# RADIOMAN 3 & 2


BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10228-E

# PREFACE

This book is written for enlisted personnel of the U. S. Navy and Naval Reserve who are studying for advancement to the rates of Radioman 3 and Radioman 2. Combined with the necessary practical experience and study of the publications in the reading list, the information in this course will assist the Radioman in preparing for Navywide examinations for advancement in rating.

Those who work in communications know how fast procedures and equipment change. Between revisions of this training course some obsolescence may be unavoidable. For this reason, it is suggested that the student with access to official communication publications use them as much as possible in his study.

As one of the Navy Training Courses, Radioman 3 & 2 was prepared for the Bureau of Naval Personnel by the Training Publications Division of the Naval Personnel Program Support Activity, Washington, D. C. It was reviewed by the Office of the Assistant Chief of Naval Operations (Communications)/Director, Naval Communications; Naval Examining Center, Naval Training Center, Great Lakes, Ill. and the U. S. Naval Schools, Radiomen, Class A, at Bainbridge, Md. and San Diego, Calif.

First edition 1950
Revised 1951, 1953
Second edition 1957
Third edition 1961
Fourth edition 1963
Fifth edition 1967

Stock Ordering Number
0500-074-0100

# 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.

# CONTENTS

# READING LIST

(The effective edition of a publication governs in all instances.)

## NAVY TRAINING COURSES

Radioman 3 & 2, NavPers 10228
Mathematics, Vol. 1, NavPers 10069
Basic Electricity, NavPers 10086, chapters 1 through 13, 20, and appendices IV, V, and VI
Basic Electronics, NavPers 10087, chapters 1 through 14, 17, and appendix II
Basic Handtools, NavPers 10085

## OTHER NAVY PUBLICATIONS

ACPs 121, 122, 124, 125, 127
DNCs 5, 14, 26
JANAP 128
NWP 16
Handbook of Test Methods and Practices, NavShips 91828 (Sec. 1, 4.5)
NavShips Technical Manual, chapter 9670
Department of the Navy Security Manual for Classified Information, OpNav Inst 5510.1

## USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your educational services officer.

Members of the United States Armed Forces Reserve components, when on active duty, are eligible to enroll for 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.

# CHAPTER 1

# YOUR CAREER AS A RADIOMAN

The fleet needs capable men in all ratings, because a modern naval force is only as good as the men who man the ships. Even with the most modern equipment, a naval force is almost powerless without competent men to operate and maintain that equipment. Good men are plentiful, but their capability depends chiefly upon their training.

This book contains the knowledge you need for advancement in rating. Skills in practical factors are also required. These can be developed only through directed practice and experience.

As a part of the Navy's training program, this self-study Navy Training Course is written for the purpose of aiding you in your preparation for advancement in rating. The course is designed to help you meet the professional (technical) qualifications for advancement to Radioman 3 and Radioman 2.

This training course consists of 14 chapters. The first chapter is nontechnical in nature and introduces you to the course. Remaining chapters deal with the technical aspects of your rating. The remainder of this introductory chapter gives information on the enlisted rating structure, the Radioman rating, requirements and procedures for advancement in rating, and references that will help you in working for advancement and also in performing your duties as a Radioman. It is strongly recommended, therefore, that you study this chapter carefully before beginning intensive study of the remainder of this training course.

Throughout this training course, the term "cycles," or "cycles per second," or the abbreviation cps is used to express electrical frequency in cycles per second. In effecting worldwide standardization of various units of measurement, the term "hertz" (abbreviated H) recently was adopted to express cycles per second and will be used in later revisions of this training course.

## ENLISTED RATING STRUCTURE

The two main types of rating in the present enlisted rating structure are general ratings and service ratings.

General ratings identify broad occupational fields of related duties and functions. Some general ratings include service ratings; others do not. Both Regular Navy and Naval Reserve personnel may hold general ratings.

Service ratings identify subdivisions or specialties within a general rating. Although service ratings can exist at any petty officer level, they are most common at the PO3 and PO2 levels. Both Regular Navy and Naval Reserve personnel may hold service ratings.

