBES REMOVED			~~VACUUM~~ TUBES INSTALLED		
TYPE	SERIAL	HOURS	TYPE	SERIAL	HOURS
5667	415071	11036.6	5667	415424	0

TUBE RE-CHECK P. O. (Signature)

DATE AND TIME OF FAILURE	DATE AND TIME REPAIRS COMPLETED
272240Z	281240Z
DATE AND TIME CIRCUIT RESUMED	CIRCUIT OUTAGE
272305Z	

ENTERED IN MACHINERY HISTORY
DATE 2 Aug 1957 BY WMR

ACTION BY OINC OF BUILDING

COMMANDING OFFICER	EXECUTIVE OFFICER	BUILDING OFFICER IN CHARGE	ELECTRONICS ENGINEER

(Use reverse side for remarks)

Figure 6-14.—Trouble report.

life indicator reading. A completed trouble report is shown in figure 6–14. Information from this report is used to complete Form DD 787, Electronic Failure Report, which is forwarded to the Bureau of Ships.

EQUIPMENT

There are a number of transmitters designed for shore stations to handle single sideband, radiotelegraph, and other types of emission. Following is a description of models commonly seen at most transmitting stations.

Radio Transmitter T–265/FRC–10

Figure 6–15 shows the Radio Transmitter T–265/FRC–10. This equipment is an amplitude-modulated, single sideband, twin-channel, suppressed-carrier transmitter. It is designed for long-range point-to-point communication and operates in the frequency range of 4 to 23 mc. Conventional double sideband transmission facilities are provided in case a single sideband receiver is not available at the distant point.

Pushbuttons permit selection of any of 10 operating frequencies. Depressing one of the pushbuttons (or operating a control device at a remote control point) energizes a servo system that changes the frequency automatically. This operation is accomplished in approximately 15 seconds. Accuracy of the tuning system is such that the over-all gain of the transmitter remains constant with ± 1 db for repeated operations over relatively long periods of time.

The FRC–10 transmitter contains a load-control circuit which allows one channel to utilize the full 4-kw peak envelope power of the transmitter in the absence of signal input to the second channel. When both channels receive inputs, this circuit controls the gain of a stage that prevents overloading and allows full utilization of the peak envelope power regardless of the actual input to the channels being used.

A monitor circuit is incorporated in the equipment to convert a small portion of the radio signal back to audio frequencies for test and measurement purposes.

Elaborate front panel metering facilities permit the measure-

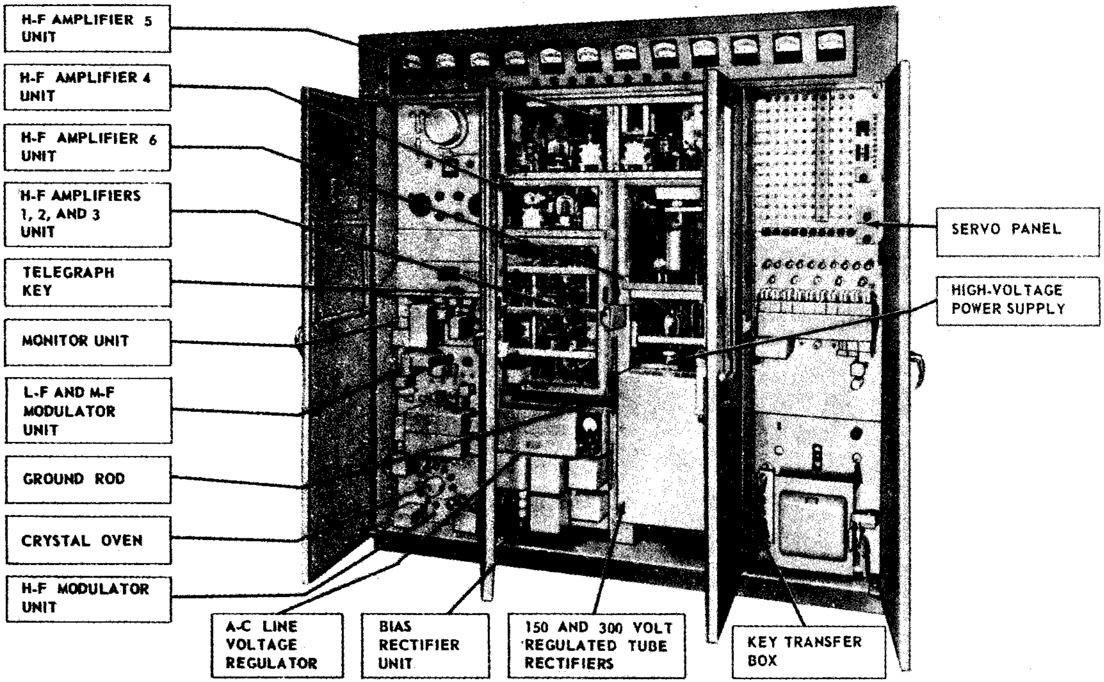


Figure 6-15.—FRC-10 transmitter.

ment of all significant voltages and currents. These include the rectifier output voltages; powerline supply voltage; the electron tube plate, screen, and cathode potentials; and the r-f potentials in the h-f power amplifiers. A separate meter indicates the number of hours of filament operation.

To protect operating personnel against lethal potentials, the equipment includes a key interlock system for each pair of locked cabinet doors, as well as gate switches on the access doors of all compartments in which the potential difference exceeds 150 volts.

Distortion measuring equipment is shipped with the transmitter. This equipment contains line amplifiers and equalizers and serves as the connecting terminus between the carrier terminal equipment and the transmitter. It is used to make signal-to-distortion measurements and other tests relating to signal quality.

TEC

Model TEC radio transmitting equipment is designed for radiotelegraph operation over a frequency range of 4000 to 21,000 kilocycles with a power output of 40 kilowatts over the entire frequency range. The transmitter can be keyed at speeds up to 400 words per minute (average 5 characters per word), and maintain good waveform. Output circuits are designed to work into a balanced 2-wire transmission line of 550- to 650-ohm impedance with zero reactance.

The circuit is adapted for A–1 (carrier ON-OFF) emission. Provision is made, however, for connecting an external frequency shifter for teletype operation. Design of the equipment is such that satisfactory service will be obtained in any ambient temperature between the limits of 0° C. and +50° C. for any relative humidity up to 95 percent.

The TEC transmitter can be used in conjunction with a single sideband transmitter. With this type of operation, the output of the single sideband transmitter is fed into the power amplifier stage of the TEC transmitter. Input and output circuits of the power amplifier in the TEC are equipped with an input and output monitoring circuit. During single sideband operation, the intermediate power amplifier (IPA) and its driver and exciter circuits can be operated as an independent transmitter with an output of approximately 2 kilowatts over a frequency range of 4000 to 21,000 kilocycles. The output circuit of the second IPA is designed to work into a balanced 2-wire transmission line of approximately 600-ohm impedance.

The control circuit provides overload protection in both the driver and power amplifier stages. Overload relays remove the plate voltages when an overload exists. Instantaneous automatic resetting of these relays reapplies plate voltages with a fixed interval for each cycle. After a preset number of recycles, the plate voltage is locked out and an alarm bell is turned on automatically. An automatic control feature provided in the transmitter shuts down the transmitter if it is not keyed for a period of 15 minutes. The automatic feature may be eliminated at the discretion of the operator, or the time period may be adjusted over the range of 2 to 30 minutes. With single sideband operation, the automatic feature will control only the exciter circuit. Exciter and driver circuits of the transmitter may be controlled manually.

TEB

Navy model TEB radio transmitting equipment is used for shore-based radiotelegraph or frequency shift operation within a frequency range from 4000 to 21,000 kilocycles with a power output of 15 kilowatts over the entire frequency range. The transmitter can be keyed at speeds over 400 words per minute, with an average of 5 characters per word, and still maintain good waveform. The output circuit is designed to work into a balanced 2-wire transmission line of 550- to 650-ohm impedance. Principal function of the equipment is to effect communication with precision and reliability from shore to ship or point to point.

The circuit is adapted for A-1 (carrier ON-OFF) emission. An external frequency shift (FS) keyer unit may be connected for teleprinter operation. Satisfactory service of the equipment will be obtained in any ambient temperature between the limit of 0° to 50° C. in a relative humidity up to 95 percent.

AN/FRT-5

Figure 6-16 shows the Radio Transmitting Set AN/FRT-5. This equipment is designed for shore-based radiotelegraph or frequency shift operation in the frequency range 4000 to 26,000 kilocycles with a power output of 15 kilowatts over the entire frequency range. The transmitter can be keyed at speeds up to 400 words per minute, with an average of 5 characters per word, and still maintain good waveform. The output circuit works into a balanced 2-wire transmission line, and has an impedance of 600 ohms, with a standing wave ratio of 2 to 1 maximum. Principal function of the equipment is to effect communication with precision and reliability from shore to ship or point to point. The circuit is designed for A-1 emission, but a frequency shift keyer unit can be used for teleprinter operation. Satisfactory service will be obtained in any ambient temperature between the limits of 0° to 50° C. in a relative humidity up to 95 percent.

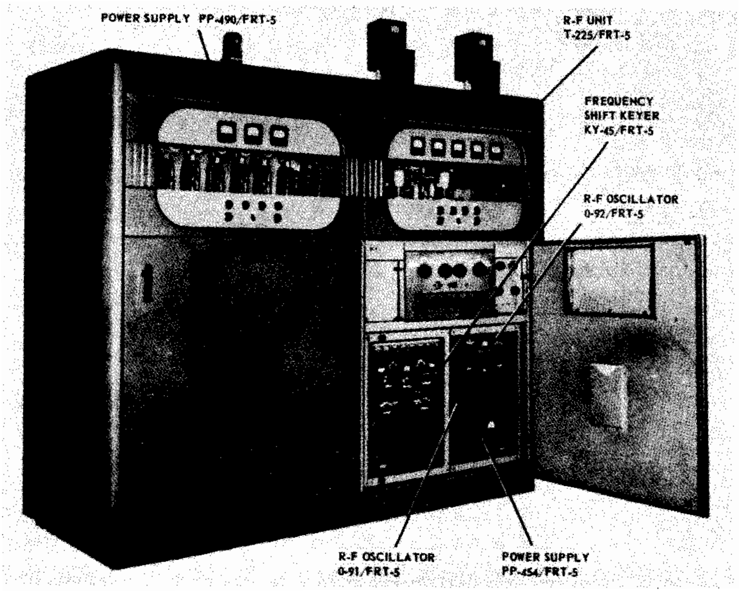


Figure 6-16.—AN/FRT-5 transmitting set.

TPA

The Navy model TPA high-frequency power amplifier is intended primarily for use in shore radio installations for amplification and transmission of radio communications from one shore station to another, or from a shore station to ships at sea. It is designed to give continuous coverage of the 4–22 mcs frequency range and, when properly excited, will deliver 50 kilowatts of peak r-f power to a properly terminated 600-ohm output transmission line. Excitation may be on-off or frequency shift keyed CW, AM carrier, or single sideband modulated carrier. For unmodulated keyed signals, the amplifier is operated in the class C region with an average power output of 50 kw, and requires an exciter capable of delivering 1 to 5 kw r-f drive into a balanced 600-ohm input circuit. For modulated signals, an exciter capable of delivering 2 kw peak r-f envelope power into a 200-ohm balanced input circuit is required.

JIM CREEK

No discussion of transmitting stations would be complete without a description of the world's most powerful radio transmitter, located on a 6000-acre site in Jim Creek Valley near Arlington, Washington.

Navy planners made an extensive search for an area which would meet special requirements: 2 mountains of equal height at least 2500 feet high, with even crests 2 miles apart and running parallel for a minimum distance of 1 mile. The site satisfying these specifications is Jim Creek Valley, bounded on the north by Wheeler Mountain, a 3200-foot peak, and Blue Mountain on the south, just 200 feet lower.

Towers

Twelve 200-foot antenna towers, 6 on the summit level of each ridge, hold the 10 spans of copper cable interlacing the 2 mountains. These spans, or catenaries, range in length from 5640 to 8800 feet. Vertical 900-foot downleads are suspended from a point midway between each span.

Transmitter Building

The transmitter building, a modified T-shaped structure, is constructed of reinforced concrete with a copper roof and copper-lined walls. The building rests on a circular web of copper matting 2700 feet in radius. The rear part of the building houses the station's two dual helix rooms.

AN/FRT-3

Housed on the second deck of the transmitter building is the heart of Jim Creek—the AN/FRT-3 radio communications set. This equipment is a complete superpower shore transmitter designed for worldwide radiotelegraph and radioteletypewriter communication in the 14.5- to 35-kc VLF band. Rated at 1000-kw output, the set is divided into duplicate port and starboard units. It includes a basic transmitter, auxiliary power and cooling systems, antenna tuning apparatus, and a suitable antenna ground system. Either on-off or frequency shift keying is used.

Each transmitter has the following components: frequency generator-monitor; exciter, with rectifier; power amplifier, with main rectifier; automatic tracking unit; antenna tuning unit; antenna ground system; control and distribution unit; and supervisory console. The transmitter proper is enclosed along the front by 14-foot steel panels called the unified front enclosure. Observation windows and access doors for various compartments are part of the assembly. Instruments, indicator lamps, control switches, and all electrically operated transmitter and antenna tuning controls are mounted on the unified front enclosure. Compartmentation and r-f shielding for rectifiers, exciters, and power amplifiers are provided by structural aluminum framing behind the enclosure. Aluminum interconnection wire ducts and catwalks are mounted atop the aluminum shielding just behind the enclosure assembly.

Auxiliary power and cooling equipment are installed on the ground floor directly below the transmitters. Located here are high-voltage switch gear, components, rectifier transformers, cooling control units, water storage tanks and pumps, heat exchangers, air blowers and filters, and flowmeter panels.

Antenna Tuning Units

Antenna tuning units are located at the rear of the transmitters in 2 copper-lined rooms. Each unit consists of a motor-driven variometer, 2 helix assemblies, an antenna lead-in trunk, and a power-operated antenna grounding switch. The variometer has windings of 2 parallel 2-inch Litz cables supported on special porcelain forms mounted in copper-shielded concrete piers. The variometer tuning motor and reduction gear are installed in a shielded pit below the vertical rotor shaft. Series-loaded helices are also wound with 2 parallel Litz cables and are sectionalized to provide multiple tap points for major changes in operating frequency.

Antenna Ground System

The antenna ground system consists of a 10-span catenary aerial system extending over an area of approximately 725 acres, 435 acres of which are covered by active radiating elements of the antennas. Installed at an average elevation of 1000 feet, the system includes a radial arrangement of buried ground conductors containing approximately 200 miles of copper wire. Ground wires extend radially to a maximum distance of approximately 3000 feet and connect to a buried copper mat under the transmitter building. All trees in the area are kept topped to a height of 10 feet to avoid excessive loss of radiation efficiency.

With a power output of approximately 1,000,000 watts, the transmitter at Jim Creek has more than twice the output of present military transmitters and is 22 times more powerful than any commercial station in the United States. Its high-power VLF transmission is not affected by atmospheric disturbances which normally interfere with the average transmitter.

QUIZ

1. What are the two principal methods of linking shore communication stations?
2. Name the two principal modes of emission used to generate teletypewriter signals.
3. What tasks are performed by MUX?
4. Why is a NAVRADSTA (R) usually located in flat country or on long, easy slopes isolated from urban areas?
5. Where is the receiver building of a NAVRADSTA (R) normally located?
6. What are your important supervisory duties as radio watch supervisor at a NAVRADSTA (R)?
7. Name the key electronics division supervisory petty officers.
8. Describe, briefly, the functions of the REA SSB receiver.
9. Why is the antenna park of a NAVRADSTA (T) near the center of the station?
10. How is a doublet antenna termed?
11. Which supervisor in a NAVRADSTA (T) has duties similar to those of the leading Radioman in radio central aboard ship?
12. What is the purpose of the control console in a transmitter room?
13. Name some important operations you are responsible for during the course of your watch as supervisor in the transmitter building.
14. What action should you take when an equipment failure occurs?
15. What are the two principal sources for SAFETY PRECAUTIONS?
16. What are the damaging effects of sleet or ice on antennas used with LF transmitters?
17. What information appears on the daily antenna checkoff list?
18. Where is the world's most powerful radio transmitter located?

CHAPTER 7

RADIO DIRECTION FINDERS

INTRODUCTION

One of the earliest discoveries in radio communication was that antennas have directional characteristics. From this knowledge came the radio direction finder (RDF), the first electronic navigational aid. Although the direction finder (DF) still is used extensively by commercial marine craft, the Navy no longer relies on this equipment for surface navigation. Electronically, Navy ships use radar, sonar, and the fathometer for piloting, and loran for long-range navigation.

INTERCEPTION

The principal use of DF in the fleet today is the interception of both friendly and enemy transmissions. On the friendly side, DF is used in rescue work, and has been found frequently more reliable than radar for homing planes. In routine situations, Navy aircraft are assisted by TACAN (tactical air navigation) equipment, or by beacons such as the YE or YG type installed aboard ship. In emergencies, such as when aircraft are about to ditch, shipboard URD-2 or URD-4 DF's are extremely useful in determining aircraft position.

RDF equipment normally is found in CIC or electronic warfare spaces. Although Radiomen normally do not operate nor maintain the equipment, the First Class or Chief should know the principles of radio direction finding and have a general knowledge of bearings and charts as they apply to radio direction finding.

ANTENNAS

All direction finders make use of the directional characteristics of an antenna. At medium frequencies the loop antenna, used in several ways in direction-finding systems, is the most efficient directional antenna. A movable loop at the receiver can be turned manually or positioned automatically until a maximum or minimum (null) signal is received. At this point orientation of the loop indicates the direction of the transmitting source.

In older systems the loop was turned manually. The operator took his bearings according to an indicator which registered maximum and minimum signals, or by listening with headsets in what still is known as the aural-null system.

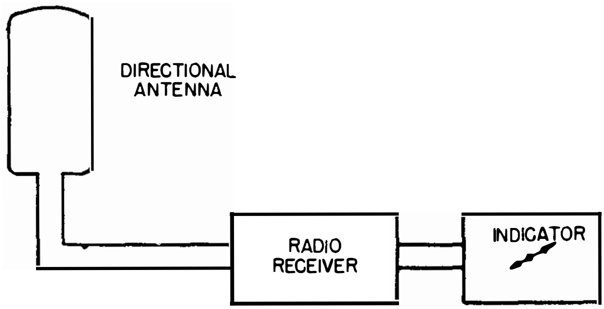


Figure 7–1.—Essential components of a mobile-type radio direction finder.

In modern DF systems the indication is made automatically on a cathode-ray scope, the antenna remaining stationary while the effect of high-speed rotation is achieved by using a device called the goniometer.

Essential components of a radio direction finder are shown in figure 7–1.

The Monopole

When a conductor is cut by magnetic lines of force, or lines of flux, a voltage is induced in the conductor. To cut lines of flux, the conductor must be perpendicular or must have a component that is perpendicular to the lines of flux; and the relative motion between flux and conductor must have a component in a direction that is perpendicular to both the lines of flux and the conductor.

A vertically polarized wave has a vertical electric (E) field and a horizontal magnetic (H) field. Therefore the wave induces voltage in vertical conductors only. A vertical wire, or monopole, is the simplest type of antenna. When a vertically polarized radio wave induces voltage in a monopole, the induced voltage is in phase with the arriving, or INCIDENT, wave and is the same for all horizontal angles of incidence, as shown in figure 7–2.

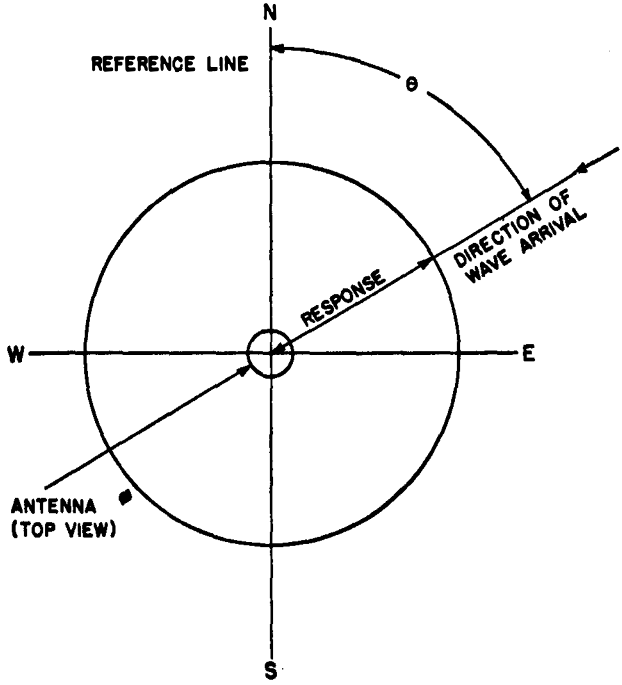


Figure 7–2.—Polar response of a monopole antenna.

The Loop

The response of a loop antenna is different from that of a vertical monopole. As a loop is rotated about its axis, the angle between the plane of the loop and the direction of propagation of the wave is changed.

If a loop is placed in a radiation field, the H vectors of the field cut the vertical sides at slightly different times. At any instant, therefore, the voltage induced in one vertical arm is slightly different from the voltage induced in the other vertical arm. The horizontal arms are not affected by the H lines of a wave polarized at right angles to them and do not contribute to the induced voltage in the loop because the horizontal members are parallel to the H lines.

If the loop is turned so that its face is perpendicular to the direction of arrival of the wave, the vertical sides are cut by the H vector at the same instant. Because the voltages induced in the vertical arms are then of the same magnitude and phase, they neutralize each other and no current flows in the antenna loop.

Since the magnetic field of the radio wave alternates at the frequency of the wave, the instantaneous flux density at any point along the path of arrival varies sinusoidally, as shown in figure 7–3A. The vertical arrows represent the flux density or magnetic field strength of the incident wave. As the magnetic field at the loop changes in phase, the flux density at the loop changes as shown at L_1, L_2, L_3, L_4, and L_5, which are the top views of the loop at various phases of the incident wave. The loop is stationary and the wave moves, but in the illustration the loop is shown at five positions along a stationary wave. The loop is seen from the top, and the voltages are induced by the flux lines cutting the vertical sides of the loop, which are in a plane perpendicular to the page.

When the phase of the incoming wave is 0°, the loop is at position L_1 with respect to the wave, and the lines of flux cutting the vertical sides of the loop are of opposite polarity. The voltages induced in the two sides are then in opposite directions, and maximum voltage is developed in one direction AROUND the loop. When the phase is 180°, the loop is at position L_4, and again the induced loop voltage is at a maximum—but in the opposite direction to that of L_1. When the phase is 90° and 270° (loop positions L_3 and L_5), the instantaneous flux cutting each of the sidearms is the same in magnitude and direction, so that the resultant loop voltage is zero.

The induced loop voltage is shown in figure 7–3B for a single cycle of the incident wave. A comparison of parts A and B in figure 7–3 shows that THE INDUCED LOOP VOLTAGE DIFFERS IN PHASE FROM THE INCIDENT WAVE BY 90°. This is an important fact to remember. Because the voltage induced around the loop depends on the small differences in voltage in opposite

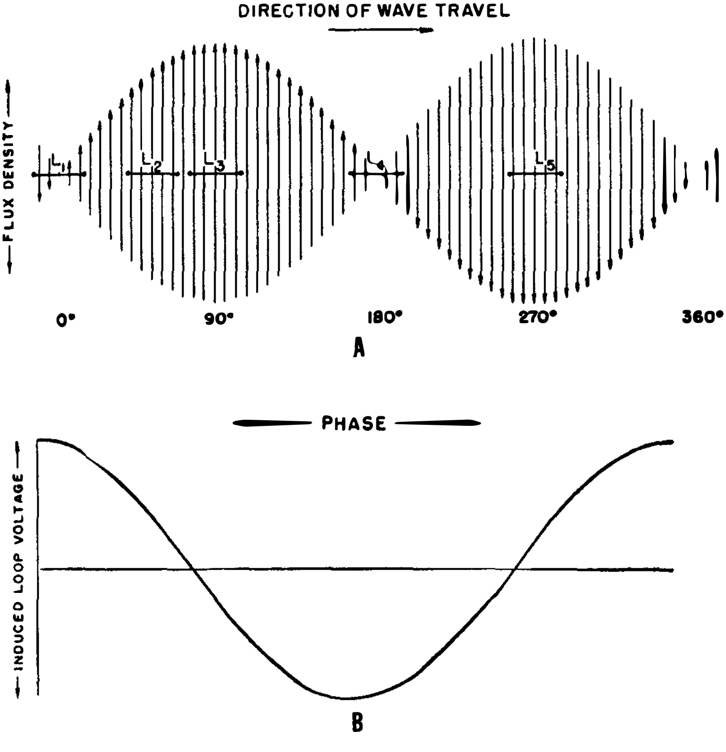


Figure 7–3.—Induction of alternating voltage in a loop antenna. A, top view of loop at various phases of the incident wave; B, one cycle of the induced loop voltage.

arms, the resultant induced voltage is very small. Because the pickup is small, the loop antenna must have a sensitive receiver.

Figure-of-Eight

The directional characteristic of the loop antenna is called a cosine, or figure-of-eight, pattern. When the loop is oriented so that the received signal is maximum, a small change in orientation produces a small change in signal. On the other hand, when the loop is at a null position, a small change in orientation produces a large change in output voltage. Furthermore, there is a reversal in phase of the signal as the loop passes through a null point. For these reasons the null points, rather than the maximum response points, are used in radio direction finding to obtain a line of bearing on a radio wave.

Because there are two null positions 180° apart, the loop can give a line of bearing (the actual bearing or its reciprocal) but cannot determine the absolute direction of the transmitter from the direction finder. As long as this condition exists, the response is said to be ambiguous. To get the absolute direction, or SENSE, the output of a vertical monopole antenna (called a sense antenna) is added to the output of the loop antenna. When the two antennas are connected properly, the combined response will indicate the direction of the transmitter.

Combined Response

The figure-of-eight pattern of a loop has two null positions for one incident radio wave (fig. 7–4). If the outputs of a loop and a monopole are combined IN PHASE, the response of the two antennas is the algebraic sum of their individual diagrams, as shown in figure 7–5. This figure contains four possible responses caused by differences in the relative amplitudes of the monopole and loop outputs. The response shown in figure 7–5C has one sharp null and is the desired pattern.

The output of the vertical monopole is independent of the horizontal direction of arrival of the wave. Assume it has positive (+) polarity. Because the phase of the loop voltage changes as the loop passes through the null, one-half of the figure-of-eight pattern will have positive (+) polarity and the

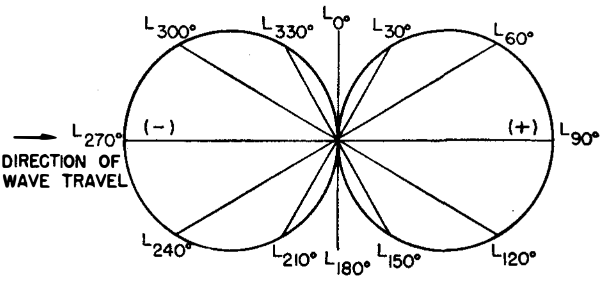


Figure 7-4.—Polar response of a loop antenna.

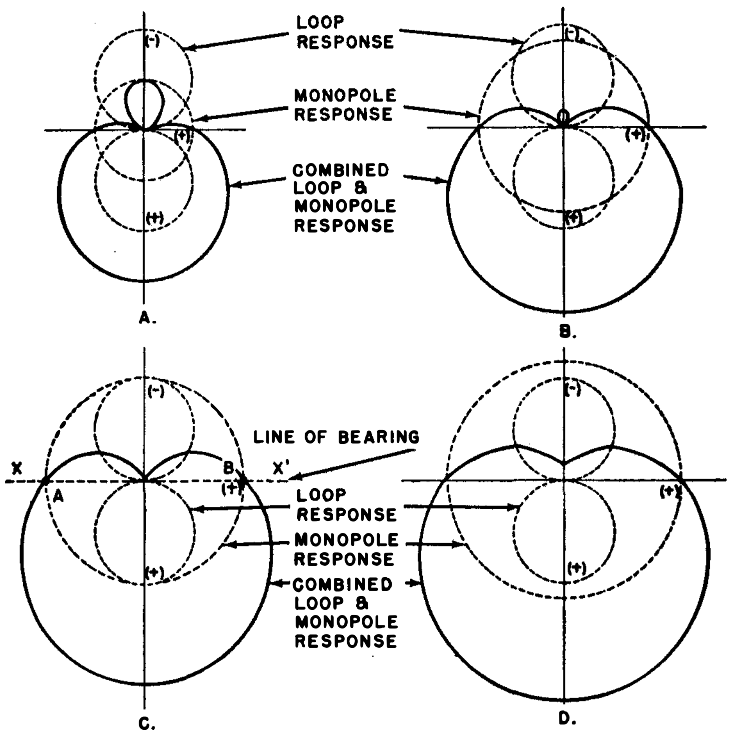


Figure 7-5.—Response of the combined monopole and loop antenna.

other half, negative (–) polarity. Addition of the loop and monopole curves gives the responses shown in figure 7–5. The shape of the resultant curves is called a CARDIOID because of its similarity to a heart.

The output of the monopole antenna is in phase with the radio wave. The output of the loop antenna, however, is 90° out of phase with the radio wave. This means that the loop voltage is at maximum when the monopole output is zero, and vice versa. The cardioid pattern of figure 7–5C cannot be obtained unless the phase of the loop (or monopole) antenna signal is changed by 90°

In operation, a bilateral line of bearing (true bearing plus its reciprocal) is obtained first by use of the loop alone. The output of the sense antenna is then added to the output of the loop antenna to give a unilateral bearing. The phase shifter is necessary to bring the signal from the loop antenna into phase with the signal from the sense antenna.

GONIOMETER

If the loop antenna could be rotated continuously, the output pattern could be recorded on an oscilloscope to give an automatic indication of bearing. But it is not always convenient to rotate the loop antenna, especially in shipboard installations. The same results can be obtained from a pair of crossed loops that are connected to a rotating pickup coil called a goniometer.

The goniometer consists of two crossed field coils, or stators, and a rotating search coil, or rotor, as shown in figure 7–6. Because the crossed radio direction finder loops can be connected to the goniometer stators through any length of r-f transmission line, it is possible to locate the goniometer at the receiver. In figure 7–7 the rotor output is inductively coupled to a rotating transformer to eliminate the necessity for slipring connections.

The response of the goniometer rotor is the same as that of a single rotating loop, and the bearings are subject to the same ambiguity of 180° To resolve the ambiguity, the output of the goniometer is combined with that of a monopole antenna

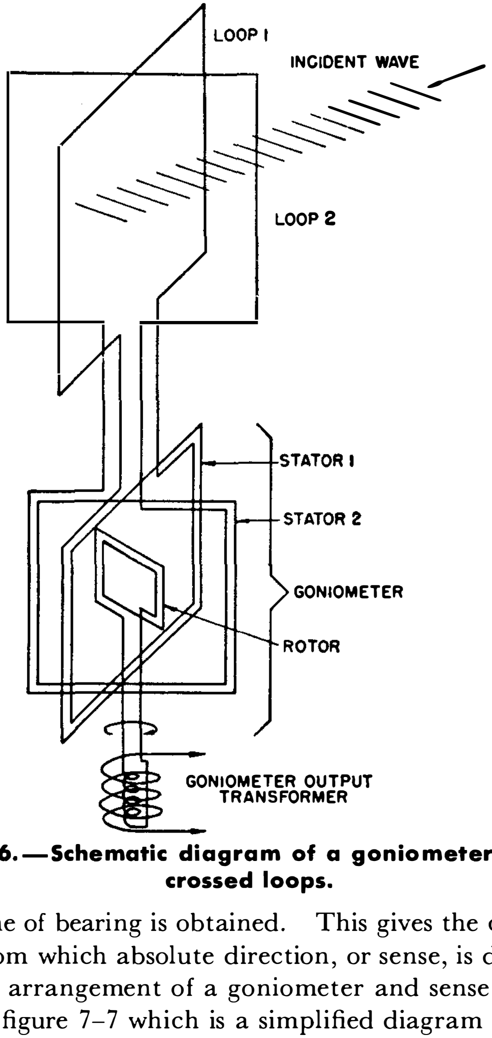


Figure 7–6.—Schematic diagram of a goniometer used with crossed loops.

after a line of bearing is obtained. This gives the cardioid response from which absolute direction, or sense, is determined. A typical arrangement of a goniometer and sense antenna is shown in figure 7–7 which is a simplified diagram of an automatic bearing indicator system.

ERRORS AND UNDESIRED EFFECTS

Nonopposite Minima

Curves A and B of figure 7–5 illustrate the effect known as NONOPPOSITE MINIMA. When the maximum signal from the

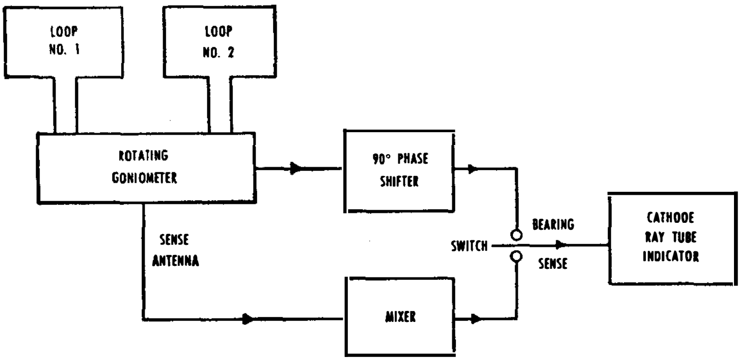


Figure 7-7.—Simplified block diagram of an automatic bearing indicator unit.

loop is greater than that from the monopole, the combined result is a nonsymmetrical figure-of-eight with two nulls less than 180° apart. When the loop is used alone, any stray pickup in an improperly shielded receiver or in the transmission lines can produce this undesired effect. Stray pickup can be recognized because it is independent of loop orientation.

Blur

Blur is an undesired effect caused by two or more waves of the same frequency reaching the direction finder at the same time, thereby causing poor nulls. Errors and poor nulls result whenever several waves of the same frequency but of different magnitude, direction, and phase are received at the same time. Electromagnetic waves induce voltages in a ship's rigging, guys, and other conductors. If the length of the element in which the voltages are induced is equal to or is a multiple of a half-wavelength of the approaching wave, the element is resonant to the wave. The resonant element acts as a transmitting antenna and reradiates a wave of the same frequency as the original wave but of different magnitude, direction, and phase. The loop receives the reradiated waves, and the results are errors and poor nulls.

Errors caused by reradiation may be reduced if the length of the element is adjusted so that it resonates outside the wavelength range of the direction finder. This may be done by breaking the element into sections separated by insulators.

Every direction finder is calibrated before use, and the effect of the ship's superstructure on the operation of the equipment is taken into account. BECAUSE ANY ALTERATION, NO MATTER HOW SLIGHT, IN ANY ELEMENT OF THE SHIP'S SUPERSTRUCTURE AFFECTS THE RERADIATION PATTERN, THE CALIBRATION MUST BE CHECKED AFTER ANY CHANGE IS MADE. Usually, recalibration is done at the shipyard after any change in the ship's superstructure.

Polarization Error

Serious errors in bearing are caused by changes in polarization of the radio wave as it travels from the transmitter to the receiver. A ground wave is diffracted as it passes over the earth and is refracted as it passes through the ionosphere, so that the wave becomes slightly polarized in the horizontal direction. The horizontally polarized components induce voltages in the horizontal conductors (or components) of the loop, thereby causing POLARIZATION ERROR. Sky waves undergo large and serious changes in polarization upon reflection from the ionosphere. These polarization errors become very large at night and are called NIGHT EFFECT. The changes in polarization cause errors of such magnitude that direction-finding bearings taken on sky waves are unreliable unless antennas are used that minimize the errors.

SPACED LOOPS

A parallel loop array sometimes is used to reduce polarization errors. The array, called a SPACED-LOOP ANTENNA, consists of two loops rigidly fixed to the ends of a boom, which may be rotated about its center.

If the loops are connected in series but are opposite in phase, the pattern has four minima. The spaced-loop antenna has the advantage that the principal nulls (the pair of nulls in the plane of the loops) are affected much less than for the single-loop antenna by any horizontally polarized component of the received wave. The signal output of a spaced-loop antenna is approximately 20 decibels less than that of a single loop, so that very sensitive receivers and great care in shielding must be used with the spaced loop. Reduction in output is a result of having the loops opposite in phase.

ADCOCK ANTENNAS

Because the horizontal conductors of the loop antenna cause polarization errors, these conductors are shielded or removed entirely. The vertical members of the loop are not affected.

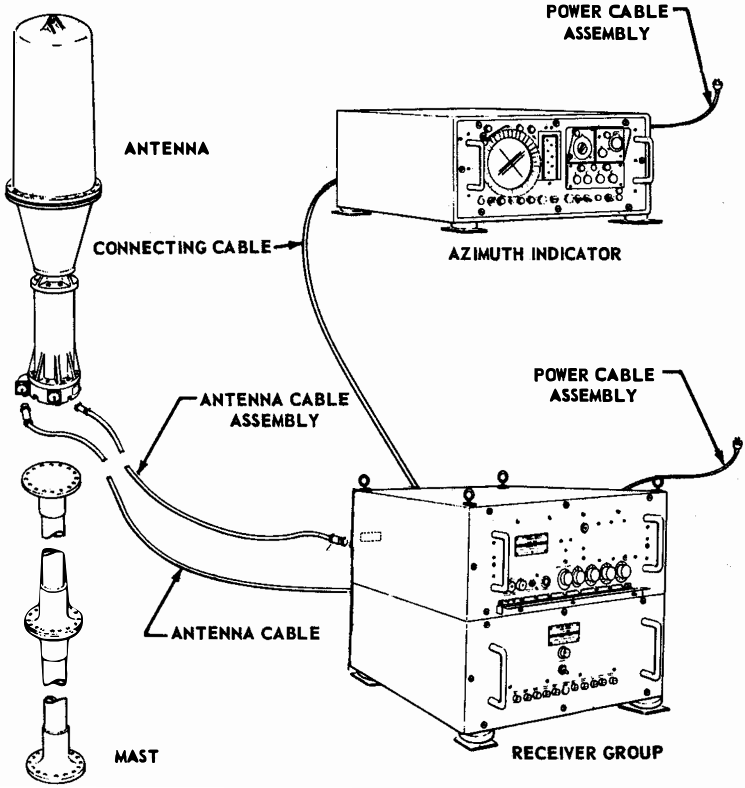


Figure 7-8.—Direction finder set AN/URD-4, Adcock antenna enclosed.

Directive loop antennas in which the horizontal conductors are shielded or removed are called Adcock antennas.

In the shielded-U Adcock antenna, the upper conductor of a single-turn loop is removed and the lower conductor is shielded. The resultant antenna consists only of vertical members.

Direct coupling may be used between the receiver and the shielded-U, or the direct coupling may be replaced by transformer coupling to produce the coupled Adcock antenna.

Two Adcock antennas may be erected at right angles and used with a goniometer. Such systems are used in both radio direction finding and in transmitting signals for direction finding. Most Adcock antennas are very large, and are widely used in fixed ground installations such as radio range stations. At higher frequencies the antennas are small enough to permit shipboard installation. The array shown in figure 7–8 is that of the model AN/URD–4 u-h-f shipborne direction finder.

THREE SYSTEMS

There are three systems of direction finding in use aboard ship: aural null, automatic bearing indicator, and matched line.

Aural Null

The oldest and least used of the direction finders is the aural null, in which the loop is hand-rotated, and the operator has headsets connected to the output of the receiver.

In operation, the loop is turned until an aural null is heard in the headphones, at which time the plane of the loop is perpendicular to the line of bearing of the transmitter. After the line of bearing is obtained, a sense antenna is used to determine the absolute direction. Some aural-null direction finders are provided with a tuning indicator or output meter for visual indication of the null. These are called aural-null direction finders with a visual-null indicator.

Aural-null systems of direction finding have been largely replaced by matched-line and automatic bearing indicators aboard naval vessels. The aural-null method of operation is usually incorporated into matched-line and automatic bearing indicator systems as a standby for emergency operation.

Automatic Bearing Indicator

In an automatic bearing indicator, the loop antenna (or goniometer) is rotated rapidly and the response of the antenna is shown on a cathode-ray indicator with a scale of 360°. The entire pattern of the loop antenna appears on the indicator, and the null points of the pattern give an automatic indication

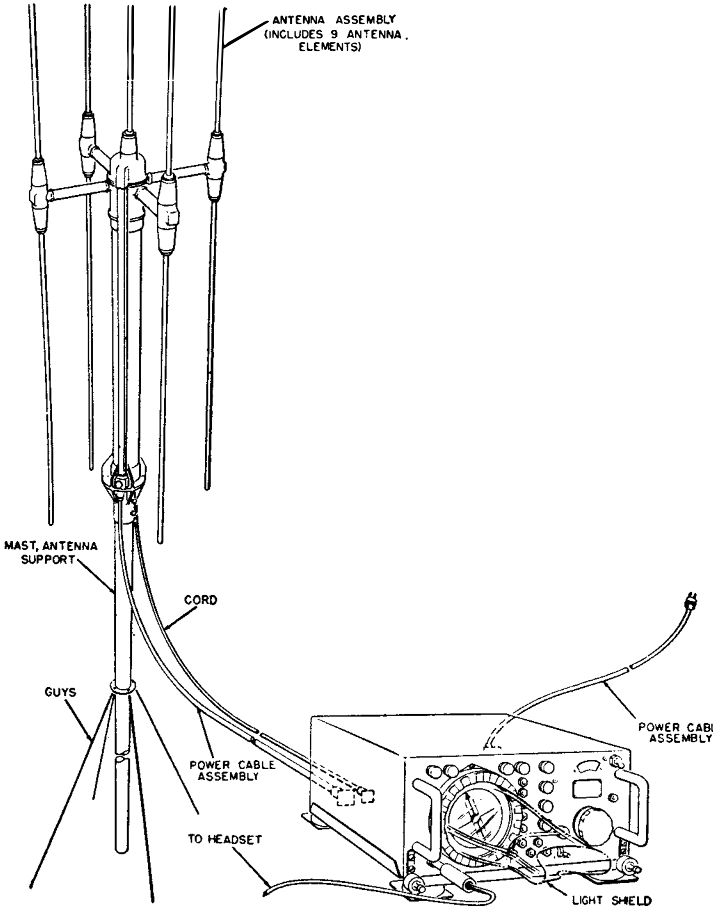


Figure 7-9.—The AN/URD-2.

of the line of bearing of the transmitter. The sense antenna output is then added to the loop output, and the position of the resultant cardioid gives the absolute direction to the transmitter.

The model DAK–2 is an example of a DF using the automatic bearing indicator. It covers the frequency range from 250 to 1500 kilocycles. Newer DF's include the AN/URD–2 (fig. 7–9), operating in a frequency range of 100 mc to 156 mc, and the AN/URD–4 (fig. 7–8), in frequency range 225.0 mc to 399.9 mc.

Matched-Line Indicator

In the matched-line method of indication the outputs of the loop and sense antennas are combined and modulated in a special circuit that puts two lines on a cathode-ray tube. Relative lengths of the lines depend on orientation of the loop, and the lines are matched in length only when the line of bearing is obtained. Sense is obtained as in aural-null systems—that is, the loop is turned in one direction after the lines are matched, to see if either line increases.

Model DAK–3 radio direction finder is an example of equipment using matched-line indication. The AN/SRD–7, intended as a replacement for the DAK–2, DAK–3, and other models, operates in the frequency range 250 kc to 30 mc.

These three systems (aural null, automatic bearing indicator, and matched-line) differ in the method of moving the loop to obtain a null, use of the sense antenna to resolve ambiguity, and the method of indicating the line of bearing and absolute direction. The null is indicated by an aural null in the headphone of an aural-null system, by matched lines of equal length in the matched-line indicator, and by an oscilloscope pattern in the automatic bearing indicator. Orientation of the loop at a null is the basic indication in all three systems.

BEARINGS AND CHARTS

Relative and True Bearings

A relative bearing is one in which the bow of the ship is used as a point of reference. It is the angle measured from the bow of the ship CLOCKWISE to an imaginary line connecting the ship with the object on which the bearing is taken. A relative bearing in direction finding is a measurement of the angle from the bow of the ship to an imaginary line connecting the ship and a radio transmitting station. In figure 7–10 the relative bearing of the received signal is 047°.

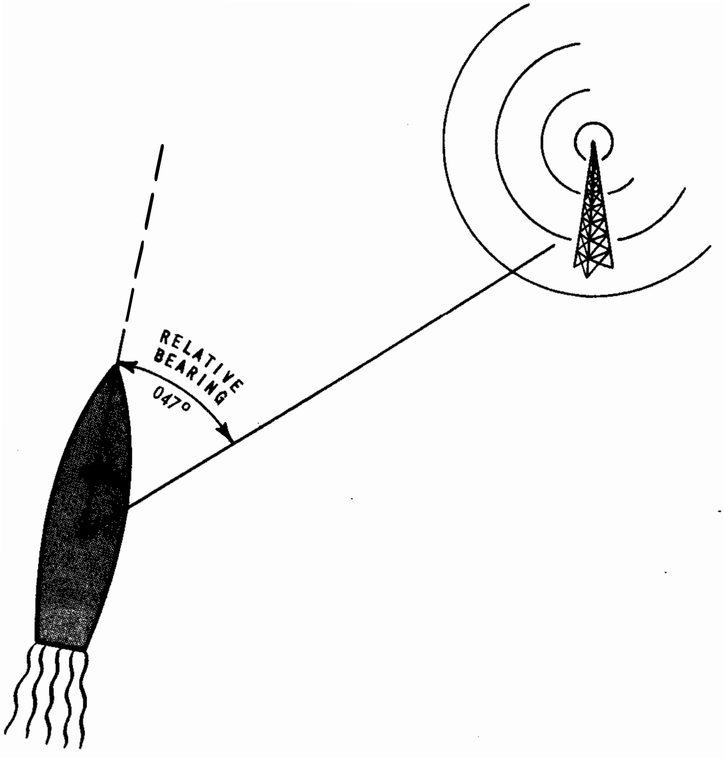


Figure 7–10.—Relative bearing of signal is 047°.

Since the bow is always 0° relative, the starboard beam is 090° relative; the stern, 180° relative; and the port beam, 270° relative.

In true bearings the reference point is the geographic North Pole, and the bow of the ship is not a factor. A true DF bearing is a measurement of the angle between true north and an imaginary line from the ship to a transmitting station.

Unless the DF is equipped to furnish true bearings, the operator must convert relative bearings to true. When converting, the ship's heading is added to the relative bearing of the radio signal to get the true bearing. For instance, assume the ship is heading 028° true and the relative bearing of the radio signal is 035°. The true bearing of the signal is 063°. If, when the heading and bearing are added, the result is greater

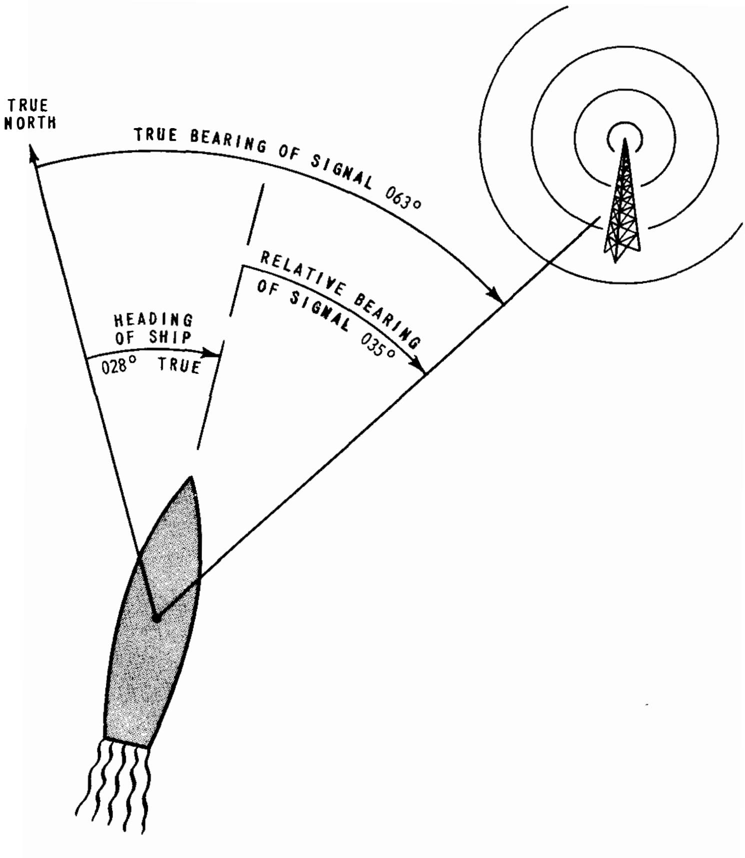


Figure 7-11.—This signal bears 035° relative, and 063° true.

than 360°, then 360° must be subtracted from the total to get the true bearing. As an example: A ship is steaming 315° true, and the relative bearing of the signal is 090°. The true bearing of the signal is 405° minus 360° or 045°.

MAGNETIC COMPASS

Any sailor who has stood a wheel watch knows that Navy ships are equipped with both magnetic and gyrocompasses. Usually, the ship is steered according to the gyro, and the course is periodically checked against the magnetic compass. Rarely does the ship's heading indicated by gyro read the same as its heading by magnetic compass. The difference is caused by two factors: variation and deviation.

Variation

Around the earth a magnetic field exists between the north and south magnetic poles. Any other magnets in the earth's field tend to line up with the lines of force in this magnetic field, just as an anchored ship will head into the wind and tide. Since the magnetic poles do not coincide with the geographic poles, the magnetic compass does not point to true (geographic) north. Thus, the direction in which the compass points is called magnetic north. The difference in direction between magnetic north and geographic north is called variation. If the magnetic north is eastward of true north, the variation is called easterly and marked E. If the magnetic north is westward of true north, the variation is called westerly and marked W.

Deviation

There is yet another force at work on the magnetic compass. Iron and steel ships have marked magnetic qualities which affect the compass so that the axis of the compass card does not coincide with the axis of the earth's magnetic field. This is known as deviation. It is partly, but not completely, counteracted by the compensating magnets located in the binnacle. Since these magnets do not completely counteract deviation, the compass will point either to the right or left of magnetic north. If the compass points to the right, the deviation is easterly; if to the left, westerly.

The amount and direction of deviation varies with the ship's head. For example, a ship on course 130° may have a deviation of 2° east, while on a course of 265° the deviation may be 4° west. The navigator determines the compass deviations for the ship and records them as a curve on deviation tables kept near all steering stations, and in CIC.

CHARTS

The chart is basic to navigation. To understand the plotting of direction finder bearings, some knowledge of chart construction and navigation terms is necessary.

Meridians and Parallels

In devising a system for locating points, the earth has been divided by imaginary lines called meridians of longitude and parallels of latitude. Each meridian circles the earth, passing through both North and South Poles. Beginning with the meridian which passes through Greenwich, England, the me-

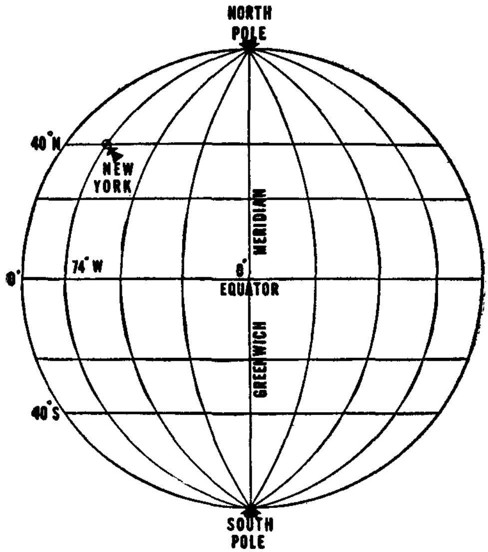


Figure 7-12.—Longitude is measured from Greenwich, latitude from the equator.

ridians are numbered 0° to 180° east and 0° to 180° west. Parallels are numbered from 0° to 90° north and south of the equator. Each degree of longitude and latitude contains 60 minutes, and each minute has 60 seconds.

Every spot on earth is located at the intersection of a meridian and a parallel. A point's location is its latitude (distance in degrees, minutes, and seconds of arc north or south of the equator, measured along the point's meridian), and longitude (distance in degrees, minutes, and seconds of arc east or west of zero meridian, measured along the point's parallel). In figure 7–12, New York City is located at latitude 40° north, longitude 74° west.

MERCATOR PROJECTION

The charts on which DF bearings are plotted are the same as those used for navigating the ship. The most common chart is produced by a method of projection known as Mercator. In this method the meridians are represented as straight lines, RATHER THAN LINES CONVERGING ON THE NORTH AND SOUTH POLES. To project the meridians as straight lines results in the distortion shown in figure 7–13. Here a portion of the globe is peeled off and the upper part stretched so that the meridians are parallel. Since the chart is stretched east and west, it must also be stretched north and south to prevent local distortion.

Inasmuch as the meridians were pulled farther apart at the poles, the parallels of latitude must also be pulled farther apart at the poles. The result is greater distortion in extreme northern and southern latitudes than at the equator. Study the two circles shown in figure 7–13 and note the difference in the amount of distortion. In the Mercator method, the higher the latitude, the greater this distortion. Charts of areas on or near the equator contain almost no distortion because the meridians at the equator are nearly parallel, and therefore require no "stretching."

What, then, is the advantage of using a chart that gives a distorted picture? The principal advantage is that the track of a ship holding a steady course can be plotted as a straight

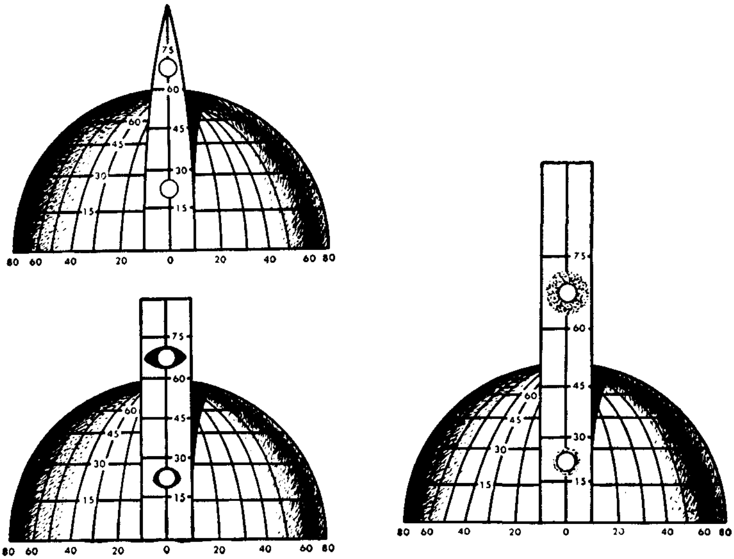


Figure 7–13.—The Mercator projection method.

line, called a rhumb line. Without this projection, only courses following a meridian (true north or true south) and a course east or west on the equator would appear on the chart as a straight line.

Measuring Distances

On a Mercator chart distances are measured against the latitude scales which appear on the left and right sides of the chart. One minute (1′) of latitude is equal to 1 nautical mile, so 1 degree (1°) equals 60 miles. Since minutes of latitude on a Mercator chart are farther apart as the latitude increases, the distance scale varies with the latitude. This means that it is extremely imporant, when measuring distances, to use that portion of the latitude scale directly to the right or left of the ship's plotted position.

Figure 7–15 is a section from the lower left corner of a chart. The latitude scale is to the left (west). With dividers, measure the distance from A to B on the latitude scale opposite

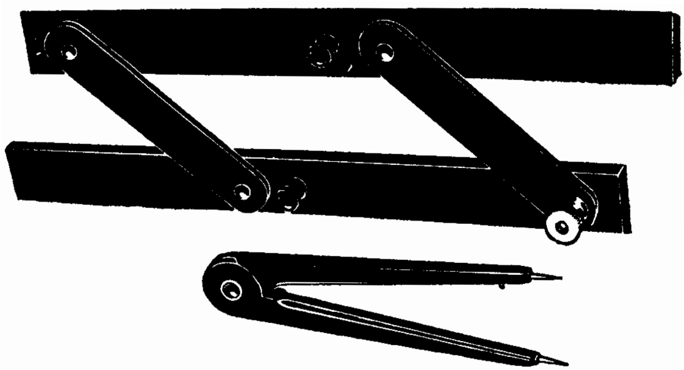


Figure 7–14.—Parallel rulers and dividers.

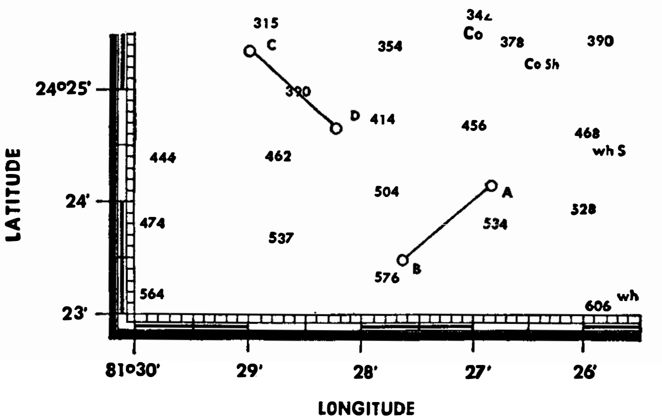


Figure 7–15.—Measure distances from the latitude scale.

points A and B. Also measure the distance from C to D from the scale opposite the latitude of points C and D.

Compass Rose

Once the true bearing of a radio transmission is determined, it can be plotted by stepping off the bearing from the compass rose which appears on every chart, or by using a parallel motion protractor.

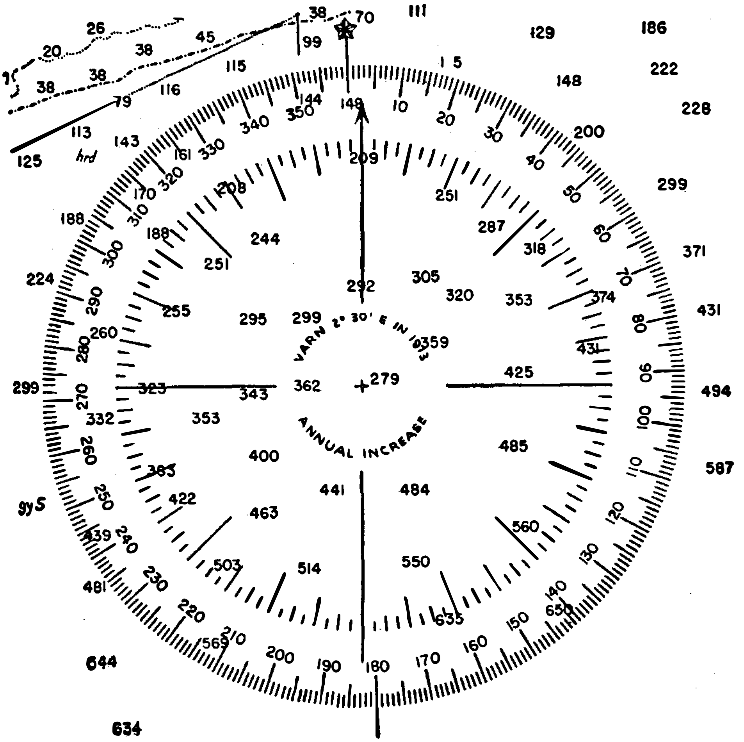


Figure 7–16.—Compass rose on a chart.

Figure 7–16 is an illustration of a typical compass rose. The outer circle is in degrees with zero at true north. The arrow in the inner circle points to magnetic north. Inside the rose is the variation for that locality, the date the variation was noted, and the annual change in variation.

Parallel Motion Protractor

The parallel motion protractor (fig. 7–17) consists of a range ruler mounted from the center of a bearing circle. This ruler can be set and clamped on any bearing. The bearing circle is attached to a linked arm and can be moved to any position

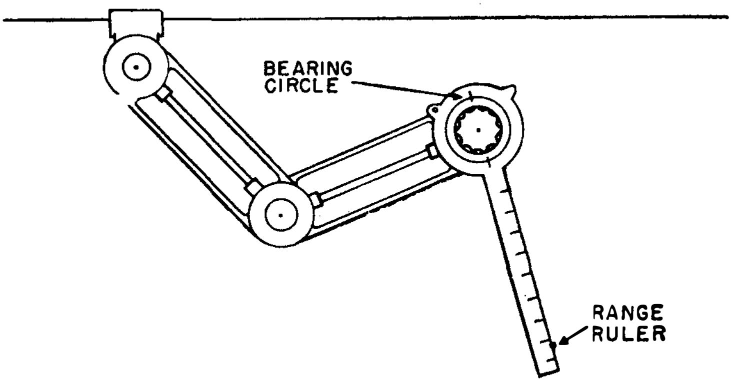


Figure 7–17.—Parallel motion protractor.

on the plotting board. Once the range ruler has been locked in place it will remain on the same bearing no matter how the protractor is moved. For example, if the range ruler is locked on bearing 045°, the protractor can be moved to several points on the plotting board, and a line drawn at each point. All lines will be parallel and all will bear 045°.

Reading the Chart

There are many symbols on a chart that provide the mariner with important information. A chart indicates the position and characteristics of lighthouses, lightships, radio beacons, buoys, and all necessary data for safe navigation. See figure 7–18 for some chart symbols pertaining to direction finding. In figure 7–16 the numbers scattered throughout indicate soundings in fathoms. At upper left of that figure there are four soundings of 38 fathoms joined by a broken line. The navigator refers to such a line as a fathom curve, in this case the 38-fathom curve. The condition of the bottom is indicated in two places in figure 7–16: *hrd* (hard) and *gyS* (gray sand). The meaning of every abbreviation used on charts can be found in H. O. 1, a hydrographic publication with the long title of *Nautical Chart Symbols and Abbreviations.*

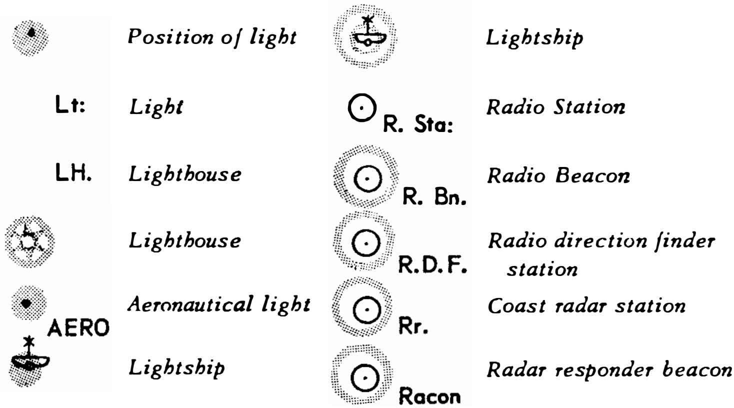


Figure 7–18.—Chart symbols pertaining to direction finding.

The Fix and the DR

In determining the position of a mobile transmitter, the first step is to establish the position of own ship at the time bearings are taken. The navigator and CIC maintain running plots of the ship's position at all times, and are prepared to supply the position as needed.

The ship's position is plotted through a series of "fixes" and by dead reckoning.

In navigation, a fix is an exact location derived from the intersection of two or more bearings. These may be visual bearings on terrestrial objects such as lighthouses, towers, etc., or on celestial bodies such as the sun or stars. Electronically, a fix can be obtained by loran and by radar.

Dead reckoning is a method of determining the position of a ship through the direction and distance traveled from a known point of departure. As a simple example, assume a ship's position has been fixed at 0800. She departs on course 180° true, steaming at 10 knots. One hour later, her 0900 DR position is 10 nautical miles due south of her point of departure.

At best, a DR position is only an estimate for it is calculated from values which seldom can be exact. Wind, current, erractic steering, and speed variations are all factors that contribute to the inaccuracy of a DR position.

The value of dead reckoning is that it affords a means of plotting a vessel's position at any desired time between fixes. Thus, a position is always available when a radio bearing is taken.

Plotting the Bearing

A little care and neatness is about all that's required for plotting a radio bearing. Assume a bearing has been taken on a radio transmission at 055° true, time 1200 GMT. Set the range arm of the protractor for the correct bearing, or step off the bearing from the compass rose with parallel rulers. Move to the position on the DR track which the ship held at the time the bearing was taken and draw a line away from the DR position along the line 055° true. Record the time (1200 GMT) above the line, and the bearing (055° true) under the line. A position by direction finder is not accurate enough to be considered a fix. Hence, a DF position when plotted is labeled EP for estimated position.

As mentioned previously, two ships operating at a distance sufficient to form an adequate baseline (as in antisubmarine warfare) can locate an enemy transmitter by taking simultaneous direction finder bearings. The time the bearings were taken and the position of each ship must be known. Bearings are plotted from the position held by each ship at the time the bearings were taken. The point of intersection of the bearings is the estimated position of the transmitter.

Frequently, direction finder plotting is restricted to a single bearing. While one bearing won't fix the position of a transmitter it can provide valuable information. The presence of a transmitter, the direction from which the transmission came, and frequency and other characteristics of the wave comprise the type of information obtained from a single bearing. In addition, a single bearing can be combined with other information—a DF bearing by another ship or a later bearing by the same ship—to provide an estimated position of the transmitter.

BEARING CONVERSION

Because the meridians on a Mercator chart have been projected as straight, parallel lines, the track (or rhumb line) of a ship holding a steady course cuts each meridian at the same angle. Actually meridians are not parallel, and a ship holding a steady course cuts each meridian at a different angle. As a result, a rhumb line is not the shortest distance between two points.

In direction finding, radio bearings are plotted as rhumb lines, but radio waves travel from point to point by the direct, or GREAT CIRCLE, path. For distances up to 50 miles there is no significant difference between rhumb line and great circle. After that, certain corrections, called bearing conversions, must be made.

Bearing conversion is essentially a navigational application of direction finding. The conversion tables, and the steps for converting, can be found in H. O. publication 205, *Radio Navigational Aids.*

M-F EQUIPMENT AND RADIOBEACONS

A medium-frequency band from 285 to 315 kilocycles has been reserved for maritime and aeronautical radio direction finding by international agreement. Marine radiobeacons transmitting in the band have been located as navigational aids all over the world. The radiobeacons transmit coded omnidirectional signals for use with the radio direction finders aboard ships or planes. The availability of a worldwide beacon system, the simplicity of marine radiobeacons, and the comparative simplicity of m-f direction finders have made the equipment standard on commercial craft of all sizes. In the United States, radiobeacons transmit in a band of frequencies from 150 to 520 kilocycles.

The United States and Canada have a coordinated plan of marine radiobeacon operation. Operating periods and group frequencies in a band from 285 to 315 kilocycles are assigned to all marine radiobeacons. A group consists of three beacons which are assigned the same frequency. Each beacon transmits its coded signal for 1 minute and is silent for 2 minutes, while the other two transmit in turn. In fog the group transmits continuously, each station in rotation and on its assigned minute—1 minute on and 2 minutes off. In clear weather the group operates the same way, but only for one or two 10-minute periods per hour. Operation of marine radiobeacons is explained in detail in Coast Guard light lists and radiobeacon charts, and in H. O. 205. The symbol RB_n designates a radiobeacon on Coast Guard lists and charts.

QUIZ

1. A ship is on course 359° true, and a radio signal is received bearing 270° relative. What is the true bearing of the signal?
2. What is the basic indication in all Navy radio direction finder systems?
3. What is the function of a sense antenna?
4. What is the cause of polarization error?
5. What is the principal advantage of the goniometer?
6. Why is the null position used in obtaining a DF bearing?
7. How can errors caused by reradiation be reduced?
8. How are meridians numbered? Parallels?
9. What is a ship's course plotted on a Mercator chart called?
10. What is dead reckoning?
11. How is a position by direction finder labeled on a chart?
12. What is the long title of H. O. 205?

CHAPTER 8

MAINTENANCE AND RECORDS

Maintenance procedures fall into two broad categories: actions taken to reduce or eliminate failure and prolong the useful life of your equipment, and actions taken when a part or component has failed and the equipment is out of service. These actions are identified by a number of terms that the *Bureau of Ships Manual* calls CATEGORIES OF MAINTENANCE. Generally, these terms refer to levels of difficulty of maintenance.

The simplest category—OPERATIONAL MAINTENANCE—is performed by an equipment operator who may not be a skilled technician. Operational maintenance, according to the *Bureau of Ships Manual,* "consists normally of inspection, cleaning, servicing, preservation, lubrication, and adjustment, as required, and may also consist of minor parts replacement not requiring high technical skill or internal alignment." The next level of maintenance, TECHNICAL MAINTENANCE, requires technical skill and detailed knowledge of equipment.

The instruction book for the particular equipment is the most important source of maintenance information. It supplies details of operational and technical maintenance although these maintenance terms, as such, are not used in the instruction book.

You should first be thoroughly familiar with each type of communication equipment so that you can demonstrate proper maintenance techniques to your men. This chapter describes general maintenance procedures such as lubrication, cleaning, and inspection, and shows you how to keep and submit accurate records and reports on your equipment.

EQUIPMENT IN GENERAL

Of necessity, maintenance procedures vary with different communication equipment. Some equipment requires almost constant attention. Other equipment requires only infrequent adjustment. There are certain items common to most equipment, however, with which you should be familiar.

Make a practice of checking all operating controls daily, noting binding, excessive play, and loose knobs. Check also for loose cable couplings or bonding straps, burned-out pilot lights, missing spare fuses, and broken meter glasses. Your operators should correct these items whenever detected.

Have all external surfaces dusted daily. Interiors of equipment should be cleaned carefully at weekly intervals with a soft cloth, if appropriate, or a vacuum cleaner. Avoid use of a bellows or compressed air. There is danger of blowing dirt and other foreign material into inaccessible places.

COMMUNICATION RECEIVERS

Every receiver must meet certain requirements of sensitivity (ability to pick up weak signals), selectivity (ability to reject undesired signals), and fidelity (ability to reproduce a signal faithfully without distortion). You should be able to note any deviation from normal operation. A technician should check periodically for these qualities by using test equipment provided.

Make a habit of testing each idle receiver daily to see if the gear is in working order. In this way you will be sure it is always operating properly, thus avoiding the unpleasant experience of finding it inoperative when it is most needed. It is advisable to check the speed of rotation of receiver power supply motor generators at least weekly. Do this to see if the motor speed is up to standard rpm. If not, it will be easier to determine the cause and fix it before the generator fails. Of course, when you are being supplied a-c power from the ship's main generators, the need for this check is eliminated.

Check radio direction finder calibration curves on at least five points and on at least three frequencies, using transmitting stations or bearings which can be determined accurately by visual or navigational means. Vary check points and frequencies as may be practicable in subsequent monthly tests.

The mechanical calibration of the direction finder may be checked by comparing the readings of the direction pointer and the checking scale on the handwheel to see if the differences agree with the original calibration data. If necessary the radio calibration can be checked by taking simultaneous radio and sight bearings on a radio beacon or ship station at several points around the indicator dial.

Measure receiver noise level in each band according to current instructions issued by the Bureau of Ships.

For example the receiver noise level may be determined by comparing the noise output voltages with the normal receiver noise values tabulated under corrective maintenance in the receiver instruction book.

All sliding mechanical contacts should be lubricated lightly with nonfluid mineral oil or vaseline. Be sure all excess lubricant is wiped off, because dust or lint will collect on the parts and leave them in worse operating condition.