## RADIOMAN RATING

Within the enlisted rating structure, ratings are divided into a total of 12 groups, with ratings in each particular group related occupationally. The Radioman rating is a general rating in group V, commonly called the administrative and clerical group. At present, there is no provision for service or emergency ratings in the Radioman rating.

Your responsibilities as a petty officer in the Radioman rating break down into two types of duties: your professional duties and your military duties.

As a Radioman Third or Second Class, your professional duties may vary slightly, depending upon the activity to which you are assigned.

The Radioman is primarily an operator, but he does have duties as a technician. You will be required to fulfill certain qualifications that require you to know what makes your equipment work, as well as how to operate it.

Radiomen are used in all important segments of the naval establishment—from large communication centers to small stations, from attack carriers to the smallest patrol craft. Radiomen keep vital information flowing.

Ashore, most Radiomen are found in communication centers. Here, they are concerned with getting messages to and receiving them from ships of the fleet, and also monitoring other circuits. Additionally, Radiomen operate teletype and facsimile equipment.

Afloat, a Radioman is a "jack of all trades" in the communication business. His assignments include a little bit of everything, such as manning radiotelephone circuits, copying fleet broadcasts, or operating teletype equipment.

Along with operating his equipment, a Radioman must be prepared to keep it in operation and perform maintenance when necessary.

Now that you have a general idea of your professional duties as a Radioman, let's discuss some of your military duties as a petty officer.

Often, the difference between a "good" petty officer and a "bad" petty officer is leadership. The guide for leadership in the Navy is General Order 21, which states, in part: "The strength of our nation and of our services depends upon courageous, highly motivated, and responsible individuals." Each command has a training program that provides instruction in leadership principles and practices. It is your duty to take advantage of this instruction, and to apply the principles and practices in your every dealing with the men around you—especially those who look to you for an example of leadership.

Many books have been written on the subject of leadership, and many traits have been listed as a necessary part of the makeup of a leader. Whether you are a successful leader is decided by the success with which you stimulate others to work willingly under your supervision—not by compiled lists of desirable traits.

Self-confidence is one of the keys to leadership, but it must be backed up by enthusiasm and especially by knowledge. For example, you not only must be able to supervise lower rated men in their communication duties, but (as necessary) you also must be ready to pitch in and help do the job. Your men will respect you as a man who has demonstrated his know-how and skill.

A cooperative attitude is another requirement of leadership. Do not let your experience in the RM rating make you unreasonable and overbearing with lower rated men whom you may have to instruct. Your attitudes will have a definite effect upon the attitudes and the actions of these men.

When you become a petty officer, you become a link in the chain of command between your officers and your men. Your responsibilities are more than merely giving orders and seeing that work is done. You likewise have a responsibility for sharing your knowledge with others. When the Navy promotes you, it expects you to bear some of the burden of training others.

Be competent in your instruction of others; the opportunity to acquire knowledge and to master new skills was not given to you solely for your own benefit, but also for the benefit of the Navy as a whole. As new types of communication equipment become available or changes in communication procedures evolve, you should be the first to learn about them. But do not be grudging in passing on this information and training to others.

A petty officer's working relationship with others is of great importance to the success of his work and the mission of his activity. In your day-to-day working relationships, you will be required to cooperate with others. This requirement is true not only within your own division but with men in other divisions. Ability to get along is, at times, just as necessary as proficiency in performing your technical skills. Ability to get along with others is, within itself, a definite skill. This skill can be developed in much the same manner as a technical skill; that is, the many different skills you must possess may each be studied and developed. Some of these skills are understanding another man's job, his problems, and his abilities. You must possess skill in instructing, leading, and (in some instances) inspiring the men with whom you work. Detailed information to help you develop these skills is given in effective editions of the training courses Basic Military Requirements, NavPers 10054, and Military Requirements for Petty Officer 3 & 2, NavPers 10056. You should be familiar with the entire contents of both training courses before taking the Navywide examination for advancement in rating.

## ADVANCEMENT IN RATING

Some of the rewards of advancement in rating are easy to see. You get more pay. Your job assignments become more interesting and more challenging. You are regarded with greater respect by officers and enlisted personnel. You enjoy the satisfaction of getting ahead in your chosen Navy career.

But the advantages of advancing in rating are not yours alone. The Navy also profits. Highly trained personnel are essential to the functioning of the Navy. By each advancement in rating, you increase your value to the Navy in two ways. First, you become more valuable as a specialist in your own rating. And second, you become more valuable as a person who can train others and thus make far-reaching contributions to the entire Navy.

## HOW TO QUALIFY FOR ADVANCEMENT

What must you do to qualify for advancement in rating? The requirements may change from time to time, but usually you must:

1. Have a certain amount of time in your present grade.
2. Complete the required military and occupational training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, NavPers 1414/1. In some cases the Record of Practical Factors may contain the old form number, NavPers 760.
4. Be recommended by your commanding officer, after the petty officers and officers supervising your work have indicated that they consider you capable of performing the duties of the next higher rate.
5. Demonstrate your KNOWLEDGE by passing written examinations on (a) military/leadership requirements and (b) occupational qualifications.

Some of these general requirements may be modified in certain ways. Figure 1-1 gives a more detailed view of the requirements for advancement of active duty personnel; figure 1-2 gives this information for inactive duty personnel.

Remember that the requirements for advancement can change. Check with your division officer or training officer to be sure that you know the most recent requirements.

Advancement in rating is not automatic. After you have met all the requirements, you are ELIGIBLE for advancement. You will actually be advanced in rating only if you meet all the requirements (including making a high enough score on the written examination) and if the quotas for your rating permit your advancement.

## HOW TO PREPARE FOR ADVANCEMENT

What must you do to prepare for advancement in rating? You must study the qualifications for advancement, work on the practical factors, study the required Navy Training Courses, and study other material that is required for advancement in your rating. To prepare for advancement, you will need to be familiar with (1) the Quals Manual, (2) the Record of Practical Factors, NavPers 1414/1, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. The following sections describe them and give you some practical suggestions on how to use them in preparing for advancement.

### The Quals Manual

The Manual of Qualification for Advancement in Rating, NavPers 18068 (with changes), gives the minimum requirements for advancement to each rate within each rating. This manual is usually called the "Quals Manual," and the qualifications themselves are often called "quals." The qualifications are of two general types: (1) military requirements, and (2) occupational qualifications.

MILITARY REQUIREMENTS apply to all ratings rather than to any one particular rating. Military requirements for advancement to third class and second class petty officer rates deal with military conduct, naval organization, military justice, security, watch standing, and other subjects which are required of petty officers in all ratings.

OCCUPATIONAL QUALIFICATIONS are requirements that are directly related to the work of each rating.

Both the military requirements and the occupational qualifications are divided into subject matter groups; then, within each subject matter group, they are divided into PRACTICAL FACTORS and KNOWLEDGE FACTORS. Practical factors are things you must be able to DO. Knowledge factors are things you must KNOW in order to perform the duties of your rating.

In most subject matter areas, you will find both practical factor and knowledge factor