For quarterly inspections and tests, make sensitivity measurements of all receivers in accordance with current instructions, and record the results of these tests prior to and after any corrective action.

Check operation of the receiver silencer and volume controls. Vulnerable points are controlling toggle switches, potentiometers, and electron tubes. Most trouble will be experienced with toggle switches. They are operated so seldom and carry and break such small voltages and currents that the small amount of oxide occurring on their contacts may render them inoperative. Periodic operation for a few minutes usually keeps these switches in good shape. Clean switches when their contacts become oxidized. Potentiometers and rheostats usually open-circuit due to wear. When this occurs, they must be replaced. Limited electron tubes are used as rectifiers only, and are critical only to low emission and low gas content.

Check the calibration of each receiver for operating frequency in actual use or for which the receiver is standing by. The calibration should be checked by an accurate frequency meter such as the LM-18 in the manner prescribed by the instruction books for these instruments. As most receivers have a slight frequency drift with time and temperature changes, they should be turned ON for at least one-half hour before checking.

Measure the receiver noise level at the operating frequency in actual use or for which the receiver is standing by. Record the results of the test prior to and after corrective action, if any, has been taken.

COMMUNICATION TRANSMITTERS

There are many visual indicators of equipment operation and adjustment on the front panel of most transmitters. These indicators are voltmeters, ammeters, pilot lights, oscilloscopes, etc. Correct interpretation of these visual indicators results in a true indication of the over-all condition of the equipment.

Prepare a log of control settings and optimum meter readings for various frequencies for each transmitter in the shack. Reference to these optimum readings at frequent intervals will help detect failing tubes, poor adjustments, and other equipment trouble before serious malfunctions develop.

Many cases of frequency instability can be traced directly to malfunctioning oscillator heater circuits, particularly in master oscillator types of transmitters. Include a daily check of master oscillator or crystal compartment temperatures as part of your maintenance routine.

Periodic cleaning of the interior of transmitters and other equipments employing high voltage is particularly important. Potentials in excess of 3000 volts are often present in these equipments, and dust on insulators or other high-voltage components forms a convenient path for arc-overs and consequent damage. In addition, a mixture of dust and lubricant forms an excellent abrasive, which can do considerable damage to moving parts.

In troubleshooting transmitters, determine which visual indicators are affected by the trouble. Then pick out the one which controls the others or which would have the most effect on all the others. For instance, a plate-starting relay will control a plate-running relay and unless it (the running relay) closes, the plate voltage will be low.

Again, both the generator field relay and an overload relay may be open. The overload relay may control the field relay. There will not, as a rule, be any indication of plate current if there is no indication of grid current and they will both be affected by a bad tube.

In the circuit of the one device which seems to control all the rest, pick out the most likely sources of trouble and check them visually or with an ohmmeter. Use the ohmmeter if possible.

If checking these does not disclose the source of trouble, check the rest of the circuit, paying particular attention to terminal contacts, wires, relay coils, capacitors, etc.

Keep These Rules in Mind

1. Always take proper precautions when working on high-voltage circuits. Never work alone.
2. Never trust a bleeder resistor to drain a filter capacitor of its charge. It may open up and cause fatal shock.
3. Always reset the overload relays. Remember, there is probably one in the starting box.
4. Always be sure that switches are seated properly. Many of them carry auxiliary contacts which make the transmitter inoperative if they do not make contact.
5. Remember that the meter may be at fault.
6. When the transmitter fails to key, always check the keying relay, both the plunger and contacts, before looking anywhere else for the trouble.

NOTE.—Be sure to review the chapter on safety in the *Radioman 3 & 2* training course, and chapter 67, sections 67-281 to 67-313, of *BUSHIPS Manual,* to refresh your knowledge of basic safety precautions.

THE ELECTRON TUBE

A common cause of failure or poor operation of equipment is the electron tube. To complicate the picture, a tube may be performing below standard, but its weakness will not be apparent in a tube tester. This may be caused by the fact that the signal applied to the tube tester is a 60-cycle sine wave, whereas in the equipment many wave shapes may be applied at frequencies varying from a few cycles to several million cycles per second.

No shipboard tube tester can determine accurately the ability of a tube to act as an oscillator or as an ultra-high-frequency amplifier. Many tubes which check "good" in a tube tester will not perform properly in actual service. Similarly, some tubes which are operating satisfactorily in service will check "bad" in a tube tester.

In certain critical circuits, replacement of a tube by another of the same type will result in detuning and poor performance of the equipment because of the slight differences in the characteristics of the two tubes. These differences are not likely to be detected by a tube checker.

Finally, there are many tubes aboard ship which cannot be tested in an ordinary tube tester, notably high-powered transmitter and modulator tubes, Klystron oscillators, and magnetrons.

For these reasons, the following policy for testing electron tubes is suggested:

1. Never test tubes as a matter of routine. The results obtained will not justify the work and time involved. Test tubes only when the equipment shows signs of improper operation, and be skeptical of results unless the tube is shown to be completely bad.
2. In testing tubes, be sure that each tube is replaced in its original socket to avoid detuning critical circuits. To put a tube of one type into a socket designated for another type is to court disaster. This is quite easy to do since so many different tubes are designed to fit the standard "octal" socket.

ANTENNAS

Major enemies of antenna systems are corrosion caused by salt spray or stack gases, paint on insulators, and mechanical damage such as broken strands, parted couplings, and broken mounting brackets. If all these areas are included in your maintenance program, you will get maximum radiation and reception efficiency.

Many general-purpose antennas are made of phosphorbronze wire rope. This material has a high degree of resistance to damage from the elements but does require a certain amount of preventive maintenance.

At frequent intervals, antennas should be lowered and inspected for signs of deterioration, particularly at clamps and where they connect to trunks or transmission lines. Nicks and kinks should be avoided, as the wire will be weakened at these points. It is a good policy to wire-brush antennas while they are down to remove soot and salt deposits and repair or replace any weak or broken strands. Insulation-type receiving antennas should be wiped rather than brushed to prevent damaging the insulation. Whip antennas are usually hollow and have a tendency to collect moisture inside. Whips should be inspected while down for rust spots or loose sections. Mounting straps and stand-off insulators should be checked carefully for breakage or deterioration, as well as cleanliness.

Dipole antennas may have one input grounded, while the other is connected to the inner conductor of the coaxial line. Any insulators on the dipole should be carefully cleaned of any paint, salt, or soot deposits. Care should be taken not to damage the glazed surface of the insulators. The mechanical condition of the dipole should also be checked at this time. Guard against loose mountings and rust spots.

Give special attention to the TBS antenna. The antenna itself is of the quarter-wave vertical type with ground plane. The lower section of the antenna support contains a grounded concentric section of the radiator. Inside this section will be found one or two circular insulators of a ceramic material with a tendency to collect moisture over a period of time. Moisture at this point may short the insulator, which in turn will detune the antenna. This will result in a mismatch between the antenna and the transmission line, with consequent poor performance of the system. Many complaints of poor TBS performance have been traced directly to this one insulator. Accordingly, the TBS antenna should be periodically disassembled and the insulators cleaned and checked.

For insulation and waterproofing, use ignition-sealing dielectric compound. This material is vaseline-like in color and consistency. It is invaluable as an electronic sealer, moisture repellent, and antiseize compound. As its dielectric constant is very high, it may be safely used at high RF potentials. A thin coating of this material on a clean insulator helps prevent formation of salt or soot deposits and repels moisture. It may also be used in assembly of coaxial fittings to prevent entry of moisture. A word of caution: Do not apply dielectric compound to polyethylene dielectric which is bent and under stress, for the polyethylene will crack, causing voltage breakdown.

Other commonly used insulating and waterproofing materials are silicone and conducting rubber, vinyl tapes, and insulating varnishes. Always use vinyl tape with recommended insulating materials for a particular cable or connector. Used alone over a connector, vinyl tape is not considered sufficient waterproofing. Insulating varnishes may be applied by dipping, spraying, or brushing.

Safety Precautions

Before working on antennas get permission from the CWO and the OOD. When work on the antennas has been completed, inform the OOD and the CWO that you are through working aloft.

While antennas are energized by radio transmitters, men are not permitted to go aloft except by ladders and landings made safe by grounded handrails or similar structures, unless it is definitely determined in advance by suitable tests that no danger exists. This will prevent casualty due to involuntary relaxation of the hand, which might occur if a small spark is drawn from a charged piece of metal or section of rigging. The spark itself may be quite harmless. Safety belts are always worn by men working aloft.

Men are not permitted to work on any antenna when that antenna or other antennas in the immediate vicinity are energized by radio or radar transmitters, unless it is definitely determined in advance that no danger exists. On board ship "other antennas" means any antenna on board a ship moored alongside, across a pier, or at nearby shore radio stations. Circuits opened to deenergize equipment must be tagged to prevent their being closed while your men are working on the gear. Provide warning signs and suitable guards to prevent men from coming into accidental contact with high voltages.

HF Operating Hazards

High-frequency transmitters must not be operated on frequencies in excess of 10 mc when the radiating portions of antennas connected to such transmitters are less than the following distances from the hazard centers defined below:

Rated power of transmitters	Distance *(feet)*
50 watts or less	15
51 to 200 watts	25
201 to 1000 watts	50
Over 1000 watts	75

The radiating portion of an antenna includes the entire exposed section not enclosed in a trunk or tube such as employed in a concentric transmission line. This does not apply to shielded and grounded shipboard installations.

The following are examples of hazard centers:

1. All guns fitted with electric firing circuits, either during the process of loading or in the loaded condition.
2. All guns using separate ammunition, percussion or electric firing, during the process of loading.
3. Gasoline fueling operations, such as delivery of gasoline from hoses, spouts, cans, etc., or any place where gasoline vapors are present.
4. Aircraft employing unshielded flare circuits whenever flares are installed.
5. Powder-handling operations when open tanks and exposed powder are utilized.
6. Oil fueling operations during the interval of time required to make or break metallic hose connections.

MOTORS AND GENERATORS

In general, precautions should be taken to protect motors and generators from moisture, dirt, and friction. Particular attention should be given to removing carbon dust caused by brush friction on sliprings or commutators. Carefully remove dust from around commutator segments, sliprings, windings, and brush rigging. Use a vacuum cleaner or other suction device rather than compressed air for cleaning, to avoid blowing paint chips, carbon dust, or other foreign material into the windings or bearings. In addition, motors and generators should always receive adequate ventilation so that operating temperature will not rise above the safe level. Proper cleaning of windings, brush rigging, commutators, and sliprings will generally ensure adequate ventilation.

Bearings

Bearings are probably the greatest single source of trouble in motors and generators. Failure of most bearings is caused by the presence of foreign material or lack of proper lubrication, rather than overload. Most bearings are of the sleeve, ball, or roller type, and in most cases have some means of lubrication. Applicable instruction books will list the proper grade of lubricant and approved method of application.

In the case of pressure-lubricated fittings, there is only one correct method of lubrication. The bottom drain plug at the base of the bearing housing should be removed first, then lubricant applied through the fitting or grease cup. Keep a close watch to prevent excessive lubrication endangering insulation of winding or commutator. When fresh grease begins to flow out the drain hole, replace the plug. Grease should never be forced into a bearing unless the drain plug is removed, as a great deal of pressure is built up by grease guns and cups. The grease may easily be forced past the retainers into the windings and brush rigging.

Bearings should be flushed once a year with hot, light oil or kerosene applied through the lubrication fitting with the drain plug removed. After flushing, remove all traces of the kerosene by running a light mineral-based lubricating oil through the

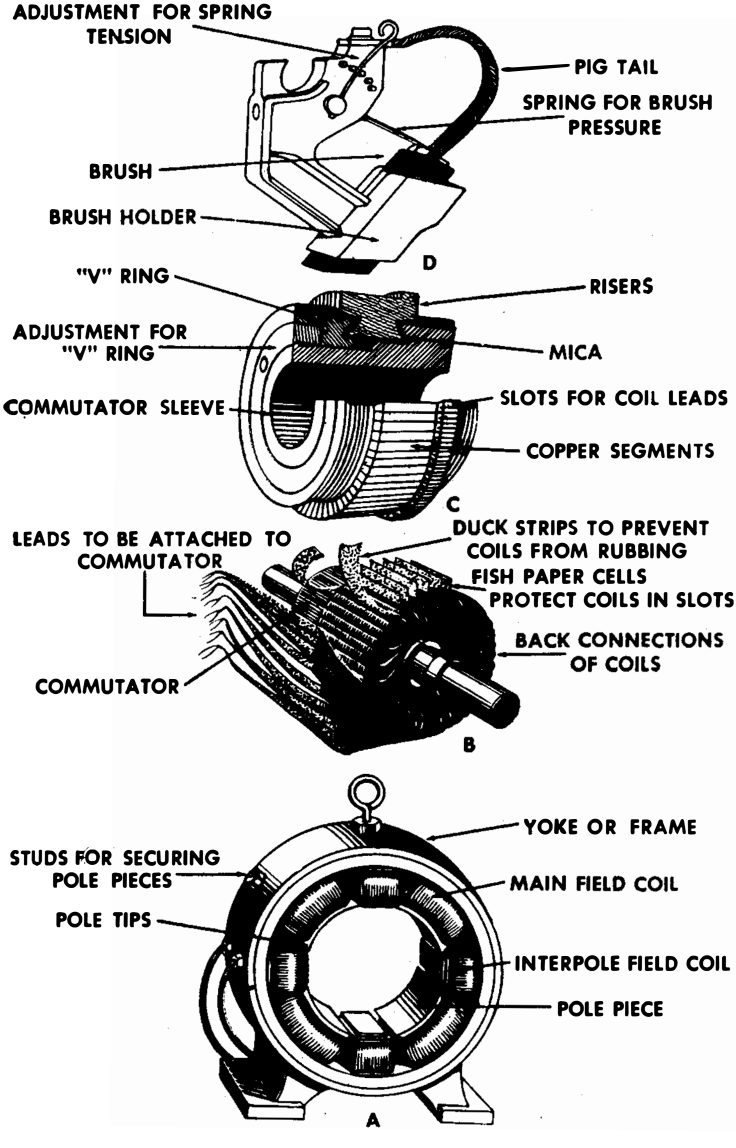


Figure 8-1.—Parts of a generator.

bearing several times. Kerosene should never be allowed to remain in a bearing, as it is highly corrosive. The bearing is then relubricated in the normal manner.

Bearings of the so-called sealed type should be checked periodically. Repack bearings of this type by carefully removing the dust seals on either side of the bearing, flushing in kerosene, washing in oil, and repacking with the proper grease. The seals should then be replaced.

In the case of sleeve-type bearings, such as those found in small motors and dynamotors, a drop of light machine oil should be placed in the oil holes periodically. Care should be taken not to mix dissimilar oils or to overlubricate.

Brushes and Holders

Brushes and holders should be inspected frequently. The brushes should not only move freely in their holders, but they should make firm, even contact with the commutator or slipring surface. Brush springs should exert a firm, even pressure on the brush ends in line with the brush axis, and pigtail connectors should always be tight. Remove brushes from their holders periodically and wipe off any carbon dust which may have collected. If dust is allowed to collect, it will often jam the brush in the holder, resulting in excessive sparking at the commutator or slipring surface as the brush wears down. While the brushes are removed from their holders, inspect the brush faces for shiny particles of copper from the commutator or sliprings that may have become embedded in the faces. All such foreign particles should be removed to prevent scoring of commutator or sliprings.

The spring tension on brushes should be checked frequently with a spring scale. Information on proper tension and method of adjustment is found in the applicable instruction book.

Commutators and Sliprings

Commutator or slipring surfaces should be kept free of dust and grease at all times. A smooth, dull, chocolate-colored coating on the surface of the sliprings or commutator where the brushes ride is normal and should not be disturbed. Any light scoring of this surface is usually caused by copper particles embedded in the brushes. The particles should be carefully removed from the brushes. A piece of light canvas wrapped around a suitable wooden block held against the commutator or sliprings for a short time while the machine is running will do much to keep the surfaces in good condition. If the surfaces are slightly scored or pitted, a commutator dressing stone held against the surface while it is rotating will usually clean it.

A periodic check of the insulation resistance of the various windings is essential to continued operation. Reference should be made to the applicable instruction book diagram to determine the best method of procedure in each case. In general, the amount of resistance between each winding and ground should be determined first, then the insulation resistance between one winding and another.

The most suitable instrument for determining insulation resistance is the familiar megger. A log of megger readings should be kept for each machine, and should include a description of the method by which the readings were taken. A suitable form for this record is the NAVSHIPS 531 Antenna Megger Card.

Any marked decrease in insulation resistance from what has been previously determined as normal for a given machine should be investigated immediately. Investigation usually will show that a low resistance reading is caused by moisture in the windings. If such is the case, an attempt should be made to dry out the machine. This may be accomplished by enclosing the machine in a canvas cover under which has been placed a series of light bulbs or space heaters. A vent hole should be left in the cover to allow the escape of moisture. Insulation resistance readings should be taken at intervals during the heating process until either consecutive readings show no change in resistance, or optimum resistance has been obtained.

Lubrication

The life of any motor or generator depends to a great extent upon the lubrication it receives. Oil and grease wear out and new lubricants must be added when necessary. Light, thin oi.

forced into a rapidly moving part will not last as long as the heavy grease used to lubricate slowly moving gear. This fact makes it essential that you inspect some parts more often than others, and here's where Navy lubrication charts come in handy. The Navy, through various manufacturers, furnishes lubrication charts for all its equipment. These charts show how often certain parts require lubrication under particular operating conditions, and the amount and type of lubricant to use. Lubrication charts are the result of years of research and experiment and should be followed as closely as possible.

Adequate lubrication is a necessity, but it can be overdone. Too much oil is almost as bad as not enough. Excess grease will cake up, gather dust, and hinder efficient operation. A thick covering of grease, oil, and dust will cause a motor to heat, making it a fire hazard. When oil cups are allowed to run over, the oil will drip into the brush riggings and field coils, often seeping into the commutator windings and causing real trouble. A high-grade lubricant will last about 60 days under normal conditions, but operating equipment must be inspected daily to make sure it is receiving adequate lubrication.

A heavy lubricant cannot reach a small, rapidly moving part, and a light oil will flow past a heavy, slow-moving gear. In cold weather, a heavy oil will become too thick to flow, and a lighter grade must be substituted. In hot weather a thin oil will become thinner and lose much of its lubricating power.

A few motors and generators have a regular pressure relief lubrication system that makes the lubricating job easy. It is not necesssary to disassemble a motor to check the amount of grease in the housing, and grease doesn't have to be removed since it is forced out of the housing as the new grease is put in. Routine greasing doesn't interfere with normal operation and overgreasing is prevented. There is one thing to remember about pressure relief lubrication: Always remove the relief plug before additional grease is forced in, else the extra pressure may force grease along the shaft into the commutator.

Figure 8–2 on pages 228 and 229 lists lubricants in general use in the Navy and which usually can be obtained aboard ship or at shipyards. The list gives various container sizes avail-

Specification No. and title	Sizes available	Stock No.	Commercial designation *	Remarks
MIL-G-16908 Grease; ordnance, bearing and ammunition.	5 lb. 35 lb.	WF9150-235-5542 WF9150-272-7655	Grade I	Use in lieu of MIL-G-3278 when neoprene will be in contact with grease.
MIL-G-3278 Grease; aircraft and instrument.	½ lb. 1 lb. 5 lb. 25 lb.** 35 lb. 100 lb.***	WS9150-261-8297 WS9150-261-8298 WF9150-223-4012 WR9150-190-0897 WR9150-190-0898 WS9150-190-0899	Grade II	MIL-G-3278 is destructive to paint, natural rubber, and neoprene. For high and low temperatures.
MIL-G-18709 Grease; ball and roller bearing.	1 lb. 5 lb.	WM9150-235-5564 WM9150-235-5544	Grade III	
VV-P-236 Petrolatum; technical.	1 lb. 5 lb. 400 lb.***	WS9150-250-0926 WM9150-250-0933 WM9150-244-4868	Petrolatum	
VV-401 Oil. Insulating; for transformers, switches, and circuit breakers.	5 gal.	WM9160-261-7907	5W	
MIL-L-17331 Oil; lubricating for turbines.	5 gal. 55 gal.	WM9150-230-9061 WM9150-235-9063	30	Military symbol 2190T, noncorrosive.

MIL-L-9000C Oil; lubricating, internal combustion engine, and diesel.	5 gal. 55 gal.	WF9150-231-6653 WF9150-231-6655	30	Military symbol 9250, class B.
MIL-L-6085 Oil; lubricating, aircraft, and instrument.	1 pint	WF9150-231-6686	---	Low volatility. Destructive to paint, neoprene, and natural rubber.
MIL-L6086 Oil; low temperature gear.	1 gal.	WS9150-265-9417	10W	Grade L
	1 pint 1 gal.	WR9150-240-2235 WS9150-223-4130	20W	Grade M
MIL-L-15016 Oil; lubricating; general-purpose.	1 pint 5 gal. 55 gal.	WS9150-235-5575 WS9150-235-5571 WS9150-235-5573	10W	Military symbol 2075. Use in lieu of MIL-L-6085 when oil will be in contact with neoprene.
MIL-2105 Lubricant; gear, universal.	5 gal. 55 gal.	WS9150-240-2242 WS9150-240-2245	75	Grade 75
	5 gal. 55 gal.	WS9150-240-2246 WR9150-240-2249	80	Grade 80
	5 gal. 55 gal.	WM9150-240-2250 WM9150-240-2253	90	Grade 90
P-S-661 Solvent; dry cleaning.	5 gal.	WM6850-S-4718-10 or G51-S-4718-10	Stoddard	Type II

* Oil—SAE number; Grease—NLGI grade. ** Special containers. *** Special drums.

Figure 8-2.—Lubricants in general use.

able as well as stock numbers for each. Lubricants similar in viscosity to those listed are sold commercially. If an extreme emergency arises, they may be used as substitutes for Navy lubricants. The commercial designations are given in column 4.

If none of the suggested emergency lubricants are available, any lubricant is better than none. However, never use an animal or vegetable oil, or grease.

In summary, follow these few rules in lubricating your gear:

1. Establish and adhere to a schedule of lubrication inspection.
2. Use only the lubricant prescribed in a specific instruction book, maintenance manual, or lubrication chart.
3. Use only clean lubricants.
4. Do NOT OVERLUBRICATE.

To give your men additional information on the how and why of lubrication, arrange for a showing of the training film on lubrication: MN–6942.

Inspections

Careful inspection will do much toward eliminating motor and generator troubles before they begin. It is necessary that specific inspection periods be set up and that all necessary precautions are taken to ensure proper maintenance. Routine inspections are established according to the needs of a particular motor, but general inspections are divided into daily, weekly, quarterly, and semiannual inspections.

DAILY.—Examine each motor and generator thoroughly and note the condition of the commutator, oil cups, rings, and bearing temperature. Check for the presence of dust and other foreign particles in the motor.

WEEKLY.—Operate each idle motor generator for at least 30 minutes, checking its operation and making sure that no troubles have developed that would impair its efficiency. Inspect each unit for sparking at the brushes. See that the commutator is clean and that the brushes are adjusted properly and running smoothly. Check the brush pressure and clean brush rigging, but don't allow dust to fall into other parts of the motor. Check the starting panels and see that they are clean.

QUARTERLY.—Go over the lubrication points of the motor, checking with the lubrication chart to make sure you don't pass up any important points. Drain oil wells and flush with kerosene. Blow each unit with dry compressed air, using a hand bellows. Dust off brush rigging and remove any dust lodged between conductors or commutator bars.

SEMIANNUALLY.—Check insulation for evidence of wear or breaks. Examine the commutators of all spare armatures, giving each a quarter turn to prevent sagging.

MOTOR-STARTING PANELS

When you start a motor that is controlled by an automatic contactor panel, be sure all starting resistance has been cut out by the end of the starting period. If an accelerating contactor fails to close, the condition will probably be indicated by the failure of the motor to build up to its normal speed. Failure of one of these contactors will leave some starting resistance in the armature circuit which, if not removed, will soon overheat and burn out part of the armature.

Protective devices on panels are installed to prevent overload and shorts that may injure a motor and necessitate expensive overhaul. These devices are essential to safe motor operation and should be inspected and tested frequently. When you go over the protective devices, check the operation and sequence of the contactors, since the failure of one contactor may disable the entire panel. Keep the flexible connector terminals tight; check for open circuits. See that flame deflectors are properly placed to prevent a spreading arc, and keep inflammable substances out of the panel. Keep the panel clean and dry, and lubricate sparingly. When panels not in use are equipped with doors or covers, keep these doors and covers closed. When dust and moisture are kept out, necessity for repairs is reduced.

It is necessary to keep the spring on the starting rheostat arm strong enough to throw the lever to the OFF position in case of current failure. Contact buttons should be tight and of uniform height, and sliding contacts should be smooth and bear evenly on the contact buttons. The overload and no-voltage pins, the starting lever shaft, and solenoid contact blocks should be dismounted occasionally and cleaned with very fine sandpaper. Contacts kept bright and free from dust or paint will operate with little danger of sticking.

CIRCUIT BREAKERS

Go over circuit breakers and contactors frequently to make sure the contacts are in good condition and that all connections are tight. If a contact is burned, it should be smoothed down with a file or renewed if necessary. Laminated brushes should be lubricated with a light film of vaseline and hinge pins should be given a few drops of medium-weight oil. Do not lubricate the copper or carbon arc-rupturing contacts. Have levers working smoothly, as they may stick and keep a breaker from opening. Check circuit breakers to make sure they will break the circuit at the limiting current for which they are set.

RHEOSTATS

Rheostats are more likely to short-circuit than any other panel accessory, so give them extra attention. In addition to keeping them dry and free from dust, all exposed surfaces should be wiped frequently to keep down surface leakage. When these surfaces crack, they should be renewed. If the rheostat gets wet it must be thoroughly dried before being put back in operation. The drying process can be speeded up by passing a low current through the rheostat, keeping it warm until all moisture has been expelled. When the rheostat is dry the insulation resistance reading will be about 1 megohm or better.

SWITCHES AND FUSES

Keep all switch clips smooth and tight to ensure good contacts. Switches are designed to give a much lower value of amperes per cross section than are the cables that enter or leave them. However, switch temperature will rise rapidly when the clips are loose or the contact areas are rough.

Fuses can be a source of trouble when they are not used or replaced correctly. A fuse should have a carrying capacity about one-third higher than the normal current it is designed to protect. To ensure tight, adequate contacts, if you are using renewable fuses, the fusible element should be installed in a shop where the light is good and where other facilities are available. Unless an immediate emergency exists, a blown fuse should always be investigated to find the cause of the current overload. Never use fuses of a higher capacity than the one replaced, and avoid increasing the circuit breaker setting without first inspecting the defective circuit.

PANEL CLEANING

Panel-type controllers should be cleaned frequently with a painter's brush. If some particles will not brush off, remove them with a flannel rag or chamois, making sure no lint is left in the connections. If moisture is present, it should be removed with a cloth. The panel must be baked if moisture is excessive. Remember that surface moisture acts as a conductor, and its presence will often account for low-circuit insulation resistance readings.

Since you must go over the panel to clean it, it is advisable to take care of your periodic inspections at the same time. Tests are divided into the following periods:

DAILY.—Check each control appliance actually in use by checking a few cycles of its operation to make sure it is functioning satisfactorily.

QUARTERLY.—Go into the back of the panel and check those spots that are hard to reach. If the panel is clean, shows no local heat, and the insulation resistance is good, it should not be dismounted if operating satisfactorily. If these conditions are not met, however, the panel should be pulled down to correct the defect.

ANNUALLY.—Shut off all power on the main power and distribution boards. Give each a thorough examination for chafing, loose nuts and connections, and breaks in insulation. Blow out dust and dirt and make an entry of your inspection in the machinery history.

When you work with motors, generators, or their starting panels, always be sure to keep all protective devices in good working order and at their designed settings. Covers for all parts of the machine or its control panel should remain closed. All gaskets must be in good condition and free from paint. In the end, the longevity of your motor or generator is a matter depending on your own common sense. It stands a good chance of a long life if you operate it sensibly, lubricate it properly, and KEEP IT CLEAN.

STOWAGE OF REPAIR PARTS

On ships where repair parts are under the custody of the supply officer, you will not be too concerned with stowage. On some of the smaller ships, however, where repair parts are under the custody of the department head, you will undoubtedly be concerned and will have to make a plan for the stowage of such repair parts.

A plan for the stowage of repair parts should be governed by the following factors:

ACCESSIBILITY.—Stow frequently used repair parts in places of easy access. Make sure repair parts which may be required while the ship is underway are easily obtainable.

PROTECTION.—Ensure that parts subject to damage by dampness, vibration, heat, or shock are favorably located. Protect yourself against loss of small parts by providing containers.

IDENTIFICATION.—Check to see that all repair parts are adequately marked and described when received to avoid possibility of loss through failure to recognize the part at a later date.

LOCATION.—Keep a record of the location of all repair parts. Such a record eliminates unnecessary delays in effecting repairs.

Suggested Stowage Plan

Most ships consider the four factors above when planning for stowage. In the bin system, for example, one or more spaces are equipped with a series of drawers that provide orderly stowage and maximum protection for spares.

Drawers in bin stowage are filled according to the stock number of the parts. Generally, the lowest numbered parts are placed in the upper left drawer. Stowage of others follows in numerical order from top to bottom and from left to right. A spare can be located quickly by simply using the correct stock number.

MAINTENANCE SCHEDULING

Shortage of technical personnel and lack of communicators trained in maintenance work mean that there is no time to waste. The communication officer relies on you to make maximum use of the limited time available for maintenance. To be effective, your methods must be systematic. You must be sure that prescribed items of work are accomplished at regular intervals.

POMSEE

A simple yet systematic approach to maintenance scheduling is through use of the *Performance Standard Sheets* and *Maintenance Standards Books* for each equipment. These aids are the result of a program called POMSEE, short for Performance, Operational, and Maintenance Standards for Electronic Equipment. Use of these aids enables your operator or striker to perform the important routine maintenance work on his equipment. The manuals are handy also for you, the supervisor. They make it relatively easy for you to insist that checks are performed correctly, and at the proper time. These manuals, which supplement rather than replace the all-important equipment instruction book, are now available for your TDZ, RBA, RBB, and most other communication equipment.

Performance Standard Sheets provide the operational performance data and basic technical measurements indicative of the minimum acceptable level of performance for electronic equipment. A binder, titled "Binder for Electronic Equipment Performance Standard Sheets (NAVSHIPS 93000)," for incorporating all sheets required on a ship under one cover has been distributed to all ships.

Maintenance Standards Books provide standard methods for determining measurements affecting the performance of a specific equipment, space to record such measurements, and a preventive maintenance schedule for the equipment. The *Maintenance*

Standards Books include Part I—Test Procedures and Maintenance References (formerly Performance Standards Book) and Part II—Preventive Maintenance Check-Off (formerly Maintenance Check Off Book). Operating Instruction Charts were originally published and distributed with POMSEE Publications.

All *Performance Standard Sheets* and future editions of *Maintenance Standards Books* covering installed equipment will be distributed directly to the ship concerned based on the inventory reported on NAVSHIPS 4110. Additional copies will be carried in stock at the nearest Bureau of Supplies and Accounts Forms and Publications Supply Distribution Point. The sheets and books for new equipment under production will be distributed with the equipment in the same manner as the technical manuals.

The current status of available POMSEE publications and their NAVSHIPS numbers are given in Electronics Information Bulletin No. 456. The availability of future sheets and books is announced from time to time in the Electronics Information Bulletin. POMSEE publications may be requisitioned from the nearest Bureau of Supplies and Accounts Forms Publications Supply Distribution Point.

The POMSEE aids can be very helpful to you in the maintenance of the operating reliability of your radio equipment. You can assure this reliability through your constant attention to the equipment as operational maintenance supervisor. You must assign the various routine daily, weekly, monthly, etc. checks to your operators and strikers and assure their systematic performance of these checks. In this way, you will be able to eliminate many of your equipment troubles before they happen. In some cases, you will need to get the leading ET to give you full technical assistance due to the complexity of the difficulties located by you or your men. In even rarer cases the ET's will not be equal to the problem at hand and it will be necessary to get immediate assistance from the nearest METU (Mobile Electronic Technical Unit), tender, shipyard or ship-in-company. The point is that in most cases you will be the first to be aware of equipment difficulties; the urgency of the remedial action taken must be according to the immediate need for the particular equipment. You never want to let inoperative equipment alone without remedial action, but on gear you need right away you must follow through on it very closely. Dont leave it to someone else; SEE THAT THE GEAR IS FIXED!

You will have to work rather closely with the leading ET. He can give you a lot of help if you keep him posted on your problems and needs. You can also save him a lot of time by seeing that your men do their POMSEE work properly and do not get the ET's involved on elementary things involving cleaning, lubrication, etc. It is surprising how many electronic troubles come about through lack of even the most elementary routine care of equipment. Your consistent supervision and use of POMSEE will go a long way toward giving your radio gang a fine reputation for communications reliability.

Working with the leading ET, you must assure that some key things are done in connection with the POMSEE program of your ship.

1. Make sure that all POMSEE aids are on board. If books are not yet available for some of your equipments, make sure that you get these books as soon as they have been issued. In the meantime, improvise an effective routine maintenance for the equipments concerned.
2. In the case of some equipments for which you already have POMSEE books but for which all test equipment required in these books is not on board, GET THE TEST EQUIPMENT. It will be impossible in many cases to give adequate care without proper test equipment. If the test equipment item cannot be furnished by the Naval Supply System, your ship can procure immediately an acceptable commercial version upon receipt of proper authorization.
3. Make sure that the test equipment used by your men is always in proper calibration and adjustment. The ET's will get this done. However, remember that checks performed with inaccurate test equipment will be worthless.

4. Remember that the recorded readings in the *Maintenance Standards Book,* Part I, tell you the level at which your equipment once performed and the level at which it will continue to perform IF MAINTAINED PROPERLY.

Importance to Supervisor

With POMSEE you are in a position to insure that routine checks and periodic maintenance are accomplished at the proper time. Review the booklets for each equipment weekly. Glance at the checkoff charts to see if the gear is being regularly maintained. Note deficiencies, if any, in checklists and make sure required repairs are completed before a specified deadline time or date as applicable. Always keep the communication officer informed on the state of repair of all equipment.

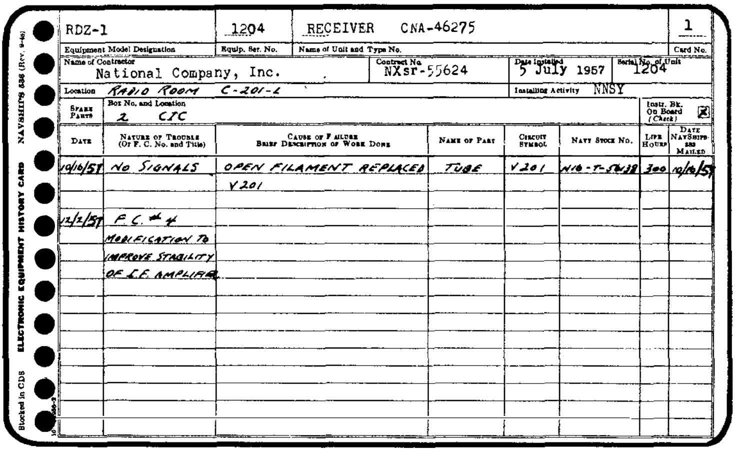
Remember, the checks for each equipment are field-tried and proven. They are there solely to improve maintenance. But you must ensure that your men perform each schedule conscientiously, accurately, and completely, and that they record the results AS FOUND.

ACCURATE RECORDS AND REPORTS

Maintenance of equipment records is an important duty of the leading Radioman. Information for these records is supplied by almost every member of the communication gang. Make sure this information is up to date and correct. Bear in mind that your records must be available for inspection at any time.

Electronic Equipment History Cards

Each ship is required to maintain a full set of Electronic Equipment History Cards (NAVSHIPS 536) for recording results of inspections and test, and for field change entries. (See fig. 8–3.) The cards are maintained according to instructions in chapter 6 of the *BUSHIPS Manual* and in the maintenance manual for the particular equipment. Electronic Equip-



NAVSHIPS 536 (Rev. 9-48) ELECTRONIC EQUIPMENT HISTORY CARD Blocked in CDS

Equipment Model Designation	Equip. Ser. No.	Name of Unit and Type No.	Card No.
RDZ-1	1204	RECEIVER CNA-46275	1

Name of Contractor: National Company, Inc.
Contract No.: NXsr-55624
Date Installed: 5 July 1957
Serial No. of Unit: 1204
Location: RADIO ROOM C-201-L
Installing Activity: NNSY
Spare Parts — Box No. and Location: 2 CIC
Instr. Bk. On Board (Check): ☒

Date	Nature of Trouble (Or F. C. No. and Title)	Cause of Failure Brief Description of Work Done	Name of Part	Circuit Symbol	Navy Stock No.	Life Hours	Date NavShips 383 Mailed
10/16/57	NO SIGNALS	OPEN FILAMENT REPLACED V201	TUBE	V201	N16-T-56438	300	10/16/57
12/2/57	F.C. #4 MODIFICATION TO IMPROVE STABILITY OF I.F. AMPLIFIER						

Figure 8-3.—Electronic Equipment History Card (NAVSHIPS 536).

ment History Cards are integrated with the ship's current maintenance program, thereby becoming a part of the ship's material history.

Electronics Field Change Report

BUSHIPS requires a record of field changes authorized for each model or type of equipment held, and a report when the change is completed. Forward your report on the Electronics Field Change Report (NAVSHIPS 2369). This is the handy, self-addressed card included in each field change kit.

You may need to report field changes for which no kit is supplied or for which no modification card is available. If such is the case, BUSHIPS suggests the following procedure: Fill in the top part of an Electronics Failure Report (DD 787) and write "Navy field change (No.) made" in the Remarks space. When properly filled in, the card contains the following information:

1. Equipment model and serial number.
2. Unit name and serial number.
3. Navy field change number.
4. Date field change made.
5. Name and rank, rating, or title of person making change.

ELECTRONICS FIELD CHANGE REPORT

IMPORTANT	
1. Specify the over-all equipment serial number, and not the unit or component serial number.	ELECTRONICS FIELD CHANGE NO. 4
2. Include ship's number when applicable.	EQUIPMENT MODEL OR TYPE RDZ-1
	EQUIPMENT SERIAL NO. 1204
	DATE FIELD CHANGE COMPLETED 2/12/57
	REPORTED BY Gwr
	SHIP AND NUMBER OR STATION LSMR 514

NAVSHIPS 2369 (REV. 10-49) (FRONT) REPORT-SHIPS-9B

Figure 8-4.—Electronics Field Change Report (NAVSHIPS 2369).

Electronic Failure Report

The Bureau of Ships must be informed promptly of all failures and deficiencies observed in electronic equipment. Accurate failure reports provide the basis for modifications to existing equipment as well as guidance for the design and manufacture of new equipments. The Defense Department Electronics Failure Report (DD 787), which supersedes NAVGEN 1025 and the earlier NAVSHIPS 383, is the form on which failures are to be reported. The report must be filled out promptly by the operator or technician who detects the failure. You should check the completed form to make sure all essential information is included.

Make sure a separate report is made out for each failure. When the model or type of equipment is indicated, ensure that all significant nomenclature, letters, and digits are included. Verify with the operator the accuracy of the entry stating why the failure occurred. Explanatory comments should appear in the Remarks portion of the form. As a final check, and when in doubt regarding the correct method of filling in a particular section of the form, break out the interleaved instructions included with each pad of failure report forms.

REPORT THE FAILURE OF ONLY ONE PART OR TUBE ON THIS FORM

1. REPORT NO.	2. REPORTING ACTIVITY	3. REPAIRED OR REPORTED BY (NAME)	4. DATE OF FAILURE
26	U.S.Navy Teletype Maint.Scol,NorVa.	A.F.DuBois.RMC	3/23/56

5. EQUIPMENT INSTALLED IN (TYPE AND NO.)	6. TIME METER READING OR INSTALLATION LOG TIME	7. WAS MISSION ABORTED?	8. OPERATIONAL CONDITION
Electronic Multiplex (AN/FGC-5)	2500	☐ YES ☒ NO	Failed

EQUIPMENT	9. MODEL DESIGNATION AND MOD. NO. AN/FGC-5	10. SERIAL NO. 149	11. CONTRACTOR Teletype Corporation	12. CONTRACT OR ORDER NO. bsr 52344
COMPONENT (MAJOR UNIT)	13. MODEL DESIGNATION AND MOD. NO. Signal Distributer drive	14. SERIAL NO. 147	15. CONTRACTOR " "	16. CONTRACT OR ORDER NO.
ASSEMBLY OR SUBASSEMBLY	17. ASSEMBLY AND MOD. NO.	18. SERIAL NO.	19. MANUFACTURER	20. (LEAVE BLANK)

PART DATA				
	21. PART NAME OR TUBE TYPE: Crystal	22. STOCK NO. (FAILED ITEM): N16-T-51734	23. PART REF. DESIG. (V-101, R-101, ETC.): CR-1101	24. REPAIR TIME (MAN-HOURS): 1
	25. HOURS IN SERVICE: 2500	26. MANUFACTURER OF FAILED PART: James Knights Co.	27. SERIAL NO. 849	28. WAS REPLACEMENT PART AVAILABLE LOCALLY: ☒ YES ☐ NO

29. FIRST INDICATION OF TROUBLE

1 ☒ INOPERATIVE
2 ☐ INTERMITTENT
3 ☐ LOW PERFORMANCE
4 ☐ NOISY
5 ☐ OFF FREQUENCY
6 ☐ OUT OF ADJUSTMENT
7 ☐ OVERHEATING
8 ☐ UNSTABLE
9 ☐ OTHER

30. CHECK TYPE(S) OF TUBE OR PART FAILURE

007 ☐	ARCING	001 ☐	GASSY	790 ☐	OUT OF ADJUST.
710 ☐	BEARING FAILURE	300 ☐	GROUNDED	006 ☐	SHORTED
780 ☐	BENT	380 ☐	LEAKAGE	770 ☐	SLIP RING OR COMMUTATOR FAILURE
040 ☐	BINDING	730 ☐	LOOSE		
070 ☐	BROKEN	004 ☐	LOW GM OR EMISSION	018 ☐	TESTED OK DID NOT WORK
720 ☐	BRUSH FAILURE	750 ☐	MISSING		
080 ☐	BURNED OUT	008 ☐	NOISY	020 ☐	WORN EXCESSIVELY
130 ☐	CHANGED VALUE	450 ☐	OPEN	☐	SEE INSIDE FLAP FOR ADDITIONAL CODES
170 ☐	CORRODED	099 ☐	OTHER No Sync.		

31. CAUSE OF FAILURE

2 ☐ FAULTY PACKAGING
5 ☐ MISHANDLING
6 ☐ INSPECTION OR TEST
1 ☐ NORMAL OPERATION
3 ☐ STORAGE
7 ☐ ASSOCIATED FAILURE. EXPLAIN
4 ☒ OTHER

32. WAS THE PART REPLACED DURING PREVENTIVE MAINTENANCE? ☐ YES ☒ NO

33. REMARKS *(Continue on reverse side if necessary)*

Fractured Crystal - cause unknown

DD (1 AUG 54) 787 — GPO : 1955 O—327037 — ELECTRONIC FAILURE REPORT

A15907

Figure 8-5.—Electronic Failure Report (DD 787).

Keep in mind that the Electronic Failure Report is not a requisition form. Replacement parts must be requisitioned separately.

Request for Survey

A survey is a means of writing off the books, articles which have deteriorated, or have been lost, damaged, or destroyed. Your communication officer will initiate action for survey of communication equipment. You may be required to prepare the survey form in the rough on Survey Request, Report, and Expenditure, S&A Form 154.

The report must include the following:

1. Detailed description of material to be surveyed.
2. Statement of the condition of the damaged or deteriorated material, or of conditions surrounding loss of material.
3. Responsibility for the cause or condition of the material. If the responsibility cannot be determined, the reason why it cannot be determined.

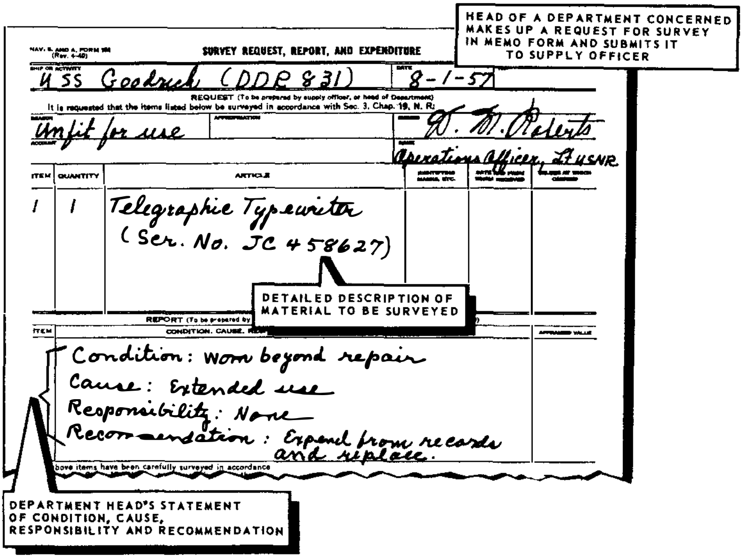


Figure 8–6.—Survey report in rough.

4. Recommendation as to the disposition to be made of the material.

After completion of the rough request and final check by the communication officer, it is turned over to the supply officer. He uses the rough survey report to prepare the smooth S&A Form 154 for submission to the commanding officer.

REQUESTS FOR MATERIAL

The head of the operations department has the authority to request stores for use in his department within limitations placed on that department by the commanding officer. Each request for material should be over the signature of the operations officer or an officer authorized by him to sign requests. Requests are submitted to the supply department.

Preparation of Requests

Requests for general stores material (GSM) are prepared on a Request for Issue or Turn-in (DD Form 1150). (See fig. 8-7.) Only one class of material is entered on a particular

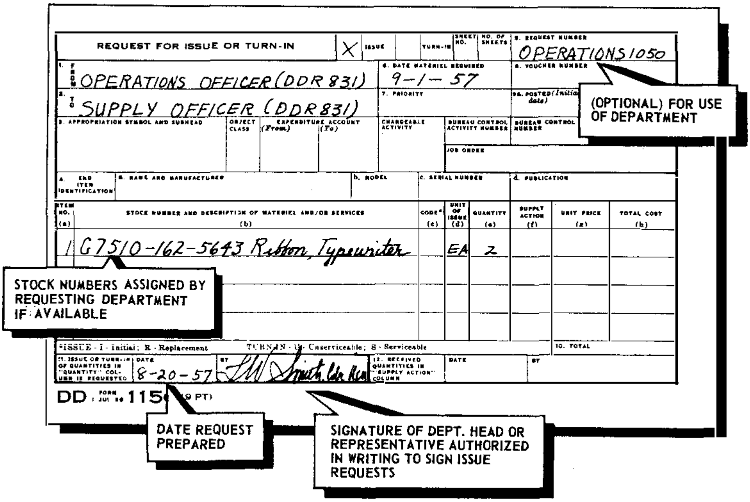


Figure 8-7.—Request for Issue or Turn-in (DD Form 1150).

form. When presented at the GSM issue room, each request is carefully checked to ensure that it has been filled out correctly.

Requisition Record Book

When it has been determined that an issue is to be made and a requisition is properly prepared for the issue, the requisition is assigned the next number in the series maintained separately for each department. A requisition record is kept for each department, and original entries are made in it at the time requests are cleared in the supply office for presentation to the GSM storeroom.

Items That Cannot Be Issued

When a requisition contains an item or items that are ordinarily carried but which are not in stock at the time, those items are normally canceled, and the department is requested to submit another DD 1150 after stock replenishment.

When a request contains an item or items which cannot be supplied from stock and which are not ordinarily carried in stock, such items are ordered by the supply department. The request is held, unnumbered, in the supply office until the material is received.

If a DD 1150 is submitted containing both items carried in stock and items that have to be ordered, the latter items are canceled. An additional request listing these items is prepared by the deparment requesting the material.

GSM Material

The Navy uses a vast number of different items. For example, there are more than 80,000 items listed in the *Navy Stock List of General Stores.* If you need a certain item in the *List* you must record the correct Federal stock number (FSN) or parts number and nomenclature on the requisition to obtain the desired item. You can get this information from the *Navy Stock List of General Stores,* which lists and identifies items of general supplies carried in stock for issue to ships and stations. The *List* contains approximately 75 GROUPS, which

CONNECTOR, PLUG, ELECTRICAL (Cont'd)

Unit of Issue: Each (EA)

Explosion-Proof

Item 177

Crouse-Hinds Co. or equal.

Delayed-action type; grounded through shell and extra pole; furnished with cable grip and rubber bushing.

Use: In spaces or areas where explosive vapors or mixtures may be present.

Item No.	Stock No.	Body Material	Cable Opening In.	Rating			Mfr. No.	Used with Item No.
				Amp.	Volts	HP		
	2-WIRE, 3-pole, 1-phase							
171	G5935-280-2386	Aluminum	0.375-0.875	7/30	460/230	½-1½	CPH7713	*231-237*
173	G5935-494-0658	Bakelite	.375- .500	15	115/230	1	CPP412	
175	G5935-162-4999	"	.500- .625	"	"	"	CPP512	
	3-WIRE, 4-pole, 3-phase							
177	G5935-280-2388	Aluminum	0.750-0.875	30/60	460/230	5	CPH7734	*241*

Locking Type

Russell & Stoll Co. or equal.

Polarized, male plug grounded thru extra pole; with clamp type cord grip. Cadmium-plated steel housing. Locks into connector by twisting.

Item No.	Stock No.	No. of Contacts	Amp. at 250V DC/440V AC	Amp. at 115V DC	Max. Cable Size In.	Mfr. No.
181	G5935-149-4011	3 round	10	20	½	8013
183	G5935-149-4192	4 "	20	30	11/16	8014

Safety Type

Appleton Electric Co. or equal.

Aluminum body; polarized type circuit-breaking plugs. Packed 1 per carton, 4 cartons per case.

Item No.	Stock No.	No. of Round Slots	Rating			Mfr. No.	Used with Item No.
			Amp.	Volts DC	Volts AC		
	CABLE-MOUNTED, grounds thru shell. Cable opening 0.750"-1.375"						
191	G5935-283-3905	2	60	250	600	AEP6212	*271*
	CABLE-MOUNTED, grounds thru extra pole. Cable opening 1.375"-1.75"						
193	G5935-283-3906	4	100	250	600	AEP10423	*273*

Heavy Duty

Crouse-Hinds Co. No. APJ-10375 (formerly AP10375), or equal.

Aluminum body; 3 polarized round contacts; with cable clamp opening, and grounded type shell. Furnished with gland nut and tapered rubber bushing.

Item No.	Stock No.	Rating	
		Amp.	Volts
201	G5935-280-2385	100	250DC/600AC

Figure 8-8.—Page from Navy Stock List of General Stores.

are further subdivided into about 500 CLASSES. Each class covers items with the same physical or performance characteristics, or those items which are generally requisitioned together.

The *Navy Stock List of General Stores* gives a short description of a particular item, specifications, illustrations, measurement equivalents, usage data, and unit of issue. Aboard most ships the *List* is primarily for the Storekeeper's use. However, a general knowledge of procedures for using it is helpful to the Radioman First or Chief in preparing requisitions.

Suppose, for example, you are ordering a heavy-duty connector plug. The first step is to determine what group of material contains connector plugs. They come under Group 59 (Electrical and Electronic Components, Part 3). The alphabetical index at the beginning of this part lists heavy-duty plugs as item 201. (Item numbers are arranged numerically and are easy to find.) The page of the *Navy Stock List of General Stores* listing this item is shown in figure 8–8.

Note the FSN: G5935–280–2385. Enter this number and descriptive data on the requisition. Letter G indicates connector plug is a general stores item; 5935 is its CLASS.

NOTE.—A few items are still listed under the old (Navy) stock number. Refer to the *Master Cross-Reference Listing of General Stores Supply Office* for the new (Federal) stock number.

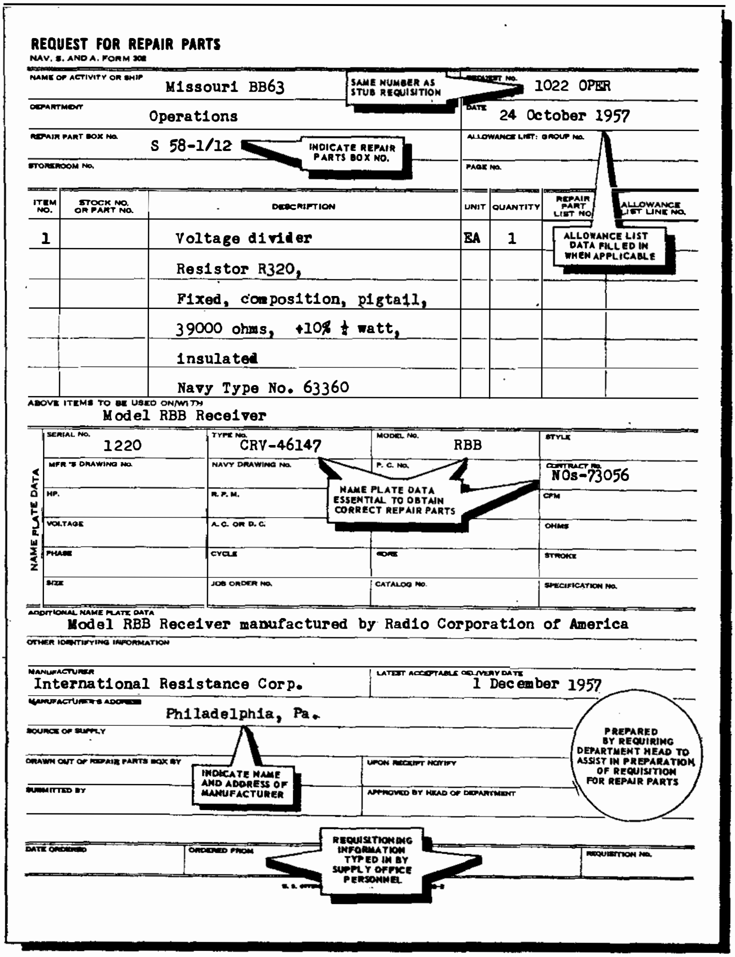
Requisitioning Repair Parts

The procedure for ordering repair parts is similar to that for ordering GSM material. If the stock number is known, it is entered on the request, together with complete identifying data. If the stock number is not known, it is necessary to fill in not only the requisition, but also a Request for Repair Parts (NAVSANDA Form 302), shown in figure 8–9.

The following information, if available, should appear on the form:

1. Full description of electrical and physical characteristics of item.
2. Equipment name, group, and class.
3. Manufacturer's reference number.

4. Joint Army-Navy military or Army-Navy aeronautical type number.
5. Contractor's part or drawing number.
6. Navy type number.
7. Army Signal Corps stock numbers.



REQUEST FOR REPAIR PARTS
NAV. S. AND A. FORM 302

NAME OF ACTIVITY OR SHIP: Missouri BB63
REQUEST NO.: 1022 OPER
DEPARTMENT: Operations
DATE: 24 October 1957
REPAIR PART BOX NO.: S 58-1/12
ALLOWANCE LIST: GROUP NO.
STOREROOM NO.
PAGE NO.

ITEM NO.	STOCK NO. OR PART NO.	DESCRIPTION	UNIT	QUANTITY	REPAIR PART LIST NO.	ALLOWANCE LIST LINE NO.
1		Voltage divider	EA	1		
		Resistor R320,				
		Fixed, composition, pigtail,				
		39000 ohms, ±10% ½ watt,				
		insulated				
		Navy Type No. 63360				

ABOVE ITEMS TO BE USED ON/WITH: Model RBB Receiver

NAME PLATE DATA

SERIAL NO. 1220	TYPE NO. CRV-46147	MODEL NO. RBB	STYLE
MFR.'S DRAWING NO.	NAVY DRAWING NO.	P. C. NO.	CONTRACT NO. NOs-73056
HP.	R. P. M.		CFM
VOLTAGE	A. C. OR D. C.		OHMS
PHASE	CYCLE	BORE	STROKE
SIZE	JOB ORDER NO.	CATALOG NO.	SPECIFICATION NO.

ADDITIONAL NAME PLATE DATA: Model RBB Receiver manufactured by Radio Corporation of America
OTHER IDENTIFYING INFORMATION
MANUFACTURER: International Resistance Corp.
LATEST ACCEPTABLE DELIVERY DATE: 1 December 1957
MANUFACTURER'S ADDRESS: Philadelphia, Pa.
SOURCE OF SUPPLY
DRAWN OUT OF REPAIR PARTS BOX BY
UPON RECEIPT NOTIFY
SUBMITTED BY
APPROVED BY HEAD OF DEPARTMENT
DATE ORDERED
ORDERED FROM
REQUISITION NO.

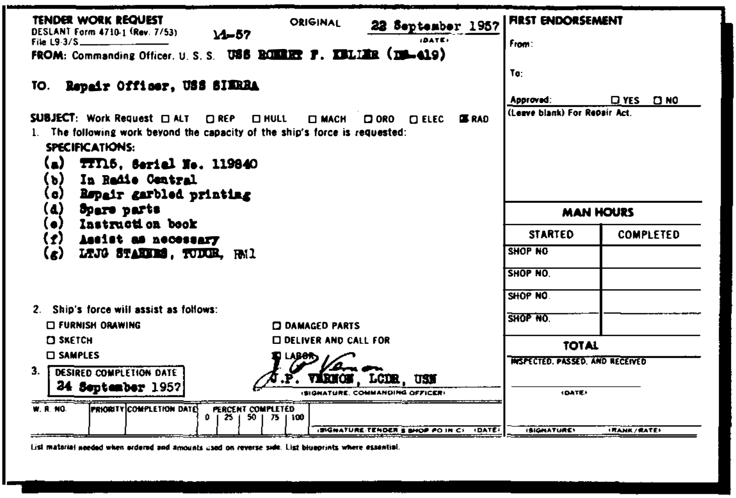
Figure 8-9.—Request for Repair Parts (NAVSANDA Form 302).

Navy Shipyard and Tender Work Requests

When your ship needs work done in the shipyard or by a tender, work requests (job orders) must be submitted in accordance with specific instructions issued by the type commander. Your job may be to make out work requests on equipment in communication spaces for submission to the communication officer. Items required on work request forms vary according to local procedures. Generally, however, the following important information must appear:

1. Name, model, and serial number of equipment.
2. Location.
3. Work to be accomplished.
4. Material to be supplied by ship.
5. Publications (instruction book, blueprints) needed.
6. Extent of assistance by ship's force.
7. Names of ship's personnel authorized to inspect job at completion.

A completed Tender Work Request form is shown in figure 8–10. In actual cases, more information and information of a more precise nature must appear than is shown in this ex-



TENDER WORK REQUEST
DESLANT Form 4710-1 (Rev. 7/53)
File L9-3/S ______ 14-57
ORIGINAL 22 September 1957 (DATE)

FROM: Commanding Officer, U. S. S. USS ROBERT F. KELLER (DE-419)

TO. Repair Officer, USS SIERRA

SUBJECT: Work Request ☐ ALT ☐ REP ☐ HULL ☐ MACH ☐ ORD ☐ ELEC ☒ RAD

1. The following work beyond the capacity of the ship's force is requested:

SPECIFICATIONS:
(a) TT15, Serial No. 119840
(b) In Radio Central
(c) Repair garbled printing
(d) Spare parts
(e) Instruction book
(f) Assist as necessary
(g) LTJG [illegible], TUDOR, RM1

2. Ship's force will assist as follows:
☐ FURNISH DRAWING ☐ DAMAGED PARTS
☐ SKETCH ☐ DELIVER AND CALL FOR
☐ SAMPLES ☒ LABOR

3. DESIRED COMPLETION DATE 24 September 1957

J. P. VERNON, LCDR, USN
(SIGNATURE, COMMANDING OFFICER)

W. R. NO.	PRIORITY	COMPLETION DATE	PERCENT COMPLETED 0 25 50 75 100	(SIGNATURE TENDER S SHOP PO IN C) (DATE)

List material needed when ordered and amounts used on reverse side. List blueprints where essential.

FIRST ENDORSEMENT

From:

To:

Approved: ☐ YES ☐ NO
(Leave blank) For Repair Act.

MAN HOURS	
STARTED	COMPLETED
SHOP NO	
SHOP NO.	
SHOP NO.	
SHOP NO.	

TOTAL

INSPECTED, PASSED, AND RECEIVED

(DATE)

(SIGNATURE) (RANK/RATE)

Figure 8–10.—Tender Work Request (DESLANT Form 4710–1).

ample. Lack of precise information on the work request is a frequent cause of delays or of incomplete repair work.

Bear in mind that work requests can be submitted only for work which is beyond the capacity of the ship's force to perform.

ADDITIONAL SOURCES

Described below are sources of maintenance information in addition to those already mentioned. You should be familiar with these publications and make sure that they are available to your men.

Basic References

MAINTENANCE HISTORY.—Cards for recording results of inspections of equipment as well as those for tests and field changes form the basis of the ship's maintenance history. These cards, such as the Machinery History Card (NAVSHIPS 527), Electrical History Card (NAVSHIPS 527–A), and Hull History Card (NAVSHIPS 537), are filed in looseleaf binders and provide a comprehensive record of the items concerned. They are kept up to date and available for inspection at all times. The cards also form the basis of preventive maintenance programs such as the Current Ship's Maintenance Project (CSMP).

CURRENT SHIP'S MAINTENANCE PROJECT.—The purpose of the CSMP is to provide a current record of maintenance, modifications, and repairs to be accomplished by ship's personnel or during availability. It comprises three cards: Repair Record Card (NAVSHIPS 529), Alteration Record Card (NAVSHIPS 530), and Record of Field Changes (NAVSHIPS 537).

ELECTRONICS MAINTENANCE BOOK (NAVSHIPS 900,000).—This book includes servicing and maintenance notes, field change information, and other pertinent information on electronic equipment. It will ultimately supersede the following bulletins: Communications Equipment Maintenance Bulletin (CEMB), Radar Maintenance Bulletin (RMB), and Sonar

Maintenance Bulletin (SMB). For convenience, the EMB comprises several volumes covering general electronic information and each major electronic field.

Periodicals

BUREAU OF SHIPS JOURNAL (NAVSHIPS 250-200).—Published monthly by the Bureau of Ships, this publication contains feature articles on new developments in ship operation, construction, and engineering, and sections on ship maintenance, electronics, and shop notes.

ELECTRONICS INFORMATION BULLETIN (EIB) (NAVSHIPS 900,022A).—This is a biweekly publication containing timely information on field changes, installation techniques, and maintenance. The EIB also carries beneficial suggestions and instruction book distribution. It is delivered to shipyards, tenders, bases, and forces afloat in the form of punched pages. These are filed in a notebook or folder by consecutive issue numbers.

Miscellaneous

1. Technical bulletins issued by the bureaus.
2. Bureau manuals.
3. Type commanders' technical instructions and checkoff lists.
4. Navy Department Instructions.
5. Miscellaneous letters on specific items of equipment.

QUIZ

1. What book is the most important source of information for communication equipment?
2. What two important points should you remember regarding the testing of electron tubes?
3. What is the full meaning of POMSEE?
4. Name the two manuals which are the result of the POMSEE program.
5. What is a survey?
6. What is the *Navy Stock List of General Stores?*
7. How many classes of material are entered on a Request for Issue or Turn-in (DD) Form 1150)?
8. What is the FSN of a particular item?
9. Name the form to be used in addition to the DD 1150 if the item's stock number is not known.

CHAPTER 9

SHIPBOARD TELETYPEWRITER EQUIPMENT

Radioteletypewriter (RATT) is now in use by all operating units of the Fleet, sharing the traffic load with radiotelegraphy and other methods of telecommunications. Fleetwide adoption of RATT means added responsibilities for every Radioman, especially First Class or Chief. Your duties often include, for example, supervision of RATT circuits, and training your men to operate and service teletypewriter equipment. Make sure, then, that you are as familiar with teletypewriters and associated equipment as you are with transmitters, receivers, and other communication gear.

The two most common teletypewriters found in communication centers are the model 19 set and the newer model 28 page printer. This chapter describes features of the familiar model 19 and points out major improvements incorporated in model 28. Associated teletype equipments, such as frequency shift keyers and converters, are also discussed. No attempt is made, of course, to supplant the applicable equipment instruction books. Refer to those publications for the more complex, infrequent adjustments and to trace the action of numerous moving parts. In the instruction books you will also find complete instructions for cleaning, lubricating, and adjusting the equipment.

MODEL 19 SET

The model 19 set is used for both radio and landwire communications. Its principal components are the model 15 page

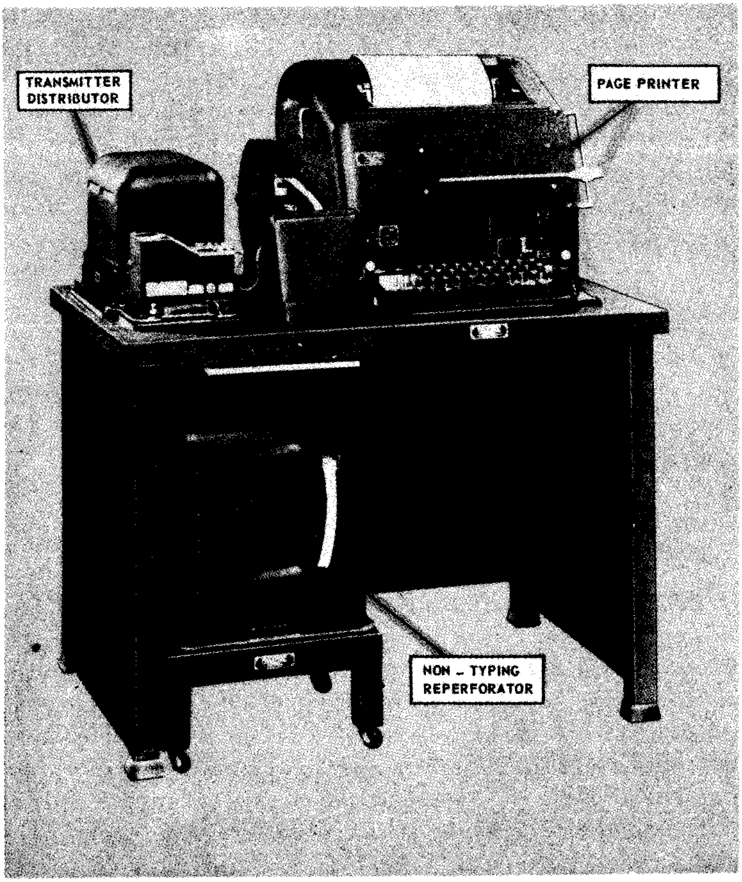


Figure 9-1.—Model 19 set.

printer and the model 14 transmitter-distributor. Various combinations of sending and receiving are possible when using the model 19 set. A switching arrangement gives direct keyboard transmission only, tape perforation only, or simultaneous direct keyboard transmission AND tape perforation.

The model 19 uses either a REC-13 or a REC-30 rectifier. A rectifier supplies direct current for perforating magnets, line relay bias winding, and local circuits of the printer (and reperforator, if used). It also adjusts motor power voltages to correct values. The REC–13 is a dry disk type of rectifier; the REC–30 uses electron tubes.

Most model 19 sets are equipped with a synchronous motor. This type is replacing the series-governor motor because the latter requires more maintenance. Most teletypewriter stations have available a constant 60-cycle current which makes the synchronous motor adequate for the job.

MODEL 15 PAGE PRINTER

The teletypewriter model 15 type bar page printer (fig. 9–2) is a motor-driven mechanism for interchanging typewritten messages between two or more points connected by wire or radio. When the model 15 is used as a sending-receiving station, it is equipped with a keyboard transmitting unit (fig. 9–3), a typing unit (fig. 9–4), and a motor unit, all mounted on a base unit (fig. 9–5).

SIGNALING CODE

Before discussing the various components of the model 15 printer, let's look at the code which carries intelligence between teletypewriter stations. Teletypewriters use an electrical code of current and no-current. Impulses which energize the selector magnets are known as MARKING (current), and those which do not energize the selector magnets are known as SPACING (no-current). Each character transmitted is assigned a code of five impulses, hence the designation five-unit code. The LETTERS key, for instance, is transmitted as five marking (current) impulses, and the BLANK key is transmitted as five spacing (no-current) impulses. All other characters have been assigned different COMBINATIONS of marking and spacing impulses.

Before a character is transmitted it is first preceded by a START impulse (no-current). Immediately upon transmission of the five-unit code, a STOP impulse (current) is transmitted. The purpose of the start and stop impulses is to maintain synchronism between sending and receiving machines. These impulses precede and follow each code group, but have no bearing on the intelligence which is being transmitted.

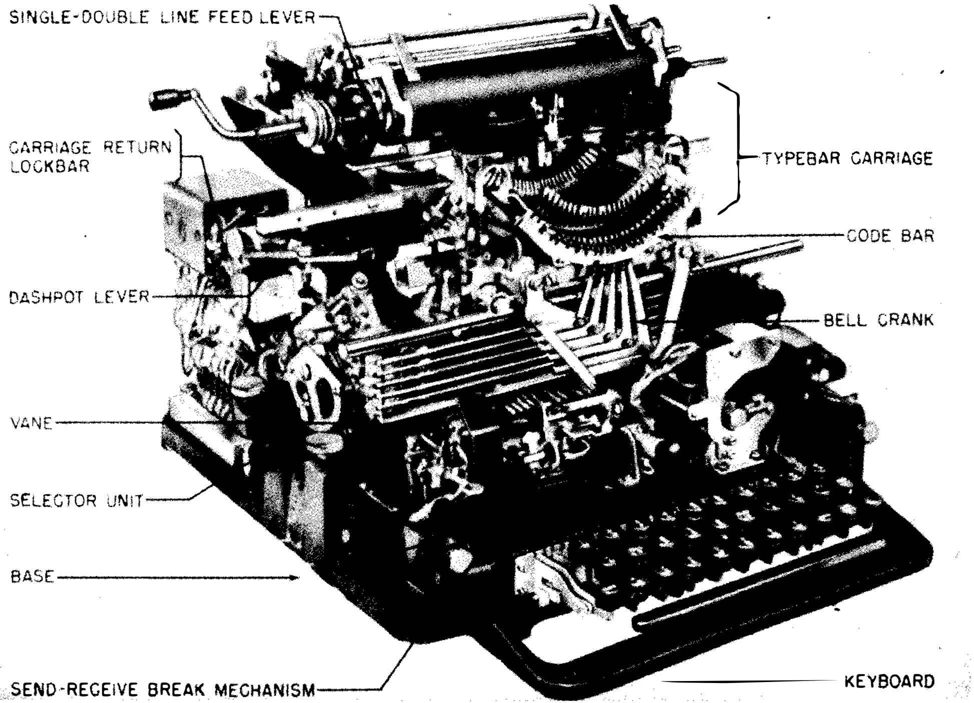


Figure 9-2.—Model 15 page printer, cover removed.