## ACTIVE DUTY ADVANCEMENT REQUIREMENTS

<table>
<tr><th>REQUIREMENTS *</th><th>E1 to E2</th><th>E2 to E3</th><th>E3 to E4</th><th>E4 to E5</th><th>E5 to E6</th><th>#E6 to E7</th><th>† E7 to E8</th><th>† E8 to E9</th></tr>
<tr><td>SERVICE</td><td>4 mos. service—or comple- tion of recruit training.</td><td>6 mos. as E-2.</td><td>6 mos. as E-3.</td><td>12 mos. as E-4.</td><td>24 mos. as E-5.</td><td>36 mos. as E-6.</td><td rowspan="2">36 mos. as E-7. 8 of 11 years total service must be enlisted.</td><td rowspan="2">24 mos. as E-8. 10 of 13 years total service must be enlisted.</td></tr>
<tr><td>SCHOOL</td><td>Recruit Training.</td><td></td><td>Class A for PR3, DT3, PT3, AME 3, HM 3</td><td></td><td></td><td>Class B for AGC, MUC, MNC.</td></tr>
<tr><td>PRACTICAL FACTORS</td><td>Locally prepared check- offs.</td><td colspan="7">Records of Practical Factors, NavPers 1414/1, must be completed for E-3 and all PO advancements.</td></tr>
<tr><td>PERFORMANCE TEST</td><td colspan="2"></td><td colspan="4">Specified ratings must complete applicable performance tests be- fore taking examinations.</td><td></td><td></td></tr>
<tr><td>ENLISTED PERFORMANCE EVALUATION</td><td colspan="2">As used by CO when approving advancement.</td><td colspan="6">Counts toward performance factor credit in ad- vancement multiple.</td></tr>
<tr><td>EXAMINATIONS</td><td colspan="2">Locally prepared tests.</td><td colspan="4">Navy-wide examinations required for all PO advancements.</td><td colspan="2">Navy-wide, selection board.</td></tr>
<tr><td>NAVY TRAINING COURSE (INCLUD- ING MILITARY REQUIREMENTS)</td><td></td><td colspan="5">Required for E-3 and all PO advancements unless waived because of school comple- tion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition).</td><td colspan="2">Correspondence courses and recommended reading. See NavPers 10052 (current edition).</td></tr>
<tr><td rowspan="2">AUTHORIZATION</td><td colspan="2">Commanding Officer</td><td colspan="3">U.S. Naval Examining Center</td><td colspan="3">Bureau of Naval Personnel</td></tr>
<tr><td colspan="6">TARS attached to the air program are advanced to fill vacancies and must be approved by CNARESTRA.</td><td colspan="2"></td></tr>
</table>

* All advancements require commanding officer's recommendation.
† 2 years obligated service required.
#8 years total service required.

Figure 1-1. —Active duty advancement requirements.

## INACTIVE DUTY ADVANCEMENT REQUIREMENTS

| REQUIREMENTS * | | E1 to E2 | E2 to E3 | E3 to E4 | E4 to E5 | E5 to E6 | E6 to E7 | E8 | E9 |
|---|---|---|---|---|---|---|---|---|---|
| | FOR THESE DRILLS PER YEAR | | | | | | | | |
| TOTAL TIME IN GRADE | 48 | 6 mos. | 6 mos. | 15 mos. | 18 mos. | 24 mos. | 36 mos. | 36 mos. | 24 mos. |
| | 24 | 9 mos. | 9 mos. | 15 mos. | 18 mos. | 24 mos. | 36 mos. | 36 mos. | 24 mos. |
| | NON-DRILLING | 12 mos. | 24 mos. | 24 mos. | 36 mos. | 48 mos. | 48 mos. | | |
| TOTAL TRAINING DUTY IN GRADE † | 48 | 14 days | 14 days | 14 days | 14 days | 28 days | 42 days | 42 days | 28 days |
| | 24 | 14 days | 14 days | 14 days | 14 days | 28 days | 42 days | 42 days | 28 days |
| | NON-DRILLING | None | None | 14 days | 14 days | 28 days | 28 days | | |
| PERFORMANCE TESTS | | | | Specified ratings must complete applicable performance tests before taking examination. | | | | | |
| DRILL PARTICIPATION | | Satisfactory participation as a member of a drill unit. | | | | | | | |
| PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS) | | Record of Practical Factors, NavPers 1414/1, 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. | | | | | | Standard EXAM, Selection Board. | |
| AUTHORIZATION | | District commandant or CNARESTRA | | | | | Bureau of Naval Personnel | | |

* Recommendation by commanding officer required for all advancements.
† Active duty periods may be substituted for training duty.