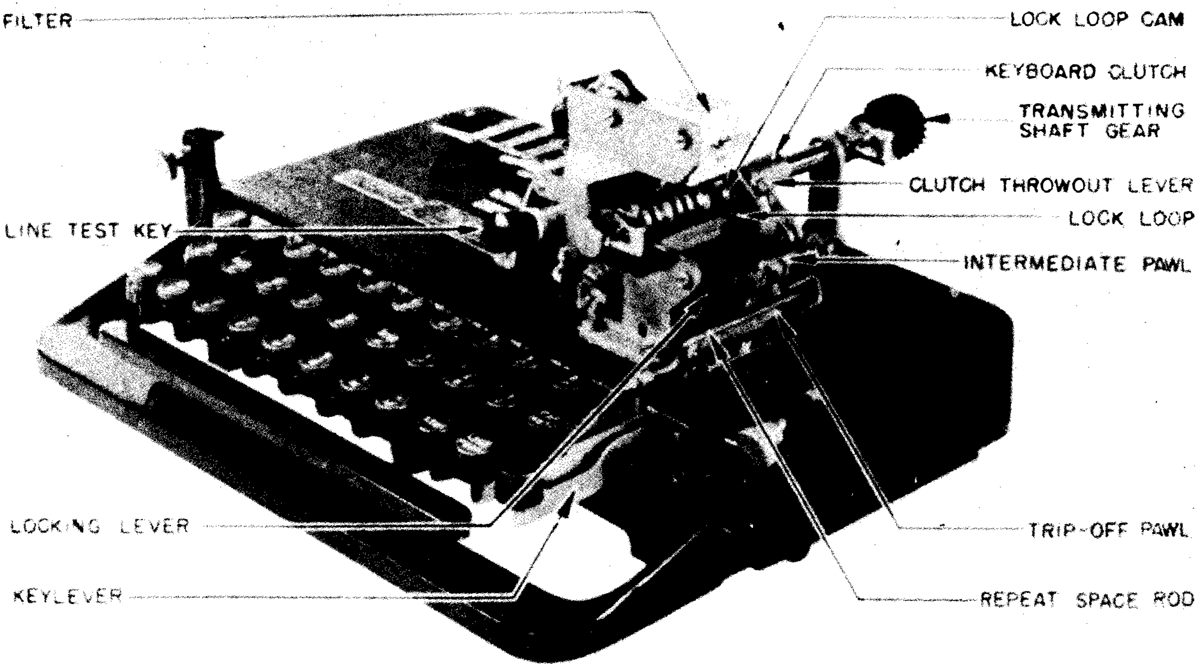


Figure 9-3.—Model 15 keyboard transmitting unit.

KEYBOARD TRANSMITTING UNIT

The keyboard transmitting unit is, essentially, a set of keys, key levers, selector bars, and locking levers. Their function is to SELECT the code combination to be transmitted when the operator depresses his key. A transmitting cam cylinder, contact levers, and contact springs then transmit the code combination which is selected (fig. 9–6). A clutch throwout lever and a clutch (fig. 9–7) are provided for starting and stopping transmission.

Beneath the key levers are five selector bars and a universal bar extending across the width of the keyboard. (This is shown in fig. 9–8.) The selector bars are made with saw-tooth shaped notches, according to the requirements of the signaling code. They rest on rollers and are guided at each end so that they are easily moved endwise. When a key is depressed, the key lever strikes the slanting sides of these notches, moving the bars either to the right or left, depending on whether the impulses corresponding to the bars are to be SPACING or MARKING impulses. In this way the correct code is selected for transmission, and the character starts on its way to the receiving machine.

Typing Unit

When a character selected is received by a model 15—operating alone or as a component of a model 19 set—it is the typing unit which will cause the letter to be printed. The typing unit has type bars similar to those of a standard typewriter. By means of a selector mechanism, the incoming signals set up five code bars which in turn permit the correct type bar to strike the platen.

The selector magnet is an electromagnet and is the heart of the typing unit. When it has current flowing through it, it is a strong magnet; when no current is flowing through it, it immediately loses its magnetism. The selector magnet operates the typing unit through mechanical action in such a way that it prints the character whose key was depressed on the keyboard. The seven impulses sent out by the transmitting

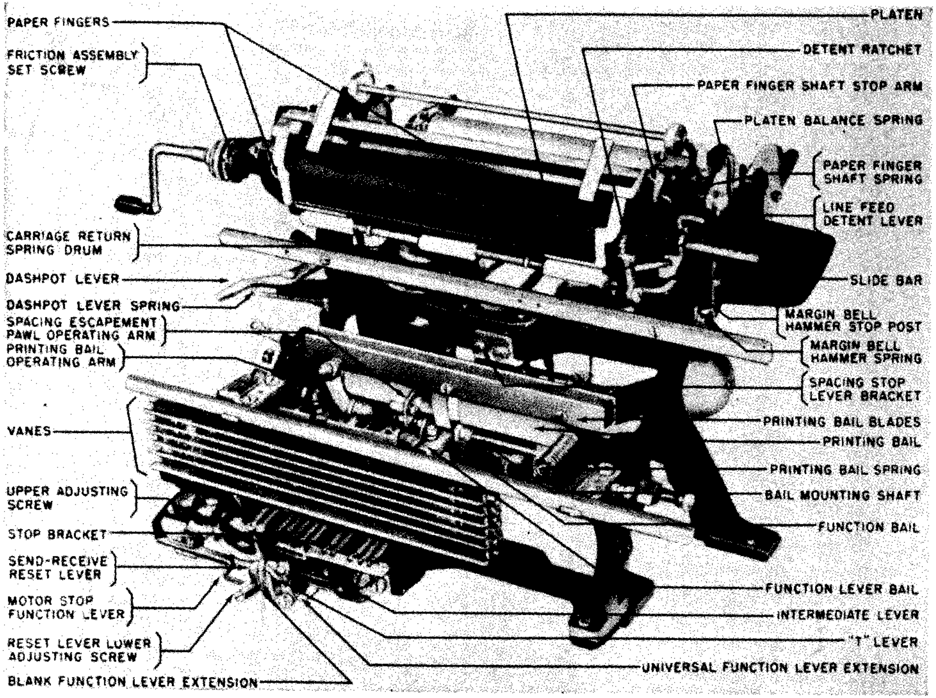


Figure 9-4.—Model 15 typing unit.

contacts will energize and de-energize the selector magnets in accordance with the impulses sent out. In other words, when the keyboard is sending out the start impulse (no current impulse), the selector magnets will receive this same no-current impulse (space) and become demagnetized; likewise for the entire sequence.

The motor which drives the main shaft assembly of the typing unit supplies power to all mechanically operated parts of the machine. It may be constant speed synchronous, operating only on regulated alternating current; or governed speed, operating on either alternating or direct current.

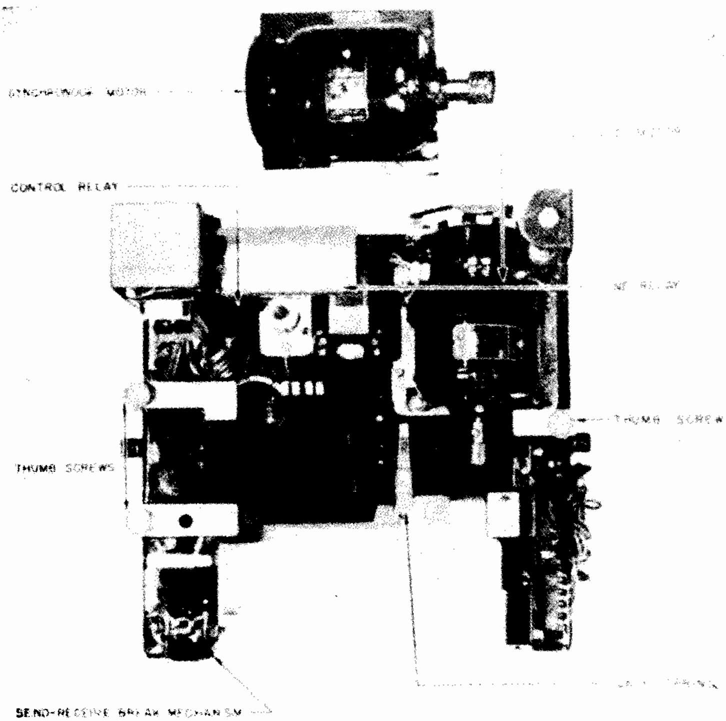


Figure 9–5.—Base unit and motor.

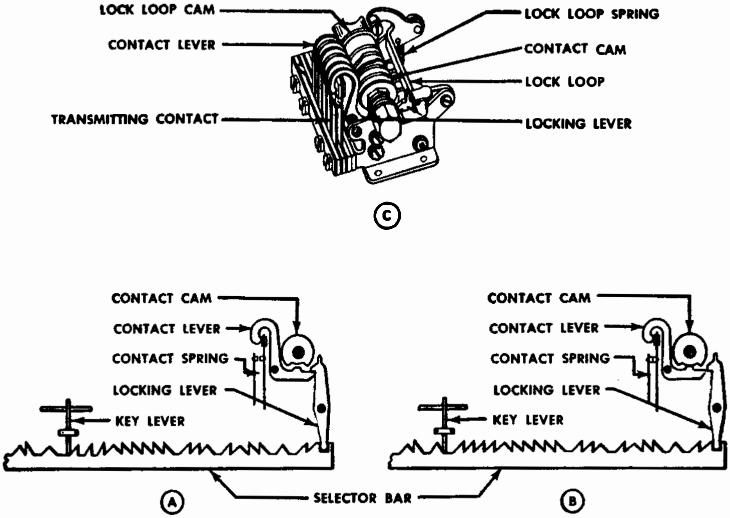


Figure 9–6.—Transmitting cam cylinder, contact levers, and springs.

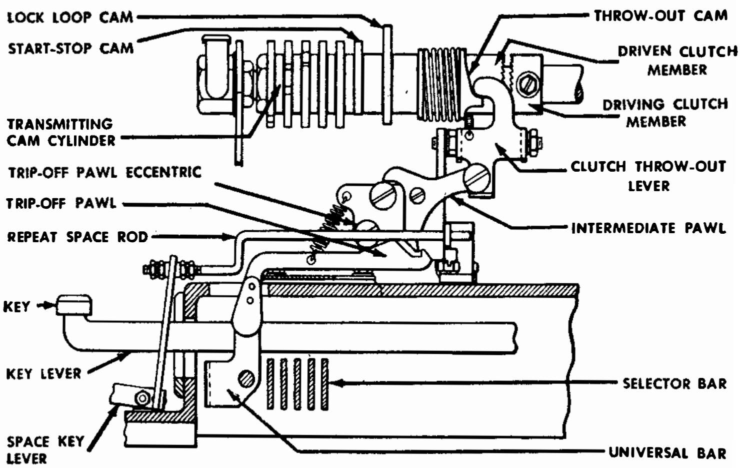


Figure 9–7.—Transmitting cam cylinder.

Line Relay

A line relay base is mounted on the model 15 printer on a bracket at the rear of the typing unit so that a line relay may be used.

Wiring is arranged so that either the line relay or the selector magnets may be connected in the line circuit. In the former case, contacts of the line relay repeat signals to the selector

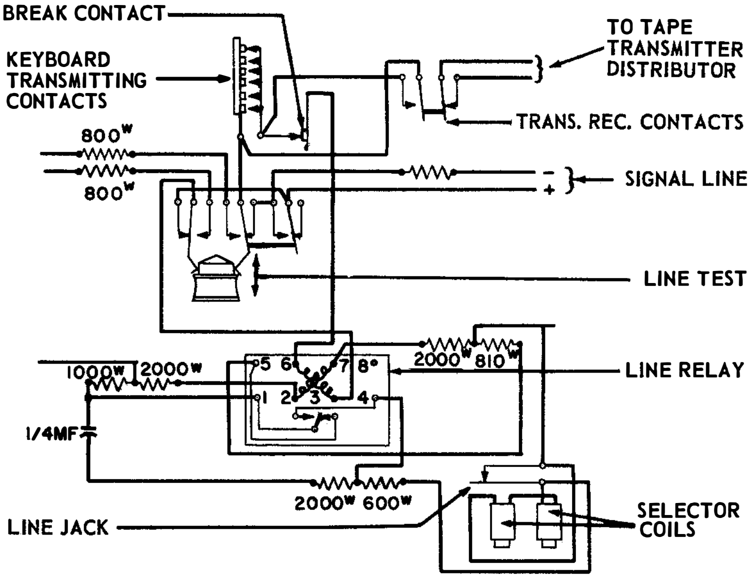


Figure 9–8.—Line and relay circuits.

magnets, whereas, in the latter, selector magnets are connected directly to the line. Line and relay circuits are shown in figure 9–8.

REC–13 RECTIFIER

With 60-cycle synchronous motors, REC–13 rectifier (rated for 60 cycles only) may be used to provide direct current suitable for either local or signal line battery. This model rectifier includes power factor correction which is advantageous when using synchronous motors.

The REC–13 is designed to deliver continuously 0.6 ampere at 120 volts d-c from a 105- to 125-volt, 60-cycle, a-c, single-phase power supply. It consists of an insulated-type input transformer with primary taps, a full-wave selenium rectifying element, a power factor correction capacitor, a filter consisting of a choke and capacitor, a bleeder resistor, and a regulator with taps. All parts are secured to a metal base which has rubber feet for shelf mounting. The REC–13 is rated as follows:

Input: 105 to 125 volts, 60-cycle, a-c, single-phase.
Output: 0.6 ampere at 120 volts d-c.
A-c component in d-c output voltages:
1 percent rms at 0.6-ampere load.
No-load voltage when new: Not over 135 volts.

REC–30 RECTIFIER

The REC–30 is equipped with multivoltage, multifrequency connecting taps which permit printers, transmitter-distributors, and reperforators driven by 50- to 60-cycle, series-governed motors to be operated on power supplies of approximately 95 to 125 or 190 to 250 volts and 25, 40, 50, or 60 cycles. Since this rectifier is to be used generally with series-wound motors, no provision has been made for power factor correction.

The power unit consists essentially of an autotransformer, necessary control and filament windings for operation of the grid-control rectifier network, an insulating-type plate transformer, suitable radio interference filters on both a-c input and d-c output circuits, d-c output filter consisting of a choke and two capacitors, resistor network, two grid-controlled rectifier tubes, one voltage standard tube, and one amplifier tube. All of these parts are secured to a metal base which has metal feet for shelf mounting.

DOUBLE POLE POWER SWITCH

The double pole power switch, when thrown to the OFF position, completely isolates the fuses and flexible leads from the a-c supply. You should always be careful to throw the switch to the OFF position before opening the hinged door of the rectifier cover. Any terminal on the main terminal panel may be 250 volts above ground potential with the switch in the ON position.

TRANSMITTER-DISTRIBUTOR

The transmitter-distributor (T-D) is a motor-driven device which translates code combinations (perforated in a paper tape) into electrical impulses, and transmits these impulses to one or more receiving stations. The tape may be perforated by any one of several models of teletypewriter perforating or reperforating machines.

The portion of the unit through which the perforated tape feeds is known as the transmitter (fig. 9–11). Its function is to

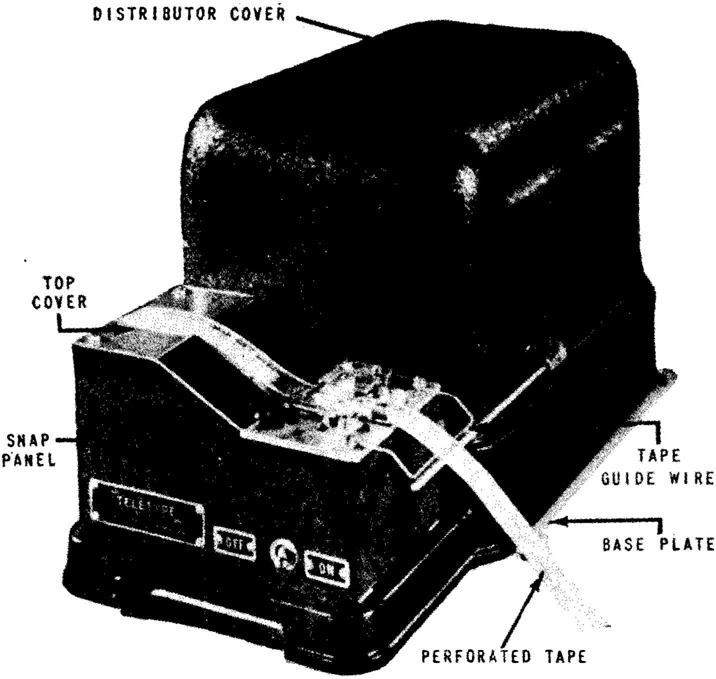


Figure 9–9.—Transmitter-distributor.

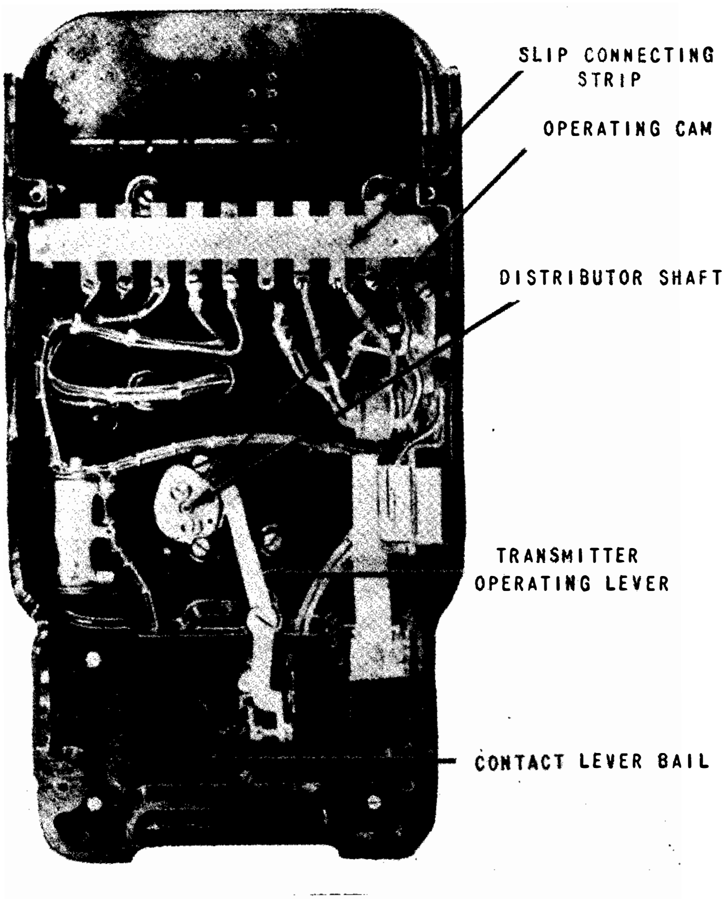


Figure 9-10.—Transmitter-distributor, bottom view.

prepare electrical paths to the commutator segments of the distributor (fig. 9-12). These paths are controlled by tape pins which sense the perforations in the tape and thereby determine the positions of the contact tongues (fig. 9-13) with relation to their upper and lower contact screws.

The distributor completes the connections of the signal line. Connections are made in sequence at a constant rate of speed by brushes which traverse the segments and the collector ring.

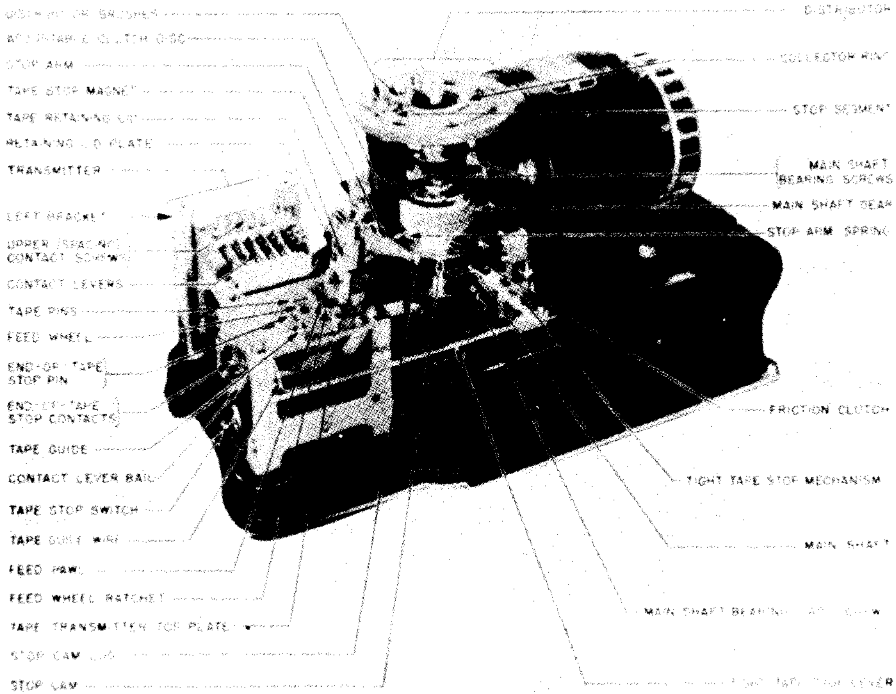


Figure 9-11.—Transmitter-distributor, cover removed.

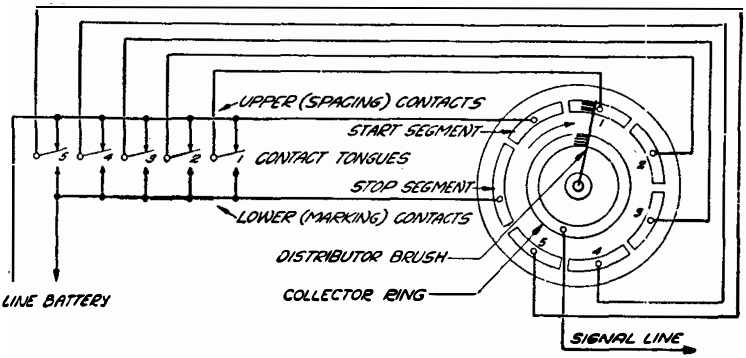


Figure 9–12.—Distributor segments and wiring.

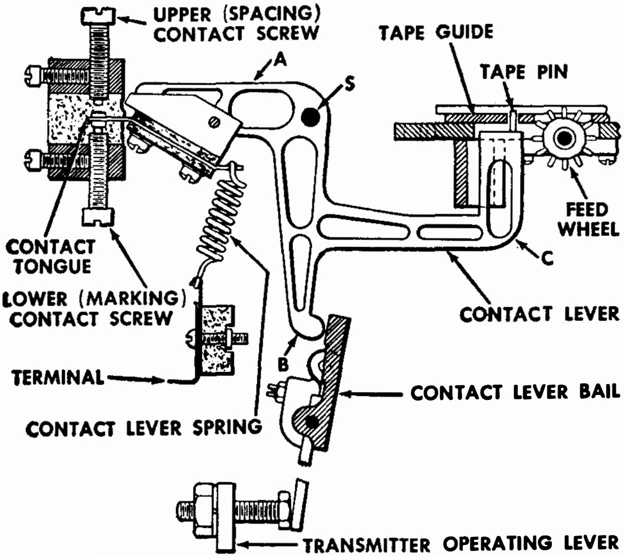


Figure 9–13.—Contact assembly.

As in the case of the model 15 printer, mechanical actions of the T-D can be sketched here only briefly.

Tape Sensing Mechanism

The contact levers (fig. 9–13) are positioned vertically in the transmitter. They pivot on a shaft (*S*), and have extensions to

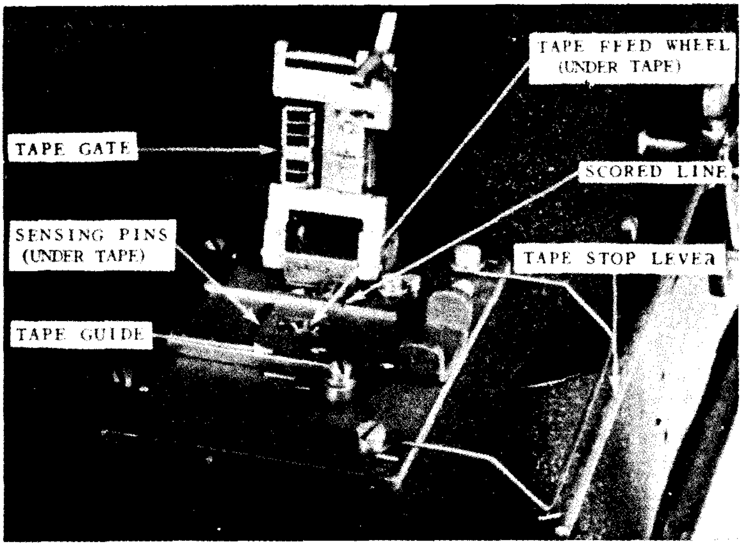


Figure 9–14.—Transmitter-distributor's tape guide and sensing pins.

the right (*C*), left (*A*), and downward (*B*). The right-hand extensions project upward at the ends and have tape pins embedded in them. An opening is provided in a tape guide, located above the right-hand extensions of the contact levers, to permit the tape pins to enter the code holes in the tape. The left-hand extensions of each contact lever carry a contact tongue attached to the contact lever by a pivotal mounting. Each contact tongue is positioned to move between two contact screws—a spacing contact screw above, and a marking contact screw below. A contact lever spring is attached to the mounting end of each contact, and tends to hold it against the lower contact screw.

A contact lever bail, pivotally mounted just below contact lever lower extensions, has an arm extending downward engaging a transmitter operating lever. This transmitter operating lever (fig. 9–10) has a central pivot screw and moves in a horizontal plane. A roller on the rear of the lever rides a transmitter operating cam mounted on the lower end of the distributor shaft. Motion imparted to the transmitter operating lever by the operating cam causes the contact lever bail to rotate the contact levers on their shafts sufficiently to move the contact tongues up and down between the marking and spacing contact screws. After the tongues strike the upper screws, any additional clockwise rotation of the contact levers is absorbed by the contact lever springs.

When the distributor brush comes to rest on the stop segment (figs. 9–12 and 9–13), the transmitter operating lever roller is on the peak of its cam, thereby holding the tongues against the spacing contacts and also holding the tape pins (located in the right-hand extensions of the contact levers) below the holes in the tape. As the transmitter operating lever roller rides to the low part of its cam, the tape pins rise. If tape perforated with code combinations is in the tape guide at this time, the contact lever pins will project through the tape wherever perforated, permitting the associated contact tongues to rest on the marking contacts. Pins will be blocked at the unperforated portions, and the associated contact tongues will be held against the spacing contacts. The tape will be held stationary, and the contact tongues will maintain their positions as determined by the code perforations, while the distributor brush is transversing segments 1 to 5, inclusive. The inner distributor will transmit (1) marking impulses to the line from segments associated with tongues that rest on the lower contacts, and (2) spacing impulses from segments associated with tongues that are on the upper contacts.

Distributor Mechanism

The distributor (fig. 9–11) is made up of 2 concentric conducting rings mounted on a fiber disk. The outer ring is divided into 7 segments. Segments 1 to 5, inclusive, correspond to the 5 intelligence intervals of the 5-unit code and are connected to 5 contact tongues shown in figure 9–12.

Immediately preceding segment No. 1 is the start segment. Following segment No. 5 is the stop segment. The stop segment and the lower contact screws are connected permanently to marking line battery (the d-c voltage applied to the line).

When the distributor brush passes over the start segment, a spacing impulse is always transmitted, whereas a marking impulse always results when the brush traverses the stop segment. These two invariable impulses cause the receiving mechanism to operate in unison with the distributor brush arm.

Positioned to the rear of the contact levers and pivoted on the contact lever shaft is a feed lever similar in shape to a contact lever. The feed lever has a spring attached to its left-hand extension and a feed pawl mounted on its right-hand extension (*C*). A feed pawl spring holds the feed pawl in contact with a feed wheel ratchet. Pins on the circumference of the feed wheel (figs. 9–13 and 9–14) project through an opening in the tape guide and mesh with the feed holes in the tape. A retaining lid, under which the tape passes, holds the tape in contact with the feed wheel pins. When action of the contact lever bail on the contact lever moves the tape pins downward, the feed lever responds in a similar manner, causing the feed pawl to engage a tooth on the feed wheel ratchet and rotate the feed wheel. With each downward motion of the feed pawl, the tape will be advanced from right to left the distance required to bring the succeeding code combination over the tape pins. The setting of the feed pawl is such that it does not start to rotate the feed wheel until the tape pins have moved clear of the tape. The feed wheel detent is provided to ensure alignment of the code perforations with the tape pins. The position of the operating cam with relation to the distributor brush is such that the contact tongues are not moved from the lower contacts until after the brush has reached the stop segment. While the brush is passing over the stop segment, the tape is advanced.

SYNCHRONOUS AND GOVERNED MOTORS

Where regulated a-c power is available, a synchronous motor may be used. The motor is 110-volt, 60-cycle, single-phase, alternating current. It has a cage rotor with cutouts and a split phase stator winding with centrifugal operated switch to open the starting winding when the motor comes up to speed. (See fig. 9–15.)

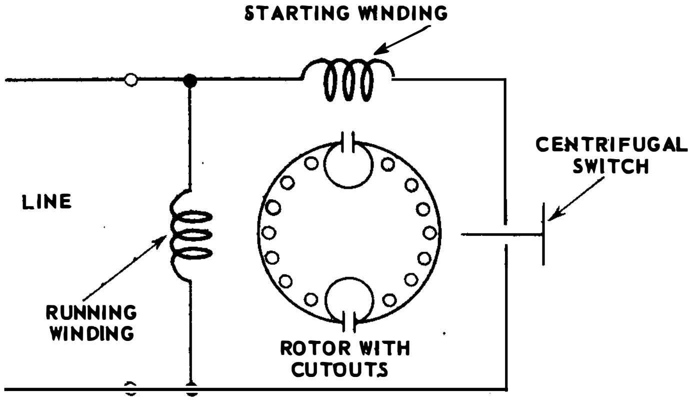


Figure 9-15.—A-c synchronous motor.

Governed motors are available for operation on either a-c or d-c power. Speed is controlled by a centrifugal contact mechanism having commutator rings or disks. In general, motors are mounted directly to the base casting; resistors and condensers used with governed motors are mounted on the base and in the base cavity. Some governed motors, however,

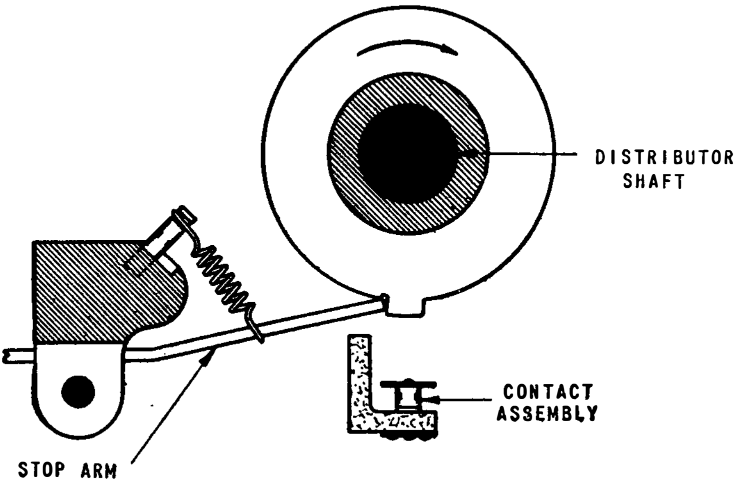


Figure 9-16.—Distributor shaft and stop arm.

are mounted to a base plate having governor resistors and a condenser mounted on it to form a complete motor unit assembly.

When an a-c governed motor is used, a contact assembly, operated by the tape stop magnet arm (fig. 9–16) is provided. Purpose of the contact assembly is to provide better speed control by (1) introducing a resistor in series with the motor when the distributor shaft is rotating, and (2) shunting the resistor when the load of the friction clutch is added to the motor.

MODEL 28 PAGE PRINTER

The model 28 is a keyboard sending and page receiving teletypewriter. It uses the same mark-space code as the model 15 but contains several major differences in design to ensure more reliable performance in ships and aircraft. Model 28 page printer and components will eventually replace the model 19 set.

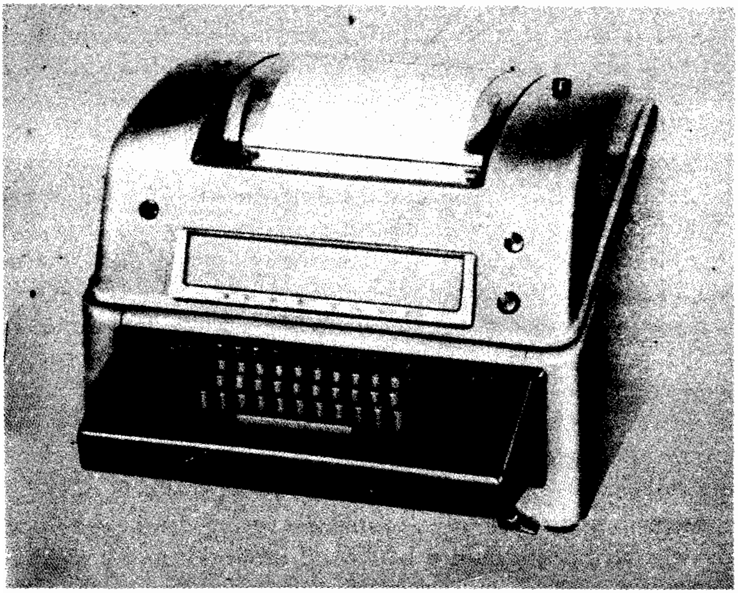


Figure 9–17.—Model 28 page printer.

This section describes several innovations in the model 28 page printer only. The transmitter-distributor and reperforator developed for use with the model 28 are not yet standard equipment in the Navy.

Type Box Printing

Of the improvements in the model 28 printer, the most obvious is in the printing mechanism. Type pallets, instead of being mounted on conventional type bars, are carried in a type box about ½ inch thick, 1 inch wide, and 2 inches long. Pallets are arranged in four horizontal rows, each row having a capacity of 16 characters. Letters are in the left half of the box, figures in the right half.

The type box is mounted in a carriage from which it may be removed for cleaning or replacement. To print any selected character, the type box carriage is so positioned that the character on the pallet is directly over the required location on the paper. Since the pallets are arranged in four horizontal rows and 16 vertical rows, it is necessary to position the type box carriage both horizontally and vertically. See figure 9–18 for character arrangement. The type box carriage rides on rollers over a track which is moved vertically for positioning in that particular plane (fig. 9–19). The carriage is positioned horizontally on its track by the oscillating rail slide and type box carriage link. The slide rides the oscillating rail and is clamped to the rear section of the upper draw wire rope. A flexible connection is provided by the link to permit the type box carriage to follow both the vertical movement of the type box carriage track and the horizontal movement of the oscillating rail slide. The lower right rear end of the upper draw wire rope is fastened to the spacing drum. From this point, it passes part way around the spacing drum, upward and around the right oscillating rail pulley, over to the left oscillating rail pulley, and downward to the spring drum.

After passing part way around the spring drum, the upper draw wire rope is doubled backward around it and passes upward to the left printing carriage rail pulley over to the right

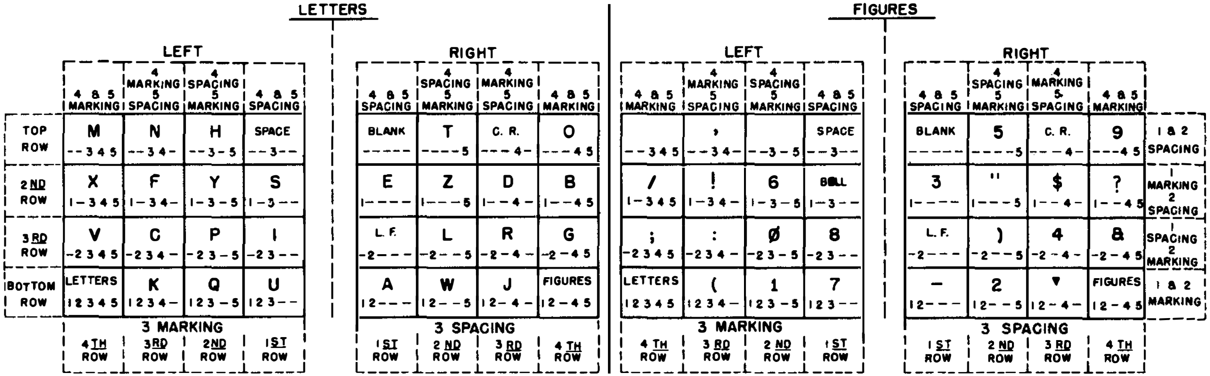


Figure 9-18.—Type box character arrangement.

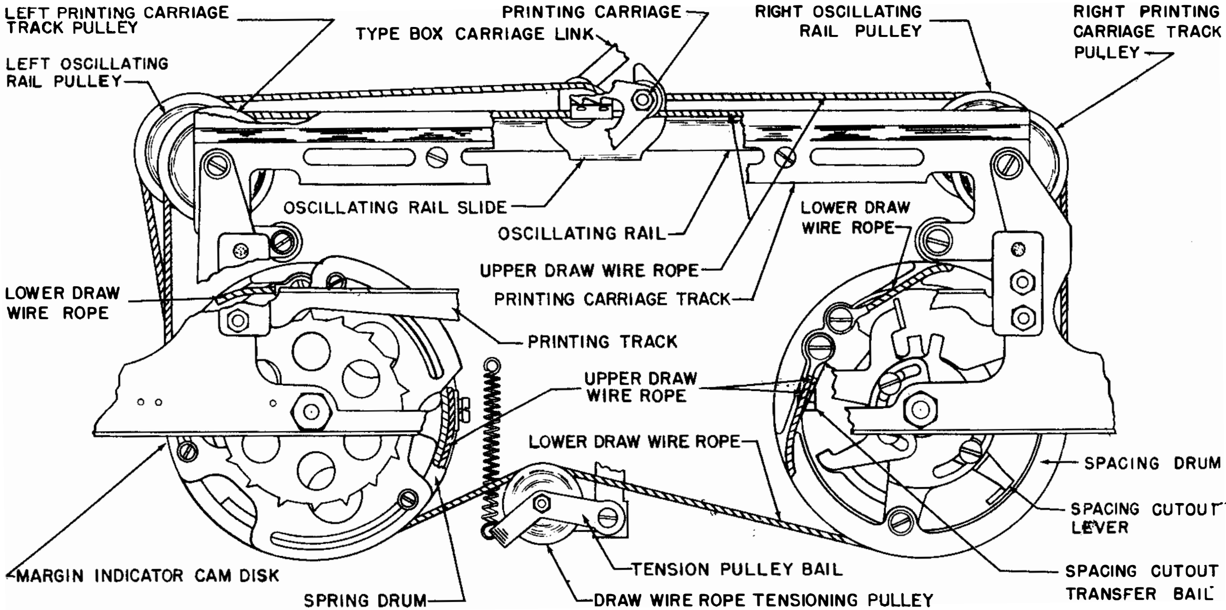


Figure 9-19.—Draw wire rope mechanism.

printing carriage rail pulley, and downward to the spacing drum to which it is again fastened. The lower draw wire rope is fastened at its left end to the spring drum and at its right end to the spacing drum. It acts in opposition to the upper draw wire rope and holds the two drums in phase (fig. 9–19).

A tensioning pulley rides the under side of the lower draw wire rope to take up any slack which may occur due to stretching of the upper and lower draw wire ropes. The oscillating rail is supported by pivoted arms at each end. These arms which extend downward are pivoted on the automatic typer frame at their lower ends. Thus, the oscillating rail and draw wire rope that it carries may be shifted to the left or right with no change in position relative to each other. The oscillating rail shift slide and the two oscillating rail shift links position the oscillating rail horizontally and also connect it with the oscillating rail shift slide. These links are pivoted and are of such length that only one at a time may be fully extended. They are used to position the oscillating rail and thus the type box, so that either the left side (letters characters), or the right side (figures characters), of the type box is selected.

Friction Clutch

The clutch is an all-steel, internal expansion friction clutch which disengages in the stopped condition. Older clutches, you remember, depend upon slippage between felt washers and steel plates when a stop is interposed so that the driven member is mechanically held from turning.

Clutches for the new design are used not only to drive selector cams but also for various other power actions, such as moving the type box, feeding the paper, etc. This type of clutch has exceptional stability, eliminating need for frequent torque adjustment. Lubrication chores are cut down, for the clutch requires oiling only once or twice a year. Printers need less frequent lubrication also, the 60-speed at 3000 hours of operation, 100-speed at 1500 hours of operation.

The magnet armature is small and light, with a very short travel, providing high-speed operation with low-power input.

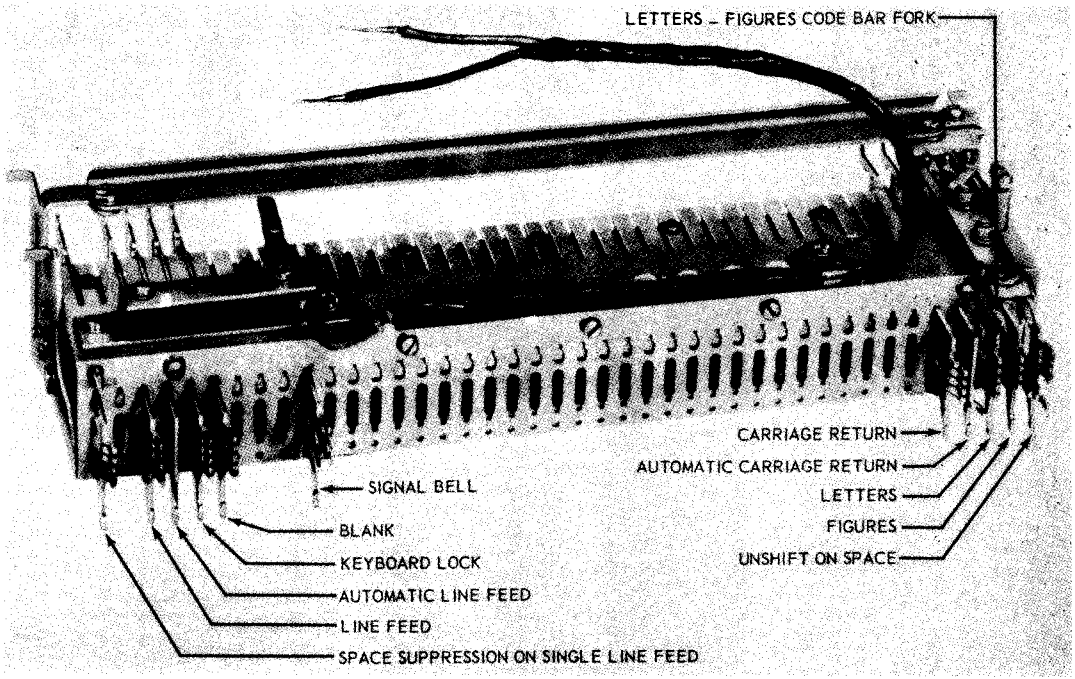


Figure 9–20.—Model 28 function box.

Function Box

In recent years there has been a growing need for a simple means of handling, without sacrificing key characters, an ever-increasing number of nontyping tasks, such as station selection, remote control, and suppression of typing and spacing.

All nontyping operations in the model 28 are controlled by the function box. It extends across the full width of the typing unit and has 42 slots. Each slot can hold a function bar capable of responding to an assigned code. Ten positions are reserved for such common functions as carriage return, line feed, and shift. Thirty-two positions are available for special assignments. This, in effect, expands the telegraph alphabet, since the number of possible code combinations is large.

Power-Driven Code Bar Selection

The code bars, the indexing mechanism from which the type box obtains its positioning information, are driven by direct motor power to either the marking or spacing position. This overcomes effects of gravity and the drag of thick lubricants under low temperature conditions. Positive drives are extensively used throughout the printer for these same reasons.

Paper Feed

For line feed, a separate clutch is used. This permits power feed-out of paper and eliminates need for an exposed platen (paper roller) crank. An improved paper straightener mechanism provides constant operation under adverse conditions without paper jamming.

Ribbon Mechanism

The ribbon spools are mounted on the machine itself, rather than on the type carriage, providing a straight course for ribbon travel. This arrangement facilitates changing ribbons and cuts down on the number of guides required.

Synchronous Motor

Ball bearings in the synchronous motor are oversize to minimize bearing trouble. The starting switch has been eliminated by a rugged external starting relay, so your maintenance man has no need to open the motor. The internal air circulating system takes heat out of the motor rapidly, and an external fan circulates warm air along the machine cover surface. Heat thus is dissipated quickly from the machine without need for external air circulation. This helps to keep noise in and dirt out. Rubber mountings are provided to minimize motor noise.

Governed Motor

The universal a-c/d-c governed motor operates at 3600 rpm, which is the speed of the 60-cycle synchronous motor, and therefore uses the same gears. The two motors are mechanically interchangeable.

The governor has a life of 3000 hours without attention. This is approximately equal to the life of the motor brushes and matches the extended service period for the rest of the machine.

Page Printer Cabinet

The cabinet was designed to provide maximum operating convenience and optimum accessibility for servicing and maintenance. All mechanical controls have been moved to the front. The manual platen crank has been replaced with a rapid motor-driven feed-out controlled by a button on the keyboard.

A lamp within the cabinet illuminates the copy. The angle of the window above the copy reduces glare.

The upper section of the cabinet swings open to provide access for inserting paper and ribbons and for maintenance. The entire page printer keyboard set is mounted on a cradle so that the set can be pivoted forward for access on all sides. If desired, you can remove the operating portions of the set from the cabinet. The lower front tray can then be slipped horizontally into the upper portion of the cabinet to provide you with a working surface for maintenance.

Electrical accessories, such as the line relay, motor control relay, and rectifier, have been placed in a box behind the typing unit.

Except for a narrow paper exit slot, the cabinet is entirely sealed to suppress noise and keep out dust.

For rack or table mounting, a lightweight cover, which includes most features of the cabinet design, is provided. It is close-fitting and takes up minimum space.

ASSOCIATED EQUIPMENT

Without connections to other teletypewriters, your models 19 and 28 are nothing more than electrical typewriters. Equipment is needed to convert teletypewriter signals to radio signals when transmitting and to change radio signals to teletypewriter signals when receiving. Patch panels are necessary to interconnect teletypewriter equipments with various radio adapters, such as frequency shift keyers and converters. This section describes common types of associated equipments found aboard ship and explains how they operate. Before studying this material, be sure to review the chapters on radio equipment and radioteletypewriter operation in the *Radioman 3 & 2* training course.

FREQUENCY SHIFT CONVERTER-COMPARATOR GROUP AN/URA-8A

Purpose and Function

Frequency Shift Converter-Comparator Group AN/URA-8A (fig. 9-21) operates from the audio output of two RBA, RBB, RBC, or similar receivers in dual-diversity reception of frequency shift transmissions. The AN/URA-8A converts the audio frequency shifts into pulses which are used to key the d-c loop circuit energizing automatic teletype printers.

The equipment will operate with radio receivers in either space diversity or frequency diversity on carriers within the frequency range(s) of the receivers employed.

The frequency shift converter-comparator group comprises two frequency shift converters and one comparator mounted in a special table-type rack. The equipment includes interconnecting cables, plugs, and accessories. In diversity reception the output of each receiver is connected to one of the two converter units. The d-c signals from the discriminator cir-

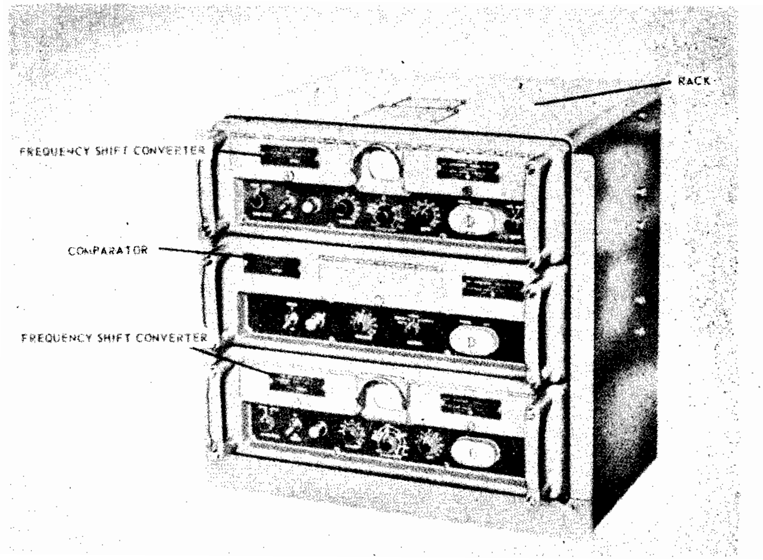


Figure 9–21.—Frequency Shift Converter-Comparator Group AN/URA–8A.

cuits of the two converters are fed to the comparator. (The discriminator circuit converts frequency shift changes into corresponding d-c voltages.) In the comparator the two signals are compared in a circuit which automatically selects the better mark and the better space pulse for each character. Therefore the better signal will always be keying the teletypewriter.

The frequency shift converters may be used separately for single receiver reception of the frequency shift signals. Each converter has its own output circuits for keying the teletype d-c loop and for providing a keyed audio tone. When the converters are on single receiver operation, the comparator may be associated with one of them to provide an additional set of output circuits, if desired.

Physical Description

As can be seen from figure 9–21, the converter and comparator units are alike in size and similar in appearance and construction. Each unit is housed in a gray aluminum alloy case fitted with double extension drawer slides. These slides support the chassis panel assembly of the unit when completely withdrawn from the case. When withdrawn, you can tilt the chassis assembly to any one of five positions and then lock it to facilitate adjustment and maintenance. A cable filter is mounted inside the rear of each case. Filters for the converter and comparator are similar physically but differ electrically. Connections between the cable filter and its corresponding chassis panel assembly are made through a pair of mating multiple contact connectors. These connectors are separated when the chassis assembly is pulled out.

A jumper cable is provided to complete the circuits to a withdrawn unit, the connectors being the same on both units. The jumper cable is stored inside a compartment in the comparator.

Input and output connections to the units are made by a row of connectors at the back, which are part of the cable filter

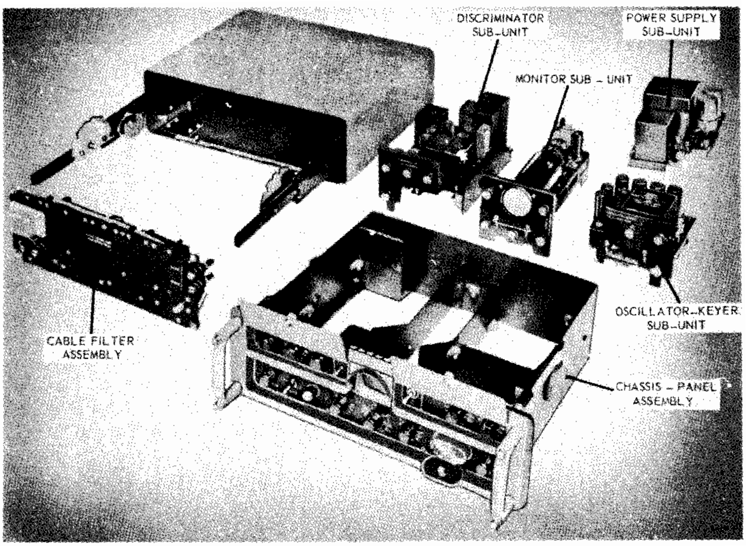


Figure 9-22.—AN/URA-8A converter subunits and major assemblies.

in each unit and extend through an opening at the back of the case.

Operating controls for each unit are in a recessed area in the lower half of the front panel. Semipermanent controls and adjustments on the front panels are covered by small hinged access doors. Two jacks are provided on the control panel of each unit for monitoring the teletype d-c loop circuit and the tone output circuit. These also are covered by a small hinged door.

Subunits

The chassis of the converter and of the comparator is divided into separate subunits which plug into the main shell of the chassis. Provision is made for removing the subunits containing operating controls by having the control knobs mounted on separate shafts. These shafts may be pulled forward to disengage from the shafts of the controls in the subunits. All

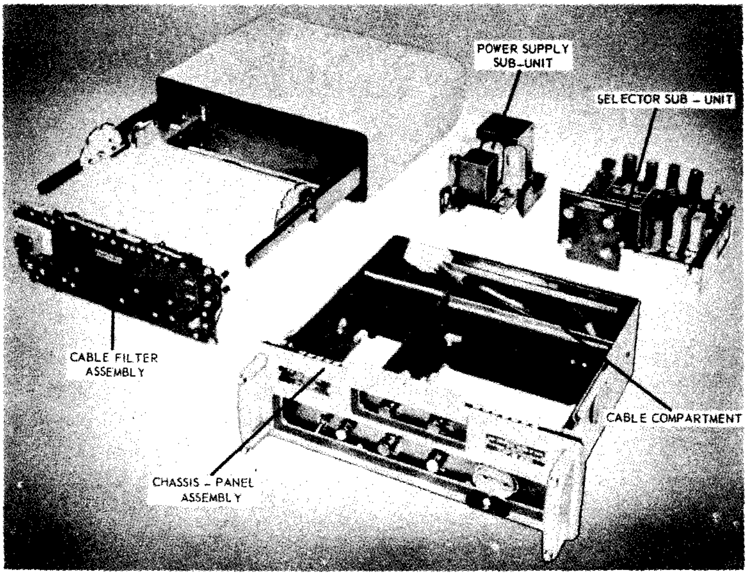


Figure 9-23.—AN/URA-8A comparator subunits and major assemblies.

subunit connections to the wiring of the chassis panel assembly are made through a mating pair of multiple contact connectors. Thus it is easy to replace a defective section of the equipment.

The AN/URA–8A group operates on power supplies of 105, 115, and 125 volts a-c, 50 to 60 cycles per second, single phase. For the frequency shift converter unit, power source is .520 ampere (115 v); for the comparator unit .343 ampere (115 v).

Frequency Shift Method

Before studying the theory of operation of the AN/URA–8A, a review of the frequency shift method of communication is necessary. This method is a system of automatic code transmission and reception that shifts the carrier frequency back and forth between two distinct frequencies to designate, respectively, the MARK and SPACE portions of the code characters. It provides noise reduction and other advantages of frequency modulation for telegraph, teletype, and similar signals.

Main advantage of the carrier frequency shift method of transmission and reception is ability of the radio transmitter to maintain a constant power output during transmission of marking and spacing impulses comprising the intelligence. Hence, the carrier wave of a transmitter produces a constant level of r-f voltage at the input to a distant receiver.

The system of reception to be considered here requires the use of a radio receiver for changing the r-f carrier into an audio tone by the beat-frequency oscillator. The carrier shift then becomes an audio frequency shift of the same number of cycles per second.

The frequency shift employed may be as little as 10 or as much as 1000 frequency separation between mark and space signals. This scope of frequency shifts is divided into two ranges called NARROW SHIFT and WIDE SHIFT. Narrow shift covers the range of 10 to 200, and wide shift covers the range of 200 to 1000.

Diversity Reception

The AN/URA–8A converter-comparator is used with two standard radio receivers (RBB, RBA) operating in a diversity system. In SPACE diversity reception, the two receivers are tuned to the same frequency but the receiving antennas are spaced more than 1 wavelength apart. In FREQUENCY diversity reception, the two receivers are tuned to separate frequency shift carriers of different frequencies which are simultaneously carrying the same mark-space characters. Advantages of diversity operation for reception of distant signals result from the fact that (1) a single r-f carrier generally does not fade simultaneously at spots that are more than 1 wavelength apart, or (2) fading of carriers of different frequencies generally does not occur at the same time.

Output of each of the receivers is connected to the frequency shift converter which converts the frequency shift characters into d-c pulses. These mark-space pulses are fed to the comparator where an automatic circuit selects and uses the better signal to ultimately control an automatic teletypewriter printer and/or to produce a keyed output tone.

Single Receiver Reception

Where conditions do not require diversity operation, each converter may be used separately with a single receiver for reception of frequency shift signals. In single receiver reception, using 1 frequency shift converter, the d-c pulses derived from the frequency shift characters are used by the converter's own output circuits to key the teletype d-c loop and produce a keyed tone output. In this manner, the two converters may be operated simultaneously in two independent communication circuits. The converter output circuits provided for this purpose are the same as the corresponding circuits of the comparator.

Simplified Block Diagram

The top row of blocks in figure 9–24 indicate the basic functions of converting an r-f frequency shift signal into a signal for controlling the d-c loop of a teletype printer. Frequency shifts of the audio-frequency output of the radio receivers are converted into d-c pulses by action of an audio-frequency discriminator. These d-c pulses are fed into a keyer and electronic relay circuit which opens and closes the d-c loop circuit

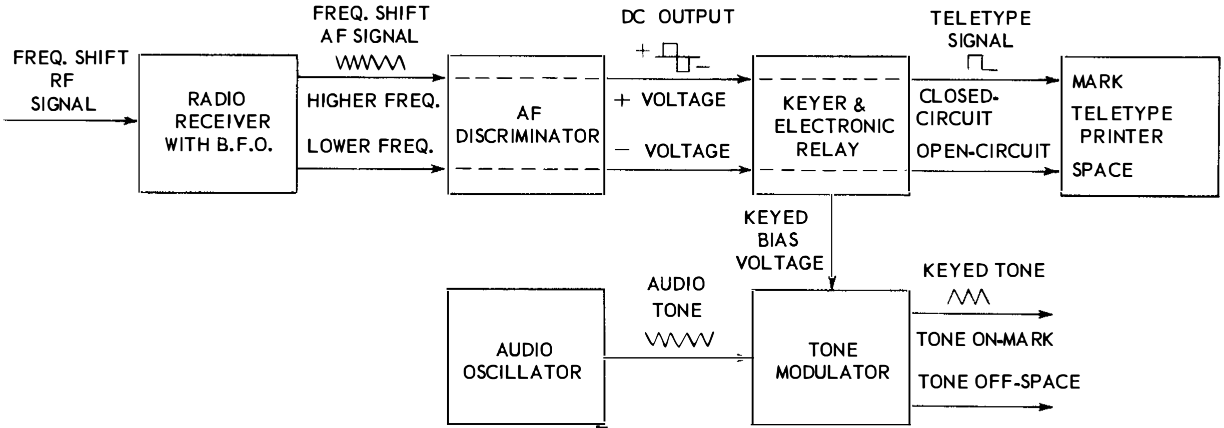


Figure 9-24.—AN/URA-8A simplified block diagram.

of the associated teletype printer. This causes the mark-space characters to operate the teletypewriter.

Lower blocks in figure 9–24 represent the circuit for the keyed tone output. A tone generated by the audio oscillator is fed to the tone modulator. The tone modulator stage is prevented from passing signal by the high bias from the keyer representing a space pulse, and is biased as a normal push-pull output stage during the mark-signal pulse from the keyer. The keyed tone output may be transmitted over landline to the frequency shift keyer of an associated transmitter for further RATT transmission, if desired. Conversion of the mark and space signals in the frequency shift keyer for transmitter operation is described later.

The frequency versus mark-space relationships shown in figure 9–24 are the most typical, but a reversing switch (not shown) following the discriminator provides for the other situations where the frequency-mark-space relationship is opposite. In the most common frequency shift modulation, the higher radio frequency represents mark and the lower represents space. However, the opposite is sometimes used. Also, in the receiver the tuning and heterodyning of the signal may reverse the relationship.

Except for comparing and selecting signals in diversity operation, basic functions of the complete equipment are the same as for a single converter unit.

FREQUENCY SHIFTER KEYER KY–30/GRT

Purpose

Frequency shift keying is used principally for long-distance communication in the higher frequencies (3 mc to 30 mc). The keyer can be connected to different types of Navy transmitters, and is arranged so that closing the contacts of a telegraph key or teletypewriter produces a mark (tone on) signal. This causes the transmitter to emit a frequency above the mean assigned frequency of the transmitter. Opening the contacts of a telegraph key or a teletypewriter produces a spacing signal (tone off), which causes the transmitter to produce a frequency below the mean frequency of the transmitter. Upper and lower values of the shifted frequency are adjusted to be located symmetrically above the assigned transmitter frequency (above and below the carrier by about 425 cycles, if the total shift is 850 cycles).

The frequency shift keyer ordinarily is used at the transmitting station of a radiotelegraph circuit. Telegraph signals are generated at a control point equipped with teletypewriter keyboards, tape transmitters, or a hand telegraph key for frequency shift transmissions. At the receiving terminal the frequency-shifted signals are copied by an operator (in the case of hand-sending), or they serve to actuate a teletypewriter, reperforator, or tape recorder. Both the transmitting and receiving radio stations may be remote from communication centers and ordinarily are connected to the stations by wire circuits.

Operating Frequencies

The radio-frequency output of Keyer KY-30/GRT (fig. 9–25) is in the range 1000 to 6700 kilocycles. This frequency is shifted upward or downward a small amount to produce r-f telegraph signals corresponding to the d-c polar or neutral signals connected to the keyer. The difference between the upper and lower r-f shifts is commonly about 850 cycles. Total shift, however, can be set for values ranging from a few cycles to 1000 cycles. The r-f output circuit of the keyer is designed to be connected to the power amplifiers of a radio transmitter.

The keyer requires a radio-frequency carrier between 0.8 and 6.5 mc, which must be approximately 200 kc lower in frequency than the assigned mean carrier frequency of the transmitter. The carrier can be obtained either from the oscillator included in the keyer, or from an external oscillator, which can be the master oscillator or crystal-controlled oscillator of the associated transmitter.

Equipment Arrangements

Keyer KY-30/GRT is mounted on a horizontal chassis with a 15½ by 19 inch panel (fig. 9–25). All controls necessary for

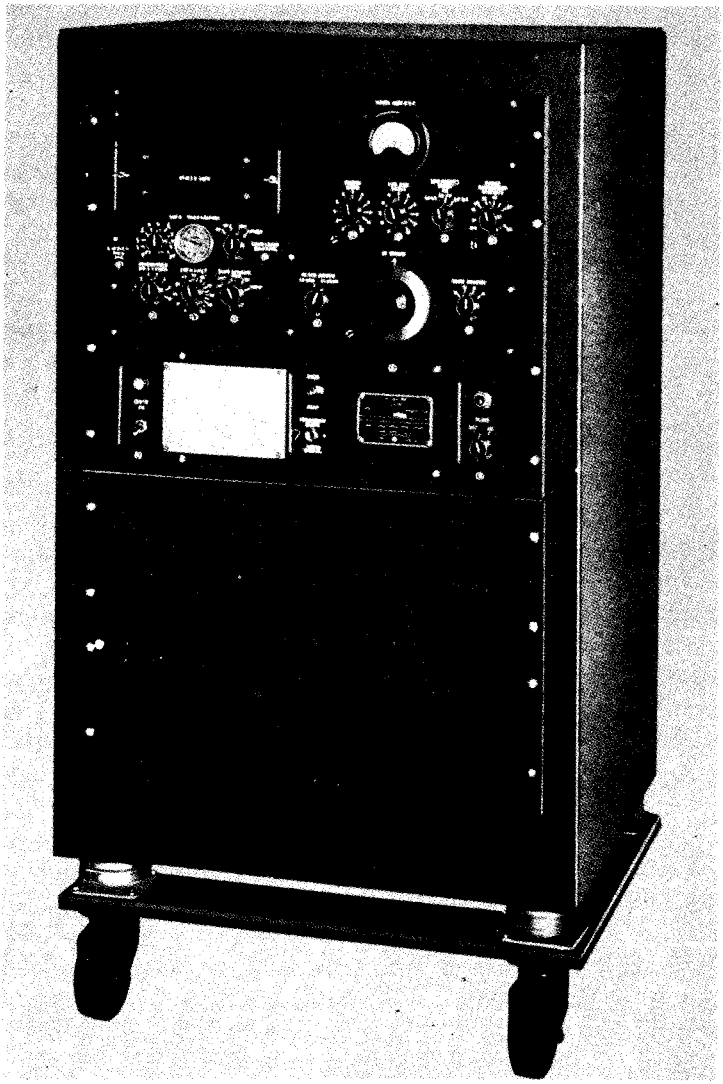


Figure 9-25.—KY-30/GRT frequency shift keyer.

normal tuning and adjustment are located on this front panel. Controls not requiring adjustment during normal operation are located at the rear of the chassis. Fuses and receptacles for attached cable assemblies are also on the rear of the chassis. A temperature-controlled oven which contains the 200-kc oscillator and its components is located on the horizontal chassis. Also included in the oven are the keyer tube circuits and phase-shifting amplifier circuits which are necessary to bring about frequency shift operation of the 200-kc oscillator. The oven includes mountings for three crystals. The radio-frequency circuits which mix the injection voltage and the 200-kc oscillator voltage and amplify the output of the mixer are located in shielded compartments to prevent interaction. A 5-gang tuning capacitor provides simultaneous tuning of all circuits within operating range of the unit.

The radio transmitter at the transmitting station is equipped with a connector panel which can be used for connections among different types of frequency shift keyers. The connector panel contains coaxial jacks, power supply, and other receptacles which correspond to those of the KY-30/GRT. The keyer can be associated quickly with other components of the system by connecting six patching cable assemblies. These six connections provide a primary power supply to the keyer and complete the input, output, and test connections.

Operation

Principle of operation of the keyer is suggested by the functional block diagram, figure 9-26. The r-f input to the keyer may be that from an oscillator associated with a Navy transmitter or that of the crystal oscillator of the keyer. The keyer oscillator is equipped with three crystals, any one of which may be selected by a crystal selector switch. Input to the keyer must be in the frequency range 0.8 to 6.5 mc, which is 200 kc less than the output frequency. Frequency of a 200-kc oscillator is raised and lowered a small amount in response to mark and space telegraph signals, and is added to the radio-frequency output of the transmitter or keyer oscillator in the balanced modulator. The transmitter or keyer oscillator frequency thus is balanced out. Only the sum and difference frequencies, resulting from mixing the keyer input and the 200-kc oscillator output, are present in the output of the balanced modulator. The plate circuit of the modulator is tuned to the higher or sum frequency, thereby eliminating the difference frequency.

Components of the crystal oscillator, the 200-kc oscillator, balanced keyer, and phase-shifting amplifiers are located in an oven. Temperature of the oven is closely regulated at about 72° C. (161.6° F.).

Output of the balanced modulator is amplified in two stages, consisting of an intermediate amplifier and an output (or power) amplifier. The intermediate stage permits a low output from the balanced modulator, and provides additional filtering of the sideband output. A ganged variable capacitor tunes the output circuit of the balanced modulator, the inter-

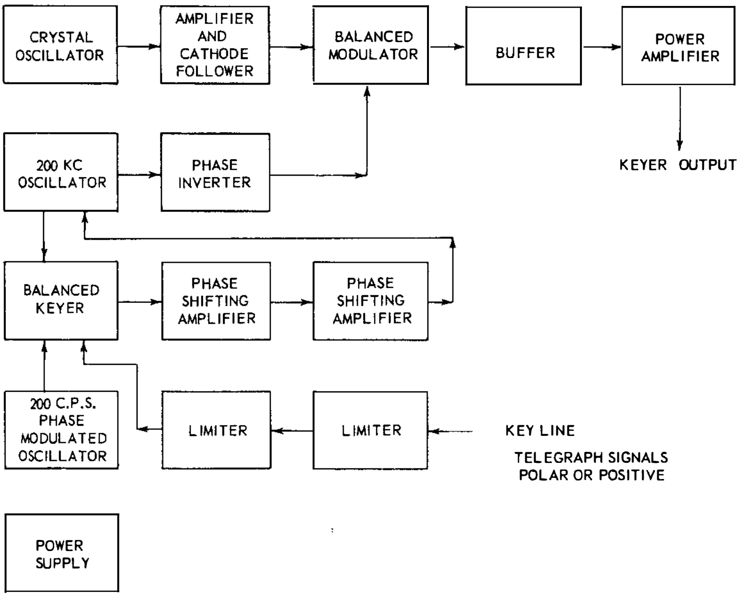


Figure 9-26.—KY-30/GRT functional block diagram.

mediate amplifier, and the output circuit of the power amplifier stage. The plate circuit of the output amplifier includes an autotransformer for matching the low impedance of the line to the radio transmitter.

Output level is controlled by adjusting the screen voltage of the power amplifier and buffer stages. Tuned circuits of the balanced modulator and the intermediate and output amplifiers are separated into three bands in the ranges 1.0 to 1.9 mc, 1.9 to 3.6 mc, and 3.6 to 6.7 mc. A band is selected by the FREQUENCY RANGE SWITCH.

The keying circuit normally operates on polar signals, or neutral signals. In ordinary cases the negative side of the external keying circuit is at ground potential. A limiter tube prevents negative key line voltage from affecting operation. A second limiter limits the maximum positive signal to the balanced keyer tube to maintain a constant value in spite of variations in amplitude of key line signals.

The form of the output keying voltage may be modified by the series inductance and bridge capacity controlled by the WAVE SHAPING switch. (See fig. 9–25.) It may also be wobbled at about 200 cycles per second by turning on the PHASE MODULATION switch. The amount of phase modulation is varied by adjusting an associated dial. Phase modulation of the transmission may tend to improve reception under some conditions of severe selective fading.

Output voltage from the limiter tube results in mark and space signals, with or without wave shaping and phase modulation, which are coupled to the balanced keyer tube. Full output of the balanced keyer tube, or a fraction thereof, is connected to a 2-stage phase-shifting amplifier through a point on a voltage divider selected by the TRANSMITTER MULT. FACTOR switch. Output of the phase-shifting amplifier is connected to the 200-kc oscillator, causing the frequency of the 200-kc oscillator to increase a small amount (for example, 425 cycles for a mark signal) or to decrease a small amount (425 cycles, say, for a space signal). The amount the frequency of the 200-kc oscillator is changed depends on the output of the phase-shifting amplifier. In turn the amplifier is influenced by the input from the balanced keyer tube.

The 200-kc oscillator is a self-excited single-ended type, frequency of which is changed by output of the phase-shifting amplifier and, to a limited extent, by a variable capacitor, CARRIER FREQ. ADJ. Output of the 200-kc oscillator is frequency-modulated by telegraph mark and space signals, with or without superimposed wave shaping and phase modulation. This frequency-modulated 200-kc oscillator output is combined in the balanced modulator with the output of the transmitter (or keyer) oscillator.

The keyer has a rectifier power supply circuit which produces a low-voltage a-c heater supply, a positive 400-volt plate supply, a positive 250-volt plate supply, a regulated positive 150-volt supply, and a negative 45-volt bias supply.

TELETYPE PANEL TT-23/SG

Teletype Panel TT-23/SG is used aboard ship to facilitate interconnection and transfer of teletype equipment with various radio adapters such as frequency shift keyers and converters and tone modulation terminal equipments.

There are six channels, each comprising a looping circuit of two looping jacks, one set jack, a rheostat for adjusting line current, and a toggle switch for selecting either a local or external source of line current. A meter and rotary selector switch is used for measuring line current in any channel. Six miscellaneous jacks are supplied to connect teletype equipment not regularly assigned to a channel. Inside the cabinet is a connection block to which all teletype equipment, radio adapters, and local current connections are terminated.

No repair parts are supplied with the patch panel. See the instruction book for a description of each part which might need replacing.