Figure 1-2. —Inactive duty advancement requirements.

qualifications. In some subject matter areas, you may find only practical factors or knowledge factors. It is important to remember that there are some knowledge aspects to all practical factors, and some practical aspects to most knowledge factors. Therefore, even if the Quals Manual indicates that there are no knowledge factors for a given subject matter area, you may still expect to find examination questions dealing with the knowledge aspects of the practical factors listed in that subject matter area.

In summary, then, the written examination for advancement in rating may contain questions relating to the practical factors and to the knowledge factors of both the military requirements and the professional qualifications. If you are working for advancement to second class, remember that you may be examined on third class qualifications as well as on second class qualifications.

You are required to pass a Navy-wide military/leadership examination for E-4 or E-5, as appropriate, before participating in the occupational examinations. The military/leadership examinations for both levels are given quarterly. Candidates are required to pass the applicable military/leadership examination only once. Each of these examinations consists of 100 questions based on information contained in the Manual of Qualifications for Advancement in Rating, NavPers 18068 and Training Publications for Advancement in Rating, NavPers 10052.

The Navy-wide occupational examinations for pay grades E-4 and E-5 will contain 150 questions related to accupational areas of your rating.

The Quals Manual is kept current by means of changes. The occupational qualifications for your rating which are covered in this training course were current at the time the course was printed. By the time you are studying this course, however, the quals for your rating may have been changed. Never trust any set of quals until you have checked it against an UP-TO-DATE copy in the Quals Manual.

### Record of Practical Factors

Before you can take the servicewide examination for advancement in rating, there must be an entry in your service record to show that you have qualified in the practical factors of both the military requirements and the occupational qualifications. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 1414/1 is used to keep a record of your practical factor qualifications. This form is available for each rating. The form lists all practical factors, both military and occupational. As you demonstrate your ability to perform each practical factor, appropriate entries are made in the DATE and INITIALS columns.

Changes are made periodically to the Manual of Qualifications for Advancement in Rating, and revised forms of NavPers 1414/1 are provided when necessary. Extra space is allowed on the Record of Practical Factors for entering additional practical factors as they are published in changes to the Quals Manual. The Record of Practical Factors also provides space for recording demonstrated proficiency in skills which are within the general scope of the rating but which are not identified as minimum qualifications for advancement.

If you are transferred before you qualify in all practical factors, the NavPers 1414/1 form should be forwarded with your service record to your next duty station. You can save yourself a lot of trouble by making sure that this form is actually inserted in your service record before you are transferred. If the form is not in your service record, you may be required to start all over again and requalify in the practical factors which have already been checked off.

### NavPers 10052

Training Publications for Advancement in Rating, NavPers 10052 (revised), is a very important publication for anyone preparing for advancement in rating. This bibliography lists required and recommended Navy Training Courses and other reference material to be used by personnel working for advancement in rating. NavPers 10052 is revised and issued once each year by the Bureau of Naval Personnel. Each revised edition is identified by a letter following the NavPers number. When using this publication, be SURE that you have the most recent edition.

If extensive changes in qualifications occur in any rating between the annual revisions of NavPers 10052, a supplementary list of study material may be issued in the form of a BuPers

Notice. When you are preparing for advancement, check to see whether changes have been made in the qualifications for your rating. If changes have been made, see if a BuPers Notice has been issued to supplement NavPers 10052 for your rating.

The required and recommended references are listed by rate level in NavPers 10052. If you are working for advancement to third class, study the material that is listed for third class. If you are working for advancement to second class, study the material that is listed for second class; but remember that you are also responsible for the references listed at the third class level.

In using NavPers 10052, you will notice that some Navy Training Courses are marked with an asterisk (*). Any course marked in this way is MANDATORY—that is, it must be completed at the indicated rate level before you can be eligible to take the servicewide examination for advancement in rating. Each mandatory course may be complete by (1) passing the appropriate enlisted correspondence course that is based on the mandatory training course; (2) passing locally prepared tests based on the information given in the training course; or (3) in some cases, successfully completing an appropriate Class A course.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. Personnal of ALL ratings must complete the mandatory military requirements training course for the appropriate rate level before they can be eligible to advance in rating.