Basic Circuit Design

Teletype Panel TT-23/SG contains six looping circuits (fig. 9-28). (Looping is the manner is which jacks are connected in series with the teletype equipment and radio adapters to

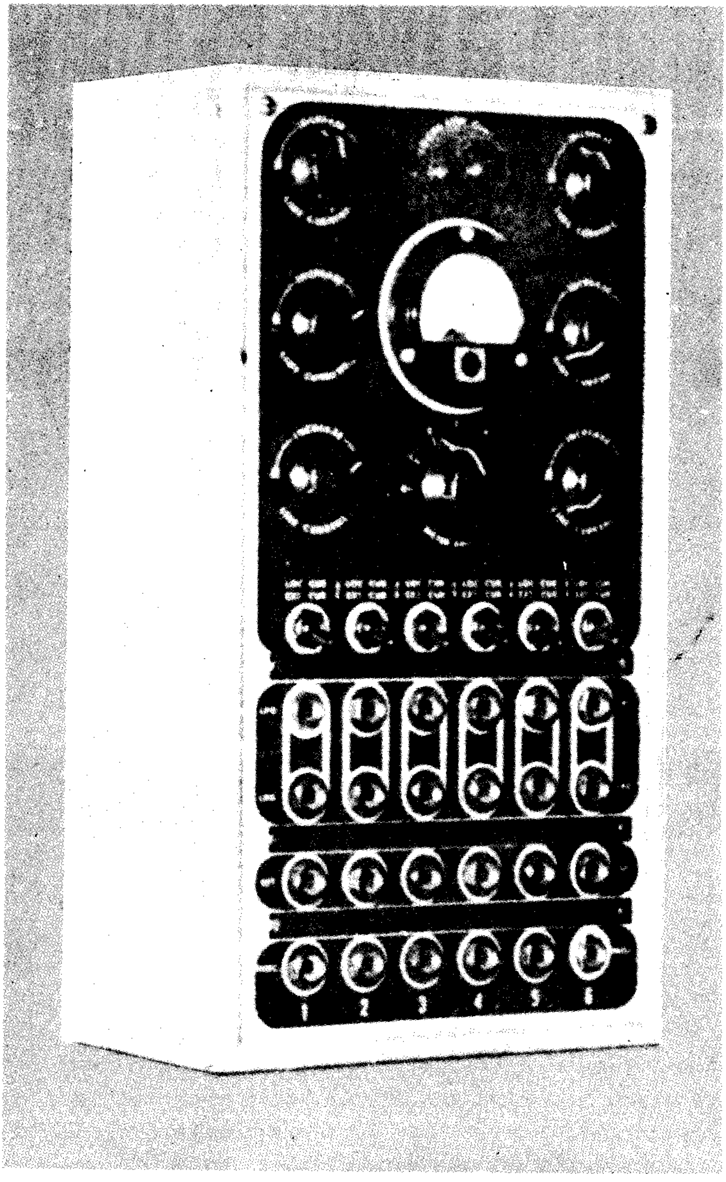


Figure 9–27.—Teletype Panel TT–23/SG.

form a complete loop.) The jacks shown in figure 9–28 are lettered for identification only. Jacks A and B are labeled LPG on the front panel. They are the standard type 49560 or similar phone jacks. With the jumper connected as shown, the tip and sleeve springs are shorted through the spring contacts, providing circuit continuity through each jack. Insert a patchcord plug in either jack A or B to open the spring contacts. This allows other equipment to be connected in the series circuit.

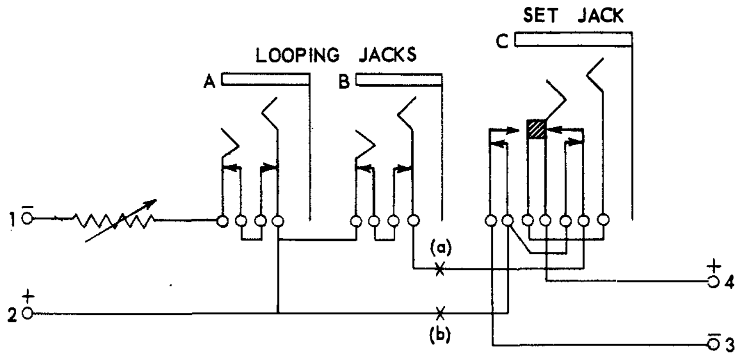


Figure 9–28.—Basic looping circuit.

Jack C, the set jack, has a double pole-double throw switch. When no plug is inserted in the jack it functions the same as the looping jacks. By inserting a plug in the set jack, however, the sleeve and tip of the plug are connected respectively to terminals 3 and 4 (series) of the connection block to which a teletype equipment may also be connected. The looping circuit is disconnected simultaneously from terminals 3 and 4 (series) and closed. Complete looping continuity is thus retained through the radio adapter and A and B. Switching action of jack C is shown in figure 9–29.

To transfer a teletypewriter from one channel to any other channel, patch the teletype equipment from its corresponding set jack to one of the two looping jacks in the desired channel. If necessary to keep the teletypewriter wired in this channel from operating, simply insert a dummy plug (supplied with the panel) in the set jack.

Any teletypewriter connected to terminals 5 and 6 (series)

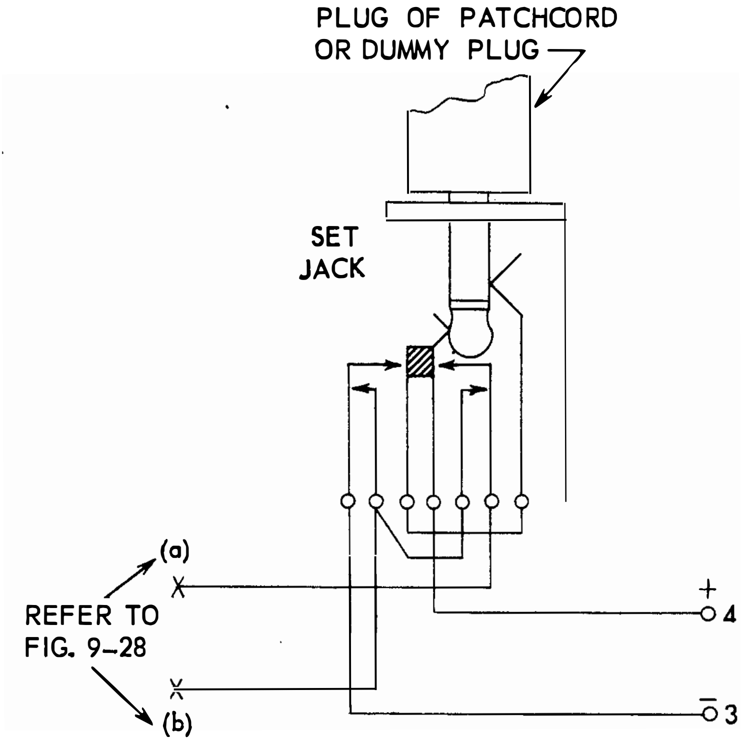


Figure 9-29.—Switching action of set jack.

of the connection block (fig. 9-30) may be patched from the miscellaneous jack to a looping jack of any desired channel.

Included in each looping channel is a battery selector switch, enabling you to select either local or external line current. There is also a rheostat for adjusting line current, and a meter shunt resistor.

Provisions are made to connect a local source of 115 volts d-c across corresponding terminals of each channel by the

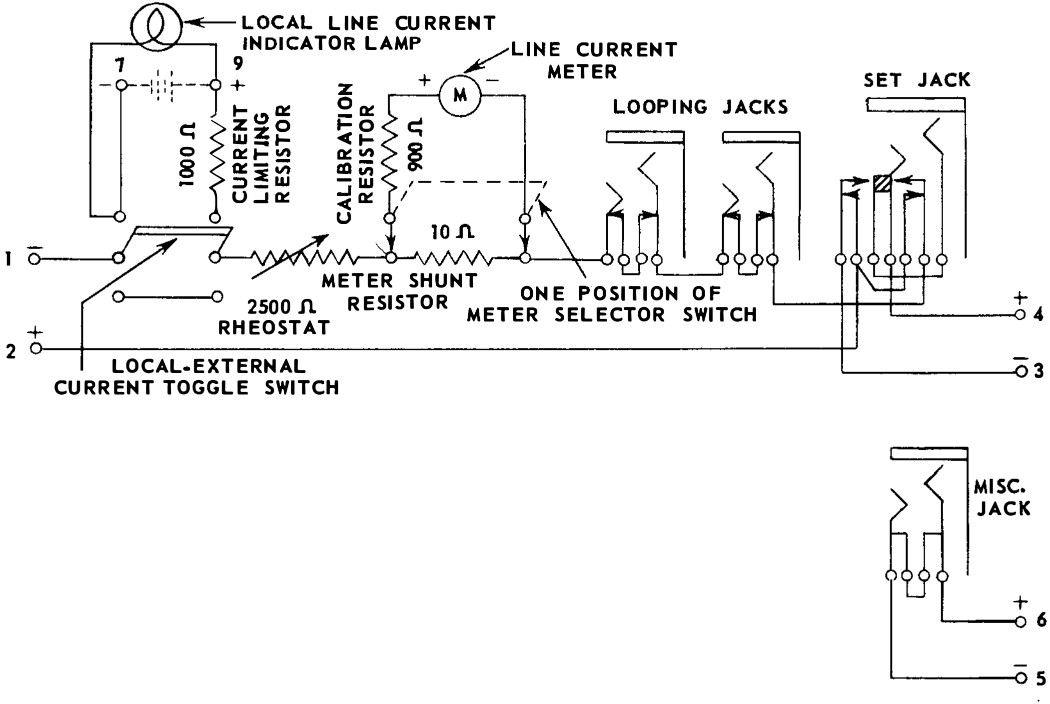


Figure 9-30.—TT-23/SG single channel schematic.

selector toggle switch. Bear in mind that this local current is required only when using radio adapters in which line current is not supplied.

The meter and meter selector switch measure the line current in each channel. By having identical meter shunt resistors in each channel, the meter may be switched to any channel without interrupting the teletype signal.

The TT–23/SG also provides for testing teletype equipment. If signal distortion test equipment is available, for example, the test equipment may be permanently connected into one channel in the same manner as a frequency shift converter or keyer. A teletypewriter terminating in this panel or an adjacent panel may be patched into the test circuit.

RADIO TELETYPE TERMINAL SET AN/SGC–1A

Radio Teletype Terminal AN/SGC–1A is used with a standard teletypewriter for the transmission and reception of teletypewriter messages by radio communication between stations similarly equipped. The terminal converts intelligence of outgoing messages to audio tone signals that can be transmitted by a VOICE-operated radio transmitter. It also reconverts the intelligence of incoming signals to a form that can cause a teletypewriter to print the message. It functions, then, as a combination keyer and converter.

The AN/SGC–1A operates on a slightly different principle than the keyers and converters previously mentioned. It uses an amplitude modulated signal instead of a frequency shift. Here is how it works:

When transmitting messages, typing on the local teletypewriter causes a direct-current series loop to open intermittently, forming pulses of current. Each letter has its own characteristic pattern of current pulses. These pulses are converted by the local teletypewriter terminal into corresponding audio tones which modulate the local voice-frequency radio transmitter. Conversion of the current pulses to audio tones is accomplished by an audio oscillator in the teletypewriter terminal. The

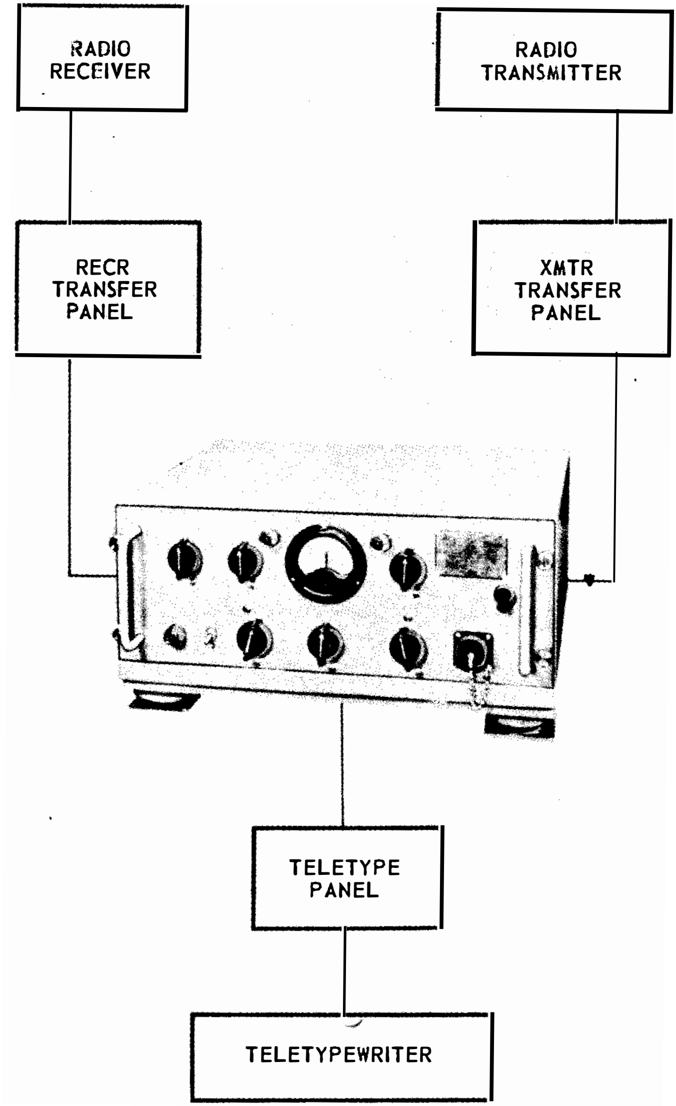


Figure 9-31.—AN/SGC-1A, showing connections to associated radiotelephone equipment.

oscillator operates at 700 cps when the teletypewriter loop is in a closed circuit condition (mark), and at 500 cps when the loop is in an open condition (space). An internal relay of the terminal closes a control line to the radio transmitter which places the unit on the air the moment the operator begins typing the message. This control line remains closed until after the message has been transmitted.

When receiving messages, the equipment accepts incoming mark and space tones from an associated radio receiver. The AN/SGC-1A then converts the intelligence of the tones to a make-and-break contact of a relay connected into the local teletypewriter direct-current loop. Thus the local teletypewriter is made to print in unison with the distant teletypewriter.

Description of Controls

Figure 9-32 shows the principal operating controls of the AN/SGC-1A. In the upper left of the front panel is the REC LEVEL calibrated attenuator. When this control is adjusted properly, the level of the incoming tone signals is set to the required level. Next to the REC LEVEL control is the LOOP CURR rheostat. The rheostat permits adjustment of the teletypewriter loop current, when in mark condition, to 60 milliamperes. In the upper middle is a zero-center meter. The METER SWITCH below it has several positions, allowing all necessary portions of the circuit to be measured. Flanking the upper part of the meter are two indicator lights. One is on in RECEIVE condition, and the other is on in TRANSMIT condition. Both lights are off when the terminal is in standby condition. The SEND BIAS rheostat to the right of the meter enables correction of any teletype distortion in the local teletypewriter loop.

At the far right is a jack marked TTY MONITOR. A test or monitoring teletypewriter may be patched into this jack, placing it in series with all other equipments in the loop. The POWER indicator light is at the lower left. Next to it is the POWER ON-OFF switch. When ON, this switch causes the source

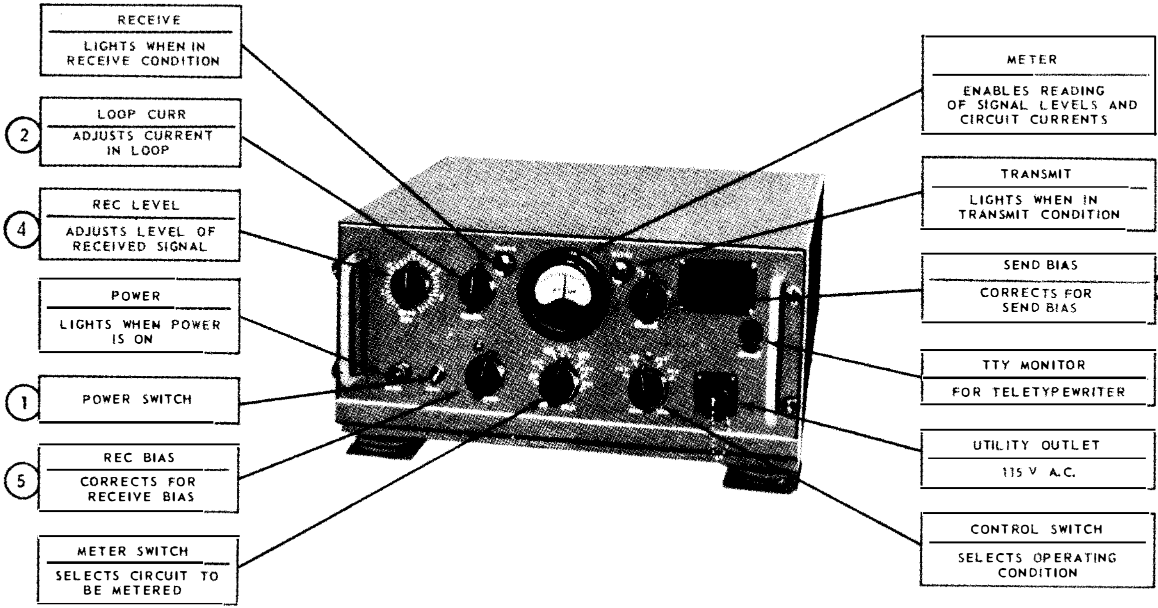


Figure 9-32.—AN/SGC-1A operating controls.

of 115-volt a-c power to be applied to the teletypewriter terminal unit. It also causes the adjacent indicator to light. The REC BIAS potentiometer enables correction of distortion in the receiving tone circuit. To the right of the previously described meter switch is the CONTROL SWITCH which may be set to determine the functioning of the teletypewriter terminal. At the lower right is the fused 115-volt a-c utility outlet. This outlet is connected directly to the power line and is not controlled by the power switch.

Chassis

On each side are two retaining bolts. When they are loosened, the front panel and chassis assembly may be pulled out on runners. After reaching the limit of free travel, the chassis may be tilted up to approximately a 90° angle, to facilitate inspection and maintenance. Power circuits and external circuits are connected to the outer cabinet by cables and by flexible cables to the chassis. The chassis may be tested in an operating condition even when tilted up.

Operation of AN/SGC-1A

All principal circuits of the teletypewriter terminal and representative oscilloscope patterns are shown in the block diagram, figure 9–35. At the input of the receive circuit is the attenuator which permits adjustment of the level of the incoming two-tone signal. A band-pass filter circuit then passes audio frequencies that fall between 400 and 800 cps, rejecting all other frequencies.

Following the filter are the amplifier limiter stages which have a constant output level. The oscilloscope wave form at the output of the amplifier limiter shows a distorted group of cycles instead of the squared top signals usually expected. This is due to the reflected losses of the following filters. The frequency discriminator filters select the fundamental frequencies, 500 and 700 cps, and route them to two germanium rectifiers. These rectifiers in turn apply the rectified d-c power to a d-c amplifier. This amplifier is so connected as to cause

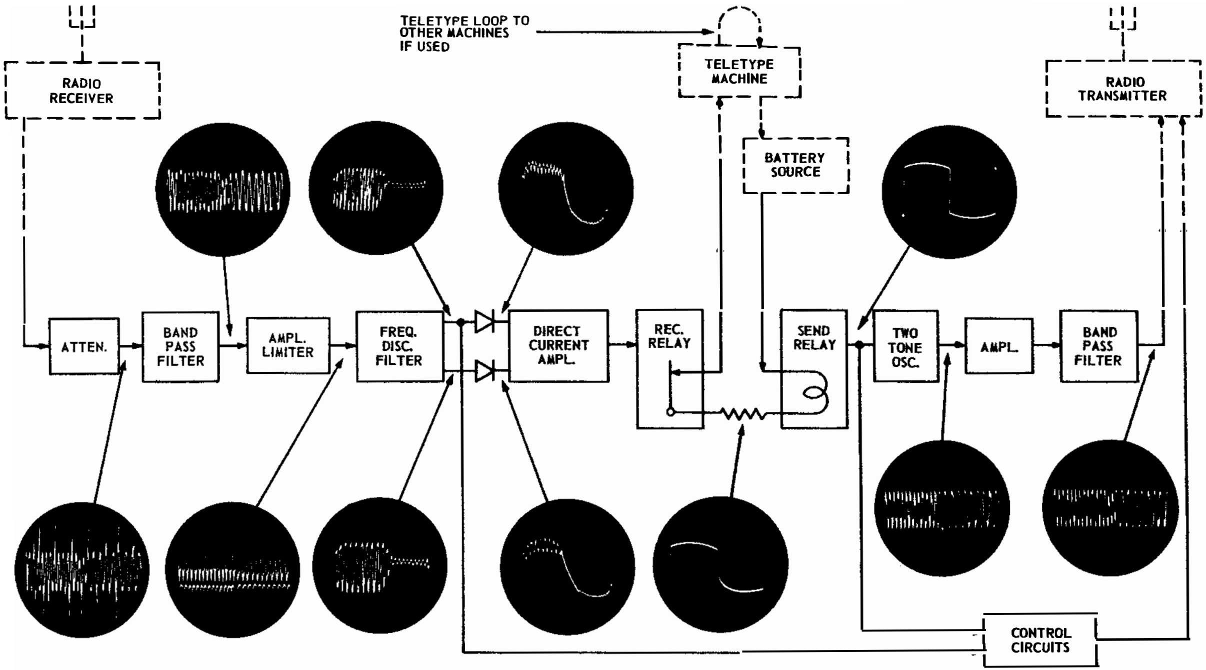


Figure 9-33.—AN/SGC-1A system block diagram.

the receive relay to close its contacts when the incoming signal is 700 cps (mark) and to open its contacts when the incoming signal is 500 cps (space).

One set of contacts of the receive relay is in series with the teletypewriter closed series loop. The closed series loop comprises one or more teletypewriters, series resistance, a battery or other 110-volt d-c source, and one winding of the send relay. Consequently, the receive relay is able to open and close the local teletypewriter loop, thus forming current pulse patterns in this loop identical to those in the transmitting teletypewriter loop.

Teletypewriters Used With Terminal Set

Teletypewriters used with the AN/SGC–1A must be those that operate on a normally closed line having a current of 60 milliamperes. These teletypewriters have the selector magnet and the keyboard contacts wired in series in the teletypewriter loop. If the loop current remains steady, the teletypewriter will be idle. But if the loop current is broken by action external to the teletypewriter machine, the closed keyboard contacts in the machine will permit the selector magnet to operate properly and cause the incoming message to be printed on the paper. Messages may be handled only by half duplex operation (transmissions in only one direction at a time).

Since the keyboard contacts and the selector magnets are wired in series, the message is also printed on the paper as it is typed, so that the operator may check and correct for errors in his typing. Depressing the keys breaks the loop current, and the send relay of the teletypewriter terminal causes a d-c voltage to key the two-tone oscillator and the control circuits. An interlock action of the control circuits prevents operation of the send relay when the teletype terminal is in the receive condition.

The two-tone oscillator operates at 700 cps when the send relay is in mark condition and at 500 cps when the relay is in space condition. Output of the oscillator passes through a level-controlling potentiometer to the amplifier stage. Then the amplified signal is fed through a band-pass filter to the ship's radio transmitter.

Control Circuits

Control circuits cause the individual sections of the terminal to be rearranged for the various functions. When the control switch is on AUTO, the terminal may be in one of three conditions: receiving, transmitting, or standby. When in standby condition, the reception of an incoming mark tone causes the control circuits to change to receiving. Following the end of the incoming message the circuits shift back to standby. When in standby condition, operation of the local teletypewriter's keyboard causes the circuits to change to transmit. After the last letter is keyed, there is a time delay of about 3 seconds, then the circuits shift back to standby.

Interlocking functions purposely prevent the equipment from shifting directly from transmit to receive or vice versa. Thus an incoming signal will not interrupt outgoing traffic, nor will keying the local machine when receiving cause the circuit to shift to transmit. Control circuits, also, when shifted to transmit, cause the control pair to the radio transmitter to close, thereby placing the transmitter carrier on the air.

QUIZ

1. The model 19 set has a switching arrangement that permits three conditions of traffic transmission. Name them.
2. What is the primary function of a teletypewriter keyboard transmitting unit?
3. What is the function of the transmitter-distributor?
4. What is the most obvious improvement in the model 28?
5. What type of clutch is used in the model 28?
6. What is the frequency shift method of communication?
7. What is SPACE diversity reception?
8. What is FREQUENCY diversity reception?
9. Where is the frequency shift keyer KY-30/GRT ordinarily used?
10. Certain components of the KY-30/GRT are contained in an oven. Name them.
11. What are the power requirements of the KY-30/GRT?
12. What is the primary function of the teletype panel TT-23/SG?
13. Teletype panel TT-23/SG contains six looping circuits. Define looping.
14. What is the function of the AN/SGC-1A?

CHAPTER 10

CASUALTY PROCEDURES

EXPEDITIOUS ACTION

When your ship puts out on a mission, all hands must do everything possible to keep the ship afloat and to protect the lives of the crew. A Radioman supervisor must know WHAT TO DO and HOW TO DO IT when accident, fire, or enemy action threatens the safety and fighting ability of his ship and men. He must indoctrinate every communicator with the necessity for prompt action in case of material failure or battle casualty. Wasted time may cause needless damage to equipment or even loss of life.

ADVANCE PREPARATIONS

You can avoid confusion during actual emergencies by making advance preparations. Have each man study the watch, quarter, and station bill so that he knows his assigned station and duties perfectly. See that each man checks the bill frequently for possible changes. Query each communicator, especially a newcomer, on the exact location of his abandon ship station as well as on his assigned station for all other emergencies. Ask him the location of the first-aid station nearest radio central and other radio spaces, and the site of the decontamination (decon) station. Find out what piece of fire-fighting equipment he'd use to extinguish a class C fire. Make sure he knows the quickest but safest route to emergency radio spaces.

Every member of the COMM section has a part in carrying out the emergency destruction bill. Your men should know the exact place for destruction equipment such as sledge hammers, crowbars, chisels, and demolition charges. You and your men will get personal instructions from the custodian of registered publications on how to destroy classified matter. Each man should read the destruction bill carefully, and note particularly the item(s) he is to destroy when directed.

Examine battle lanterns daily and make sure spare flashlights are available for immediate use. Ascertain that lanterns in COMMCEN are located so that working personnel can carry on when lighting failures occur. Have lanterns relocated and bracketed to more suitable locations if necessary.

Examine first-aid kits to see if they are fully stocked. If a kit's seal wire is broken, an item may be missing. Have the medical department replenish as necessary. (On some ships only medical department personnel are authorized to inspect first-aid kits.)

Make sure that emergency, distress, scene of action, and SAR frequencies for your area are posted conspicuously. Each operator must be alert and acutely aware of the fastest means for delivery of such traffic.

Ensure that any defect which could affect the safety of an individual or cause electric shock is brought to the attention of the division officer.

Check all portholes, hatches, and spaces for watertight integrity.

Your gang may be responsible for weighing CO_2 extinguishers in radio spaces. Be sure this is done monthly, and check to see that the date of weighing is on the CO_2 bottle tag.

Review, in the damage control bill and associated bills, the procedures for controlling the blast and thermal radiation damage resulting from attacks by atomic weapons. Since radiological hazards occur only with atomic weapons, procedures for controlling the effects of nuclear radiation on personnel are found in the radiological defense bill, one of the associated bills. Know the contents of this bill and make sure your men are familiar with its provisions.

See that your men take the recommended precautions to avoid radiation effects in the event of an atomic attack.

Appendices C and D of *General Training Course for Petty Officers,* NAVPERS 10055 and *Atomic Warfare Defense,* NAVPERS 10097 contain additional information on the subject of defense against atomic attack.

STANDBY EQUIPMENT AND STATIONS

Designate backup frequencies, transmitters, receivers, antennas, and power supplies for emergency operations in locations as widely separated as possible. Ensure that spare emergency receiver and transmitter antennas are made up and stowed in appropriate locations for rapid rigging when required. See that all standby stations have all necessary communication publications such as call sign books, authentication tables, call sign cipher machines, spare logs, and message blanks. Your operators at standby stations should monitor major frequencies constantly so they can take over instantly if a breakdown or more serious casualty occurs in main radio.

KNOW YOUR EQUIPMENT

During emergencies such as fire or electrical failures there is no time to teach a man how to tune a transmitter or patch in transmitters and receivers to the various remote stations. Loss of key COMMCEN or radio central personnel may leave your strikers to carry on. Each man should know each type of equipment thoroughly. Remember, he may get rusty if he doesn't get to work on all the gear. When new gear comes aboard, break out its equipment instruction book, study the manual thoroughly, then show your men how the equipment works. Stress safety precautions found in the front of the book, and don't let a man touch the gear on his own until he is COMPLETELY CHECKED OUT.

If a frequency meter is knocked out, you may have to revert to calibration charts found in equipment instruction books, or calibration cards posted on each piece of equipment. Hold drills to see that each man can set up frequencies from these charts. Stress proper procedures for silent tuning. Make up a board listing the stages for tuning each transmitter and hang these instructions on the appropriate transmitter.

Each man should understand the flexibility of transmitter switchboards in the various radio spaces. In case of a shorted trunk line from radio II to radio I, for example, the associated transmitter can be patched through radio III in seconds if your men are well trained in switchboard operations.

HEAVY WEATHER PRECAUTIONS

Damage and loss of equipment sometimes occur during heavy weather when equipment is not properly secured. Loose gear can cause injuries to personnel and may start a fire if it slides into electronic equipment.

Check all radio spaces as soon as the word is passed to rig ship for heavy weather. Spare parts boxes, chairs, typewriters, fire extinguishers, and other loose gear must be properly lashed down. Ensure that positions and receivers are securely held in place. Once you are certain that all necessary steps have been taken to rig for heavy seas in your spaces, notify the OOD and the COMM officer or division officer.

Ready Spares

Ready spare are items necessary to make permanent or temporary on-the-spot repairs to equipment to keep it in operation. Such spares consist of tubes, fuses, antenna wire, insulators, and other items you deem necessary. Keep these spares in a separate and distinct location in COMM spaces and don't use them for anything but EMERGENCY REPAIRS. You may be custodian of the ready spare parts stowage spaces, so ensure that a record is kept of all spares taken. Also see that items are replaced at the first opportunity after use.

SAFETY PRECAUTIONS

Fast action and an automatic regard for safety precautions are extremely important in coping with casualties to communications equipment and personnel aboard ship. Too often, however, measures recommended to prevent accident or damage are overlooked during actual emergencies.

Each man should fully appreciate the hazards of working with electricity. You should stress special precautions due to employment of high-voltage power supply circuits and even higher radio frequency potentials; effect of fields existing in vicinity of antennas and antenna leads which introduce fire hazards; danger of shock to personnel; explosion hazards where ammo or explosive vapors are present; and dangers to men working aloft complicated by the ever-present toxic stack gases and electrical shock.

Review the following important points with your men frequently:

Basic electrical precautions and safeguards;
Proper methods of resuscitating a man unconscious from electrical shock;
Proper treatment for electrical shock and burns;
Safety regulations associated with communication equipment;
Proper procedures in event of electrical accident.

INSTILL AN ELECTRICAL SAFETY CONSCIOUSNESS IN ALL HANDS.

If you find a man is hazy regarding precautions to follow, have him reread chapter 13 of the *RM 3 & 2* training course and the following references given in that chapter pertaining to safety precautions: Chapter 1, Safety and First Aid, in the BUSHIPS *Electronic Installation Practices Manual*; *Electric Shock, Its Causes and Prevention,* NAVSHIPS 250–660–42; and chapter 18 of *U. S. Navy Safety Precautions*, OPNAV 34 P1. Remember, if there is any doubt as to what procedures should be followed, consult the radio officer.

LECTURES

Make arrangements with the medical department for lectures. Schedule these talks on your training program so that each watch stander as well as day workers get the up-to-date word on artificial respiration (back pressure arm lift method), decontamination procedures, types of bandages and splints, and other life-saving aids and techniques.

SCHOOLS

ABCD (atomic, biological, and chemical warfare defense) and fire fighters' schools offer further preparations for casualties. Subject to approval of your division officer, select men to attend courses offered at these schools. Choose men who can help you as instructors in these subjects during regular shipboard training. You will have to adjust the watch bill accordingly, but it is well worth the effort.

The ABCD course for rated men normally lasts several weeks. There are two short courses for fire fighters. The 2-day course teaches basic fire-fighting techniques. Methods of distinguishing shipboard fires and use and maintenance of equipment are offered in the 5-day course.

SIMULATED CASUALTIES

Have your radio gang demonstrate ability to make repairs quickly and handle satisfactorily each simulated casualty or failure. For best results, follow a detailed plan of action, stressing necessity for speed and accuracy. To get the most out of your men in the shortest possible time, follow in general the procedures described below.

After first clearing through the radio officer or COMM officer, ask the OOD for permission to hold a casualty drill. Then assemble necessary radio equipment, instruction books, and other material.

Brief participating personnel thoroughly on the purpose and importance of the drill and the procedure to be followed in conducting the exercise. Each man must know exactly what his job is. Questions should be asked at the briefing—not later.

When you are ready to proceed with the drill, declare the casualty. For example, state "Main radio completely destroyed," and specify "All personnel assigned to main radio are casualties." (Or you may declare a certain percentage of personnel as casualties.)

Participating personnel should then carry out the objective of the drill.

Notify OOD when communications have been reestablished.

Normal communications should not be disrupted. Be sure to analyze errors and discrepancies, if any, and show each man how to correct them.

ACCURATE REPORTS

Many precious minutes can be saved by COMM personnel in reporting casualties promptly and accurately. Drill your men in the following procedures so that when the next emergency comes up the casualty will be reported swiftly and correctly.

To report the casualty, use sound-powered telephones, MC units, ship's service telephone, voice tubes (if installed), or messenger. The initial report should contain the following:

1. Nature of damage (class C fire, bomb hole, shock casualty);
2. Location of damage;
3. Extent of damage (fire, smoke, or toxic gases present, etc.);
4. Measures being taken to combat damage (fire-fighting type of extinguishing agent, etc.);
5. Assistance required.

CASUALTY SITUATIONS

Every Radioman knows that the damage control organization aboard ship is primarily responsible for accomplishing emergency repairs or restorations after damage occurs. During battle, collision, heavy weather, or serious fires, the damage control and fire-fighting parties are ready with trained men and special tools for action against fire and damage. A damage control party may supply casualty power, regain a safe margin of stability and buoyancy, replace essential structures, and man essential equipment. But no one can foresee just where the damage or fire will strike. Remember, COMM spaces are not immune to bomb hits causing electrical fires or personnel casualties. In case of a casualty in a radio space, the regular damage control party may be tied up in other parts of the ship. Your men on the spot in radio central or other COMM spaces may have to fight the fire and repair the damage.

The remainder of this chapter describes common types of communication casualties and suggests remedial measures to correct them. Bear in mind that a method suggested may not be the ONLY solution. As supervisor, be ready to improvise, for you may not have time to follow an established pattern. Just remember to adapt yourself and your men as expeditiously as possible to the conditions confronting you.

Rigging an Emergency Antenna

Loss or damage to an antenna from bomb hits, heavy seas, or violent winds may cause serious disruption of communications. Certain sections of a whip antenna may be carried away, external insulator(s) may be damaged, or a bomb hit may cause one end of a wire antenna to snap loose, or even break in half. Your job is to supervise the rigging of an emergency antenna to restore communications on a temporary basis until replacement or repair of the antenna. Methods of rigging vary, of course, in accordance with the type of ship, location of transmitting and receiving equipment, and extent of loss or damage.

Before rigging an emergency antenna, make sure power is secured, then get permission from the OOD. Men assigned must have proper equipment such as safety belts and necessary tools. Notify the OOD when antenna is rigged satisfactorily and have the transmitter retuned to the proper frequency.

Cable Fire

Cable fires are sometimes hard to control, because inner layers of insulation, or insulation covered by armor, support combustion. In case of a cable fire in radio spaces, secure power first. To prevent the fire from running the length of the cable, disconnect or cut the cable with side cutters or other available tool.

Electrical Fire in Radio Central

The senior officer or, in the absence of an officer, the senior man present is in direct charge of extinguishing the fire until arrival of the damage control party. He makes certain that the fire is reported immediately to the OOD. If you are the one in charge, proceed as follows:

Deenergize circuit, then attack the fire with a portable CO_2 or dry chemical extinguisher. Direct the stream from the extinguisher at the base of the flames for best results. If the fire reaches a dangerous degree of heat radiation, you or the damage control party will have to cool bulkheads separating adjacent compartments from radio central.

If all efforts with CO_2 fail, use fog furnished by the damage control party. Keep these points in mind when using fog: The fine diffusion of its particles reduces but does not entirely remove danger of electric shock, and condensation of fog on the equipment may cause serious damage. Regardless of these disadvantages, however, employ fog on class C fires whenever circumstances warrant.

To prevent spread of fire to the area in the vicinity of radio central, station men with fog nozzles near adjacent compartments on the same deck and on the decks immediately above and below. These standby fire fighters are necessary in case the fire begins to radiate heat to a dangerous degree in their area. If necessary, remove gear in the vicinity likely to be damaged by water, and use low-velocity fog to cool the equipment.

Remember: Carbon dioxide is your first choice in fighting the fire. Fog is a poor second. Water or foam are least desirable and should not be used except with special fire nozzles.

CASUALTIES TO EQUIPMENT

Communication equipment failures during fleet maneuvers or in battle are casualties which, if not corrected immediately, can cause serious delays in handling traffic. COMM division personnel must be able to detect and remedy such casualties as quickly as possible. The following list contains some common casualties which may occur and indicates what to check before calling for technical assistance.

CASUALTY	WHAT TO CHECK
No signal or noise output in HF receiver.	1. If pilot lamps do not light, check input to power supply. 2. See that all knob settings are correct. 3. Check headphones and associated equipment. 4. Check to see if receiver is totally inoperative in other positions of the band switch.
Power failure	1. Switch to emergency power. 2. Notify OOD of casualty.
S/P circuit becomes inoperative.	1. Establish communication by emergency S/P circuit. 2. Any S/P circuit convenient. 3. MC units as available.
Starting relay in transmitter does not operate.	1. Emergency switch in STOP (OFF) position. 2. Check to see if line voltage is too low. 3. Magnetic controller disconnect switch open. 4. Control switch in wrong position. 5. Transmitter door open. 6. Blown fuse in transmitter.
No antenna current on HF transmitter.	1. Antenna short-circuited or open. 2. Antenna ammeter defective. 3. Antenna switch defective, or in wrong position.
Abnormal frequency drift	1. MO tube defective. 2. Oven cover screws not tight. 3. Oven cover gasket defective. 4. Thermostats not functioning.
No indication on OSC plate current meter when test key switch is operated.	1. Check to see if switch interlocks are open. 2. Relay not making contact. 3. Keying relay inoperative. 4. Test key switch contacts dirty.

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CASUALTIES ASHORE

Passive defense bills and emergency communication plans for your communication activity emanate from the local district COMM officer (DCO) and conform with directives from DNC. These instructions specify procedures in case of fire, flood, accident, enemy attack, hazardous weather, and other disasters. Common examples of passive defense bills are fire bills, flood bills, and hazardous weather bills. These instructions are supplemented from time to time by station regulations.

You are particularly concerned with the fire regulations and bills posted in the COMMCEN, terminal buildings, and other operational COMM spaces. Keep up with any changes in these bills, and frequently quiz your men on their contents.

Fire Fighting

Communication activities ashore maintain fully equipped fire departments capable of dealing successfully with practically any type of fire. In districts where COMM units are within easy reach of each other, a central fire department serves all units in the area.

What you do as supervisor of the watch until the fire department arrives is governed by the conditions of the moment. However, in general, the following procedures apply to most situations.

As is always the case, first secure power to the equipment on fire, and always notify the fire department immediately—even for small fires. Fire spreads rapidly, and at shore stations fire extinguishers are no more than first-aid appliances.

For continuity of communications, come up on standby circuits or other available equipment as soon as possible, and notify associated COMM units of your actions. For example, a fire in the main building of a receiving station must be reported immediately to the associated COMMCEN and transmitting station.

Secure ventilation if time permits. Have your men shut off any air-conditioning or forced draft air heating, cooling, or ventilating system. As a last resort it may be necessary to secure or cut electric service lines to the building. Close windows and doors if possible.

In fighting the fire, ensure that the most appropriate extinguisher is used. Fight class A fires with hand pump type, chemical reaction type (soda and acid), pressure reaction type (carbon dioxide cartridge and water), and the foam type (hand type) of extinguisher. Use the pressure reaction, foam, or CO_2 types on class B fires. Extinguish class C fires with CO_2 or pressure reaction type.

Make sure exposures are covered. (Exposures are structures in danger of becoming ignited by fire originating in an adjoining or neighboring building.) Evacuate and protect exposures by wetting surfaces, closing windows and doors, and protecting wood-shingled roofs, and other combustibles from sparks and burning brands. Break up radiating heat waves with heavy streams of water.

Evacuation

When it becomes necessary to evacuate the building, evacuation is under the direct supervision of the senior officer present, supervisor of the watch, or other enlisted personnel if designated.

Prior to evacuation, take the following steps to ensure protection of classified and unclassified material and correspondence:

1. Ensure that all windows are closed.
2. Ensure that all steel file cabinets and desks are closed.
3. Ensure that all classified publications and correspondence are placed and locked in steel file cabinets or carried from the building.
4. Where practicable have all power shut off from equipment.

After these precautions are accomplished, march all personnel to a place of safety. Follow the evacuation route(s) prescribed in your station's fire and evacuation bill.

QUIZ

1. What ship's bill contains procedures for controlling the effects of nuclear radiation on personnel?
2. What are ready spares?
3. In regard to safety precautions, what important points should you review with your men frequently?
4. For best results, what procedures are necessary in preparing a simulated casualty?
5. In the initial report of a casualty, what should be included?
6. What action should you take in case of a cable fire?
7. Name two disadvantages of using fog on electrical fires.
8. Give some common examples of passive defense bills.

APPENDIX I

ANSWERS TO QUIZZES

CHAPTER 1

TRAINING AND SUPERVISION

1. In addition to ability in technical skills, a candidate for PO 1 or C needs the ability to lead men.
2. Major factors to consider in setting up a training program are the size of ship, needed emphasis on certain phases of the program, and extent of integration with the all-hands shipboard training program.
3. The following communication publications should be made available to the new communicator during his indoctrination: ship's organization and regulations manual, ship's communication instructions, operations department or communication division organization manual; and ACP's, JANAP's, and DNC's.
4. To qualify as instructor, a man must know his subject, be enthusiastic about it, and present it in a well-organized, interesting manner.
5. On-the-job training is the best way to increase a new man's efficiency.
6. The traffic checker is responsible for checking all incoming and outgoing messages processed through a message center.
7. The three key billets to supervise in a tape relay center are the sending, receiving, and tape factory operators.
8. Visual training aids are helpful in presenting clearly certain phases of your training program.
9. *Navy Training Courses and Publications for General Service Ratings,* NAVPERS 10052, contains a working list of publications to study for advancement in rating.
10. Job rotation gives a man the advantage of being trained in ALL important areas of communications.

CHAPTER 2

NAVAL COMMUNICATIONS

1. The mission of naval communications is to provide fast, reliable communications, adequate to meet the Navy's needs, both in peacetime and wartime.

2. There are three elements of naval communications: (a) Office of Director, Naval Communications; (b) the Naval Communication System; and (c) communication organizations of forces afloat.
3. Distribution of frequencies to the various nations is made by international treaty.
4. Within the United States, the assignment of radio frequencies to Government radio stations is effected by the Interdepartmental Radio Advisory Committee (IRAC), through the Office of Defense Mobilization, acting in the name of the President of the United States.
5. The central executive authority of the Naval Establishment is the Navy Department, Washington, D. C.
6. A COMMCEN normally includes a message center, cryptocenter, control center, facsimile branch, tape relay station, and facilities for telephone and teletypewriter conferences.
7. A primary communication center provides the following services for forces afloat: (a) a primary fleet broadcast; (b) a general broadcast of hydrographic information, weather forecasts and warnings, time signals, and press; and (c) ship-shore communication.
8. The Naval Security Group performs special communication intelligence functions as directed by CNO.
9. The operations department collects, evaluates, and disseminates combat and operational information concerned with the operations of the ship and designated airborne aircraft.
10. The Joint Communications-Electronics Committee (JCEC) coordinates Navy, Army, and Air Force communications.

CHAPTER 3

OTHER COMMUNICATION SYSTEMS

1. The three zones of Army communications are: Zone of Interior, communication zone, and combat zone.
2. ACAN is the Army Command and Administrative Network.
3. The Chief Signal Officer in the Army holds a position which corresponds to DNC.
4. The division is the smallest unit to which Signal Corps troops normally are assigned.
5. The principal Air Force communication network is Airways and Air Communication Service (AACS).
6. Air Force communication unit commanders assist and advise the Air Force communications officer.
7. The commander of each district is responsible for communications within the district.

8. The Federal Communications Commission is charged with regulating interstate and foreign communications, including radio and wire services.
9. A common carrier is any person or company furnishing wire or radio communication to the public for hire, with the exception of broadcasters.
10. The FCC monitors transmissions to make sure they are in accordance with treaties, laws, and regulations.
11. CONELRAD (CONtrol of ELectromagnetic RADiations) is a method of using electrical radiations as a defense measure.
12. The four methods used by the Bell Telephone System to connect cities are open wire, ordinary types of cable, coaxial cable, and radio relay.
13. Principal services of Western Union include domestic and international message services, telegraphic money orders, private wire systems, leased facsimile systems, domestic and international method communications, and a variety of nontransmission services such as correct time and messenger errand.
14. The Marine Bureau offers a 24-hour ship location and routing service to the public.
15. RCA utilizes an automatic tape transmission and reception system on the major circuits of its network.
16. In addition to handling message correspondence, Globe offers STS (Sheduled Press Transmission/Reception Service), TELEX (direct teletypewriter service between the U. S. and Hawaii), and leased radio channel service for the customers' exclusive use.
17. Tropical Radio Telegraph Co. operates a Western Electric 3-channel single sideband transmitter working directly with AT&T, New York.

CHAPTER 4

COMMUNICATION CENTER PRACTICES

1. The senior Radioman in the OR division and the man in direct charge of all personnel in the division is the Radioman in charge.
2. The Radioman in charge should make a thorough inspection of spaces and equipment to get thoroughly acquainted and to sight everything for which he is responsible.
3. The responsibility for keeping traffic clear and maintaining discipline in radio central is mainly the concern of the supervisor of the watch in radio central.
4. The leading Radioman coordinates all phases of communications with the Radioman in charge and sees that all equipment is operating properly in radio central and associated spaces.
5. The COMMCEN is the major activity of a NAVCOMMSTA.
6. Usually a small vessel has no CWO's. Consequently, the supervisor assumes duties of a CWO.

7. Two important supervisors at a message center ashore are the supervisor of the watch and traffic checker.
8. The internal router sees that messages received by the message center for delivery to activities in the area are properly distributed.
9. The movement report center (MRC) furnishes the routing section with movement reports of all Naval, Army, Coast Guard, and Marine Corps commands.
10. The circuit control supervisor is in charge of circuit control.
11. The FAX branch of a primary COMMCEN transmits a primary fleet facsimile broadcast for its designated areas, works point-to-point FAX circuits, and receives ship-shore FAX traffic.

CHAPTER 5

TAPE RELAY STATION

1. The function of a tape relay station is to relay teletypewriter messages by tape.
2. The chief in charge of the relay center and the civilian administrative assistant are the two principal assistants to the OIC of a tape relay center.
3. The RCOW keeps the CWO of the COMMCEN informed of unusual events such as excessive outages and delays, screens all traffic and takes appropriate action to deliver high priority traffic, and checks all received record cards for the previous day when final numbers are completed.
4. A STOP and GO message is a procedure message directing a distant station to either stop transmission or go ahead with transmission on channels indicated.
5. The relay station supervisor is charged with proper operation of all circuits and equipments, and expeditious movement of message traffic.
6. Tape relay stations conduct intensive indoctrination courses because they often experience rapid loss of trained watch standers and consequently must train new men as soon as possible.
7. In the operational section of the relay status report the RCOW indicates circuit conditions and backlogs, and certifies that all received message records and number comparison sheets have been checked.
8. The four message accountability logs are: NUMBER COMP SHEET; RECEIVED MESSAGE RECORD, RERUN REQUESTS, and RERUN AND MONITOR RECORD.
9. A DUPLEX circuit as used here refers to any circuit using separate sending and receiving loops for simultaneously sending and receiving messages.
10. The channel outage indicator and bank control system furnishes the relay station supervisor and radio control board supervisor a visual reminder when a channel is out due to equipment or circuit difficulties.

CHAPTER 6

RADIO RECEIVING AND TRANSMITTING STATIONS

1. Landlines and radio links are the two principal methods of linking shore communication stations.
2. Single sideband (SSB) and electronic time division multiplex (MUX) are the two principal modes of emission used to generate teletypewriter signals.
3. MUX performs these tasks:
   a. Storage of incoming signals.
   b. High-speed automatic transmission in proper sequence of the signals from each TTY circuit.
   c. Storage of high-speed incoming signals at the receiving end.
   d. Transmission of stored high-speed signals to the separate TTY circuits at normal TTY speed.
4. A NAVRADSTA (R) usually is located in flat country or on long, easy slopes isolated from urban areas to obtain optimum radio reception.
5. The receiver building of a NAVRADSTA (R) normally is located near the center of the antenna area to reduce length of transmission lines.
6. Your important supervisory duties as radio watch supervisor at a NAVRADSTA (R) are direct supervision of the 10 or 12 watch standers in your crew, including control of ship-shore personnel through the ship-shore supervisor. You are also responsible for handling local traffic and keeping required records.
7. The key electronics division supervisory petty officers are the electronics chief, maintenance chief, and supervisors for special equipment, line equipment, and communication control link and landline equipment.
8. The REA SSB receiver is a high-frequency SSB receiver designed to operate in the frequency range from 4000 to 22,000 kcs. It provides for reception of either one or both telephone channels arranged as a twin-channel system.
9. The antenna park of a NAVRADSTA (T) is near the center of the station to permit expansion of the area and easier observation of required clearances.
10. A doublet antenna is termed DA followed by numerals indicating frequency to which antenna is lined.
11. The day supervisor has duties similar to those of the leading Radioman in radio central aboard ship.
12. The control console gives the operator access to all transmitter keying lines, interstation and intrastation lines, and necessary keyers, amplifiers, and adapters for all equipment.

13. Some important operations you are responsible for during the course of your watch as supervisor in the transmitter building are energizing or securing transmitters, tuning and adjusting equipment, and frequency shifts as directed by the control station.
14. When an equipment failure occurs you should resume service as quickly as possible by bringing up other equipment or by restoring equipment to operation after minor repairs and/or adjustments.
15. Two principal sources for SAFETY PRECAUTIONS are chapter 18 of *United States Navy Safety Precautions* and applicable sections of chapter 67, *BuShips Manual.*
16. Sleet or ice on antennas used with LF transmitters causes leakage over insulators, increases the loss resistance of antennas, and makes antennas difficult to tune.
17. The daily antenna checkoff list shows each transmitter and antenna to which it is tuned. There is also a column for new antenna shifts.
18. The world's most powerful radio transmitter is on a 6000-acre site in Jim Creek Valley near Arlington, Washington.

CHAPTER 7

RADIO DIRECTION FINDERS

1. The true bearing of the radio signal is 269° true.
2. The basic indication in all Navy radio direction-finder systems is the orientation of the loop at a null.
3. The output of a sense antenna is added to the output of a loop antenna to get absolute direction.
4. Diffraction and refraction of the wave which produces polarization in the horizontal direction.
5. The goniometer gives the effect of high speed loop rotation without moving the loop.
6. The null is used because a small change in loop orientation produces a large change in output voltage, and, further, there is a reversal in phase of the signal as the loop passes through a null point.
7. Errors caused by reradiation can be reduced by adjusting the length of the reradiating element so that it resonates outside the wavelength range of the direction finder.
8. Meridians are numbered 0° to 180° east and west of the Greenwich meridian. Parallels are numbered from 0° to 90° north and south of the equator.
9. A ship's course plotted on a Mercator chart is called a rhumb line.
10. Dead reckoning is a method of determining the position of a ship through the direction and distance traveled from a known point of departure.

11. A position by direction finder is labeled on the chart as EP for estimated position.
12. The long title of H. O. 205 is *Radio Navigational Aids*.

CHAPTER 8

MAINTENANCE AND RECORDS

1. The Bureau of Ships instruction book for the equipment is the most important source of maintenance information.
2. The two important points to remember regarding the testing of electron tubes are: (a) Never test tubes as a matter of routine. (b) In testing tubes, be sure each is replaced in its original socket.
3. POMSEE stands for Performance, Operational, and Maintenance Standards for Electronic Equipment.
4. The two manuals which are the result of the POMSEE program are the *Maintenance Checkoff Booklet* and the *Performance Standards Book*.
5. A survey is a means of writing off the books articles which have deteriorated, or have been lost, damaged, or destroyed.
6. The *Navy Stock List of General Stores* lists and identifies items of general supplies carried in stock for issue to ships and stations.
7. Only one class of material is entered on a request.
8. The FSN of a requisitioned item is its FEDERAL STOCK NUMBER.
9. The form to be used in addition to the DD 1150 if the stock number is not known is Request for Repair Parts (NAVSANDA Form 302).

CHAPTER 9

SHIPBOARD TELETYPEWRITER EQUIPMENT

1. The switching arrangement on the model 19 set provides for direct keyboard transmission only, tape perforation only, or simultaneous direct keyboard transmission and tape perforation.
2. The primary function of a teletypewriter keyboard transmitting unit is the transformation of mechanical motion into electrical impulses of the 5-unit code for transmission to receiving stations.
3. The transmitter-distributor translates code combinations, perforated in a paper tape, into electrical impulses and transmits these impulses to one or more receiving stations.
4. Of the improvements in the model 28 printer, the most obvious is in the printing mechanism.
5. The clutch in the model 28 is an all-steel, internal expansion friction clutch which disengages in the stopped condition.

6. The frequency shift method of communication is a system of automatic code transmission and reception that shifts the carrier frequency back and forth between two distinct frequencies to designate, respectively, the MARK and SPACE portions of the code characters.
7. In SPACE diversity reception two receivers are tuned to the same frequency but the receiving antennas are spaced more than 1 wavelength apart.
8. In frequency diversity reception the two receivers are tuned to separate frequency shift carriers of different frequencies which are simultaneously carrying the same mark-space characters.
9. The KY-30/GRT frequency shift keyer ordinarily is used at the transmitting station of a radiotelegraph circuit.
10. The components of the crystal oscillator, 300-kc oscillator, balanced keyer, and phase-shifting amplifiers are located in an oven.
11. The keyer has a rectifier power supply circuit which produces a low-voltage a-c heater supply, a positive 400-volt plate supply, a positive 250-volt plate supply, a regulated positive 150-volt supply, and a negative 45-volt bias supply.
12. The teletype panel TT-23/SG is used aboard ship to facilitate interconnection and transfer of teletype equipment with various radio adapters, such as frequency shift keyers and converters and tone modulation terminal equipment.
13. Looping is the manner in which jacks are connected in series with the teletype equipment and radio adapters to form a complete loop.
14. The teletypewriter terminal AN/SGC-1A converts the intelligence of outgoing messages to audio tone signals that can be transmitted by a voice-operated radio transmitter. It also reconverts the intelligence of incoming signals to a form that can cause a teletypewriter to print the message.

CHAPTER 10

CASUALTY PROCEDURES

1. The radiological defense bill contains procedures for controlling effect of nuclear radiation on personnel.
2. Ready spares are items necessary to make rapid repairs to equipment to keep it in operation until there is time to make permanent repairs.
3. Review the following important points with your men frequently:
   Basic electrical precautions and safeguards;
   Proper methods of resuscitating a man unconscious from electrical shock;
   Proper treatment for electrical shock and burns;
   Safety regulations associated with communication equipment;
   Proper procedures to be taken in event of electrical accident.

4. In preparing a simulated casualty, for best results follow a detailed plan of action, stressing necessity for speed and accuracy.
5. The following should be included in the initial report of a casualty: (a) Nature of damage (class C fire, bomb hole, shock casualty); (b) location of damage; (c) extent of damage (fire, smoke, or toxic gases present, etc.); (d) measures being taken to combat damage (fire-fighting type of extinguishing agent, etc.); (e) assistance required.
6. In case of a cable fire, secure power first, then disconnect or cut cable with side cutters or other available tool.
7. Two disadvantages of using fog are: The fine diffusion of its particles reduces but does not entirely remove danger of electric shock; and condensation of fog on the equipment may cause serious damage.
8. Common examples of passive defense bills are fire bills, flood bills, and hazardous weather bills.

APPENDIX II

QUALIFICATIONS FOR ADVANCEMENT IN RATING

QUALIFICATIONS CURRENT THROUGH CHANGE 10

RADIOMEN (RM)

General Service Rating

SCOPE

Radiomen transmit, receive, log, route, file, and maintain security of messages in accordance with existing regulations, instructions, and procedures by applying thorough knowledge of U. S. Navy Security Manual for Classified Matter and the communications doctrine and procedures contained in DNC 5 and NWIP 16-1; and advise on capabilities, limitations, and condition of assigned equipment.

Radiomen operate typewriter and teletypewriter equipment; tube radio transmitters and receivers; operate and perform operational and preventive maintenance on, and locate the more common failures in radio equipment, including associated frequency shift keyers, converters, motors, motor generators, and power supplies; radiotelephone, facsimile, teletype, radio direction finder, and assigned communications countermeasures equipment.

Emergency Service Rating

Same as General Service Rating.

Navy Enlisted Classification Codes

For specific Navy enlisted classification codes included within this rating, see Manual of Navy Enlisted Classifications, NavPers 15105 (Revised), codes RM-2300 to RM-2399.

100 PRACTICAL FACTORS

101 Operational

1.	Start, stop, operate, and tune facsimile equipment to which assigned on own ship or station	3
2.	Start, stop, adjust, and operate manual and automatic teletypewriter equipment on own ship or station	3
3.	Energize, de-energize, and make operational adjustments on radio receivers, transmitters, and associated motors and motor generators on own ship or station	3
4.	Assemble, energize, de-energize, tune, and make operating adjustments to emergency and/or portable radio equipment on own ship or station	3
5.	Set up antenna patch panel, select proper antennas and antenna matching equipment for receiving	3
6.	Set up radio patch panel. Patch transmitters and receivers into remote units	3
7.	Identify all communication antennas on own ship or station	3
8.	Tune transmitter, using dummy antenna	3
9.	Compare WWV against frequency standard and log results	3
10.	Operate telegraphic typewriter, using touch system	3
11.	Read perforated teletypewriter tape	3
12.	Stand watch on teletypewriter circuit, keeping required logs	3
13.	Tune radio receivers and associated teletypewriter equipment for teletypewriter reception	3
14.	Copy standard fleet broadcast	3
15.	Transmit, receive, and authenticate on fleet CW circuit, handling traffic at approximately 18 words per minute, keeping required logs	3
16.	Detect and report electronic jamming on radio receiving equipment. Demonstrate procedures for receiving through electronic jamming or other types of interference	3
17.	Transmit, receive, and authenticate on radiotelephone circuits, using standard procedure. Keep required logs	3
18.	Observe regulations governing communication procedures and use of DNC 5 and NWIP 16-1 publications in transmitting and receiving traffic on naval circuits	3
19.	Use call signs, address groups, address indicating groups, routing indicators, prosigns, operating signals, and prowords in handling traffic	3

Qualification	RM
101 Operational—Continued	
20. Use call-sign cipher devices for encoding and decoding message headings and for frequency shifts	3
21. Start, stop, operate, calibrate, and tune all radio equipment and assigned communications countermeasures equipment on own ship or station	2
22. Tune radio transmitters and associated teletypewriter equipment for teletypewriter transmission	2
23. Tune, calibrate, and adjust multicouplers and antenna matching equipment and select antennas for transmitting	2
24. Transmit, receive, and authenticate on fleet circuit, handling traffic at approximately 25 words per minute, keeping required logs	2
25. Transmit, receive, and authenticate on radiotelephone circuits, using standard vocabularies and techniques; be familiar with terminology utilized in tactical maneuvering, air control, air defense, naval gunfire support, electronic countermeasures control, and antisubmarine warfare	2
26. Supervise communications watch	1
27. Transmit, receive, and authenticate on any fleet CW circuit, using standard procedures. Keep required logs.	1
28. Take measures to restore communication facilities due to battle casualty and under other emergency conditions including fire, personnel injuries, and loss or damage to radios and associated communication equipment	1
29. Determine radio frequency that will obtain maximum distance of transmission	1
102 Maintenance and/or Repair	
1. Rig emergency radio receiving and transmitting antennas	3
2. Clean and lubricate duplicating machines	3
3. Clean and lubricate typewriters and change ribbons	3
4. Clean and lubricate teletypewriters; change ribbon, paper, and tape	3
5. Determine whether teletypewriter failures are due to mechanical or electrical defects	3
6. Demonstrate under simulated conditions the rescue of a person in contact with an energized electrical circuit, resuscitation of a person unconscious from electrical shock, and treatment for electrical and acid burns	3

102 MAINTENANCE AND/OR REPAIR—Continued	
7. Demonstrate, while servicing equipment, safety precautions such as tagging switches, removing fuses, grounding test equipment, using shorting bars and rubber mats	3
8. Locate and identify units and component parts of radio and communications countermeasures equipment to which assigned	3
9. Repair radio headsets and microphones	3
10. Check and replace as necessary:	
a. Indicator lamps	3
b. Fixed fuses	3
c. Crystals	2
11. Make tests for short circuits, grounds, and continuity of interconnecting cables between components of electronic equipment	2
12. Test electron tubes for operational effectiveness and replace those found defective or below standard	2
13. Use test equipment, such as tube testers, multimeters, and output meters, required in operational and preventive maintenance of general purpose radio equipment	2
14. Inspect, clean, lubricate, and make adjustments on assigned radio and communications countermeasures equipment, as specified in routine checkoff lists	2
15. Identify, in schematic diagrams, basic radio circuits such as amplifiers, oscillators mixers, and rectifiers	2
16. Locate and identify maintenance test points and make tests on equipment to which assigned, as specified in technical manuals	2
17. Identify, by reference to block diagrams, circuits affected by operation of associated external controls	2
18. Maintain and repair teletypewriters	1
19. Locate electrical and electronic failures employing, systematized procedures of isolating inoperative sections of radio equipment and assigned radio countermeasures equipment as specified in technical manuals	C
103 ADMINISTRATIVE AND/OR CLERICAL	
1. Perform routine clerical duties of a communications office, including maintenance of files	3
2. Enter corrections to communications publications	3
3. Prepare in naval form, plain dress, abbreviated plain dress, and codress messages for transmission	3

103 ADMINISTRATIVE AND/OR CLERICAL—Continued

4. Keep required supervisory logs	2
5. Maintain records of intercepted electromagnetic radiations in accordance with current electronic countermeasures doctrine	2
6. Keep maintenance logs for radio equipment. Prepare required BuShips electronic failure reports	2
7. Route traffic to, from, and within own ship or station	2
8. Prepare international and domestic telegraph messages in commercial form	2
9. Prepare requests for survey; requisition equipment, parts, and supplies	1
10. Prepare naval shipyard and tender work requests	1
11. Instruct and supervise personnel in communication operation and procedure	1
12. Train, drill, and supervise radiomen at cruising watches and general quarters stations	1
13. Supervise and train personnel in performing operational and preventive maintenance functions on communications and associated equipment	1
14. Instruct personnel on radio theory	C
15. Serve as assistant to radio officer	C
16. Organize duties and assign communications personnel to tasks to be performed aboard ship or shore station	C

200 EXAMINATION SUBJECTS

201 OPERATIONAL

1. Purposes of common external controls on radio transmitting and receiving equipment	3
2. Types and functions of radio receiving and transmitting equipment	3
3. Meaning of terms commonly used in connection with manipulation of radio and related equipment, such as heterodyning, antenna loading, tuning, zero beating, calibrating, and audio band-pass and intermediate frequency band-pass	3
4. Procedures to be followed in tuning radio transmitting and receiving equipment, including use of audio band-pass control and selectivity controls	3
5. Procedures for energizing, de-energizing, and tuning emergency and portable radio equipment	3

	RM
201 OPERATIONAL—Continued	
6. Transmit: (See 400 Performance Test Instructions.)	
a. A file (containing 500 characters) of 3 messages by radio (international Morse) in 8 minutes	3
b. A file (containing 600 characters) of 3 messages by teletypewriter in 9 minutes	3
7. Receive a file (containing 500 characters) of 3 messages by radio (international Morse) in 8 minutes. (See 400 Performance Test Instructions.)	3
8. General content of DNC 5	3
9. International radio procedures; regulations regarding communications as prescribed for the safety of life at sea and for communication with a merchant vessel at sea	3
10. Communication procedures prescribed for transmitting and receiving traffic on all naval communication circuits including use of call signs, address groups, address indicating groups, prosigns, routing indicators, prowords, and operating signals	3
11. Principles of, and requirements for, communications security as prescribed in the U. S. Navy Security Manual for Classified Matter, DNC 5, and ACP 122	3
12. Construction of naval messages; forms, types, and classes	3
13. Precedence of traffic, internal and external routing of traffic, and regulations governing circuit discipline on radiotelephone, radiotelegraph, and teletypewriter circuits	3
14. Time zone computations and conversions	3
15. Nomenclature and principles of operation of radio equipment and associated communications countermeasures equipment	2
16. Transmit: (See 400 Performance Test Instructions.)	
a. A file (containing 600 characters) of 4 messages by radio (international Morse) in 8 minutes	2
b. A file (containing 750 characters) of 4 messages by teletypewriter in 9 minutes	2
17. Receive a file (containing 600 characters) of 4 messages by radio (international Morse) in 8 minutes. (See 400 Performance Test Instructions.)	2
18. Capabilities and limitations of radio equipment and associated communications countermeasures equipment	2

	APPLICABLE RATES RM
201 OPERATIONAL—Continued	
19. General content and application of Navy, Joint, DNC 5, and NWIP 16-1 publications used in naval, other military, commercial, and international communication procedures	2
20. Commercial traffic instructions and procedures related to naval communications	2
21. Transmit: (See 400 Performance Test Instructions.)	
a. A file (containing 700 characters) of 5 messages by radio (international Morse) in 8 minutes	1
b. A file (containing 1,200 characters) of 5 messages by teletypewriter in 9 minutes	1
22. Receive a file (containing 700 characters) of 5 messages by radio (international Morse) in 8 minutes. (See 400 Performance Test Instructions.)	1
23. Radio direction finding as utilized in interception of electronic emissions	1
24. Fundamental concepts of radio wave propagation, including skip distance, sky-wave, and ground-wave, and ionosphere and the effect on wave propagation	1
25. Rules and regulations of Federal Communications Commission pertaining to naval communications as set forth in naval communications publications	1
202 MAINTENANCE AND/OR REPAIR	
1. Lubrication and routine cleaning of standard office machines used in performance of communication duties	3
2. Lubrication and routine cleaning of typewriters	3
3. Definitions of common electrical and electronic terms used with radio equipment such as: Volt, ohm, ampere, watt, cycle, frequency, phase, resonance, and selectivity	3
4. First-aid procedures for treating electrical shock and burns	3
5. Safety precautions to be observed in connection with operating and maintaining electronic equipment	3
6. Types physical structures, and electrical characteristics of batteries; proper care, maintenance, and safety precautions used in handling batteries	3
7. Reading and interpretation of block diagrams	2
8. Types of information shown and meaning of electrical, electronic, and mechanical symbols used in schematic diagrams of radio equipment	2
9. Elementary electricity; simple problems in a. c. and d. c. current	2

	APPLICABLE RATES RM
202 MAINTENANCE AND/OR REPAIR—Continued	
10. Functions, physical structure, and operating principles of electron tubes used in radio equipment	2
11. Handling and testing electron tubes	2
12. Operational and preventive maintenance of radio equipment, teletypewriters, and communications countermeasures equipment	2
13. Purposes and uses of test equipment in performing operational and preventive maintenance	2
14. Procedures and purposes of routine tests on electronic equipment	2
15. Construction of a block diagram of a transmitter and/or receiver, given specific components and symbols	2
16. General effects of circuit components such as resistors, capacitors, and inductors on flow of direct and alternating current	2
17. Basic circuits such as rectifiers, amplifiers, oscillators, detectors, and band-pass filters	2
18. Color codes and circuit markings used to identify and describe electrical characteristics of circuit components and connections	2
19. Operating principles of various types of teletypewriters, radiotelephones, and teletypewriter terminal equipment	2
20. Characteristics of a. c. and d. c. current	2
21. Methods of matching and loading shore-based antennas	1
22. Types and uses of common antennas	1
23. Compute length of an antenna at a given frequency	1
24. Reading and interpreting circuit schematic diagrams of Navy communications equipment	1
25. Operating principles of basic circuits such as rectifiers, amplifiers, oscillators, and detectors	1
26. Functions and operating principles of special circuits such as bridge circuits, sweep circuits, and special oscillator circuits used with communications equipment	1
27. Calculate current, resistance, and voltage through any part of a circuit	C
203 ADMINISTRATIVE AND/OR CLERICAL	
1. Security classifications of correspondence and regulations governing the transmission of each classification	3
2. Uses of and procedures for preparing operating logs	3

Qualifications for Advancement in Rating	RM
203 ADMINISTRATIVE AND/OR CLERICAL—Continued	
3. Missions, policies, and fundamental considerations of naval communications as outlined in DNC 5	3
4. Standard shipboard communication organization	3
5. Authority for, methods of promulgation of, and entry of various types of corrections in communications publications	3
6. Stowage requirements and other safeguards of registered and other classified matter	3
7. Regulations for sending messages involving tolls	3
8. Organization of the naval communications system	2
9. Uses of and procedures for preparing BuShips electronic failure reports	2
10. Destruction bill for registered publications and procedure for effecting destruction	2
11. Types, purposes, and entries made in equipment histories	1
12. Procedures for preparing requests for survey and requisition of equipment, parts, and supplies. Procedures for preparing naval shipyard and tender work requests	1
13. Commercial accounting and abstracting as used by the Navy	1
14. Planning, organizing, and supervising a preventive maintenance program	1
15. Planning, organizing, and supervising training programs	C
16. Preparation and utilization of communications annexes to operation orders	C

400 PERFORMANCE TEST INSTRUCTIONS

420 PERFORMANCE TESTS (Examination Subjects.)

A. Telegraphy:

The following standard procedure shall be observed when conducting the performance tests (operational) for international Morse and teletypewriter—

1. Messages:

   a. Messages shall be approximately the same length, the heading containing about 30 percent and the text about 70 percent of the total number of characters. One complete rehearsal immediately preceding the official test is permissible. Results of the rehearsal test shall not preclude an individual from taking the official test nor affect the score of the official test.

420 PERFORMANCE TESTS—Continued

b. Messages used for the official test must differ from messages used for the rehearsal, and must be unknown to the applicant before the test starts. Time limits for the official test shall include "servicing" each message by endorsing thereon the time of transmission or reception, circuit used, and operator's sign. Of the total number of messages required in the test, one message shall be plain language. The remaining messages shall be composed of 5-letter groups, random mixed letters, and random mixed numerals.

2. Transmitting (international Morse and teletypewriter):
   a. All known errors must be corrected.
   b. A total of 5 errors (uncorrected or omitted characters) in transmitting will be permitted in the official test.
3. Receiving (international Morse)—Receiving shall be done on a telegraphic typewriter. Five errors in receiving will be permitted in the official test.

Note.—For teletypewriter transmitting test, use of a teletypewriter is mandatory if one is assigned to ship or station.

500 PATH OF ADVANCEMENT TO WARRANT OFFICER AND LIMITED DUTY OFFICER

Radiomen advance to Warrant Electronics Technician and/or to Limited Duty Officer, Electronics.

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