The references in NavPers 10052 which are recommended but not mandatory should also be studied carefully. ALL references listed in NavPers 10052 may be used as source material for the written examination, at the appropriate rate levels.

### Navy Training Courses

There are two general types of Navy Training Courses. RATING COURSES (such as this one) are prepared for most enlisted ratings. A rating training course gives information that is directly related to the occupational qualifications of ONE rating. SUBJECT MATTER COURSES or BASIC COURSES give information that applies to more than one rating.

Navy Training Courses are revised from time to time to keep them up to date technically. The revision of a Navy Training Course is identified by a letter following the NavPers number. You can tell whether any particular copy of a Navy Training Course is the latest edition by checking the NavPers number and the letter following this number in the most recent edition of List of Training Manuals and Correspondence Courses, NavPers 10061. (NavPers 10061 is actually a catalog that lists all current training courses and correspondence courses; you will find this catalog useful in planning your study program.)

Navy Training Courses are designed to help you prepare for advancement in rating. The following suggestions may help you to make the best use of this course and other Navy training publications when you are preparing for advancement in rating.

1. Study the military requirements and the occupational qualifications for your rating before you study the training course, and refer to the quals frequently as you study. Remember, you are studying the training course primarily in order to meet these quals.

2. Set up a regular study plan. It will probably be easier for you to stick to a schedule if you can plan to study at the same time each day. If possible, schedule your studying for a time of day when you will not have too many interruptions or distractions.

3. Before you begin to study any part of the training course intensively, become familiar with the entire book. Read the preface and the table of contents. Check through the index. Look at the appendixes. Thumb through the book without any particular plan, looking at the illustrations and reading bits here and there as you see things that interest you.

4. Look at the training course in more detail, to see how it is organized. Look at the table of contents again. Then, chapter by chapter, read the introduction, the headings, and the subheadings. This will give you a pretty clear picture of the scope and content of the book. As you look through the book in this way, ask yourself some questions:

What do I need to learn about this?

What do I already know about this?

How is this information related to information given in other chapters?

How is this information related to the qualifications for advancement in rating?

5. When you have a general idea of what is in the training course and how it is organized, fill in the details by intensive study. In each study period, try to cover a complete unit—it may be a chapter, a section of a chapter, or a subsection. The amount of material that you can cover at one time will vary. If you know the subject well, or if the material is easy, you can cover quite a lot at one time. Difficult or unfamiliar material will require more study time.

6. In studying any one unit—chapter, section, or subsection—write down the questions that occur to you. Many people find it helpful to make a written outline of the unit as they study, or at least to write down the most important ideas.

7. As you study, relate the information in the training course to the knowledge you already have. When you read about a process, a skill or a situation, try to see how this information ties in with your own past experience.

8. When you have finished studying a unit, take time out to see what you have learned. Look back over your notes and questions. Maybe some of your questions have been answered, but perhaps you still have some that are not answered. Without looking at the training course, write down the main ideas that you have gotten from studying this unit. Don't just quote the book. If you can't give these ideas in your own words, the chances are that you have not really mastered the information.

9. Use Enlisted Correspondence Courses whenever you can. The correspondence courses are based on Navy Training Courses or on other appropriate texts. As mentioned before, completion of a mandatory Navy Training Course can be accomplished by passing an Enlisted Correspondence Course based on the Navy Training Course. You will probably find it helpful to take other correspondence courses, as well as those based on mandatory training courses. Taking a correspondence course helps you to master the information given in the training course, and also helps you see how much you have learned.

10. Think of your future as you study Navy Training Courses. You are working for advancement to third class or second class right now, but someday you will be working toward higher rates. Anything extra that you can learn now will help you both now and later.

## SOURCES OF INFORMATION

As you refer to your quals, you probably will discover certain areas in which you need more basic study. Consequently, you will need to obtain additional books. The most useful books for this purpose are the training courses listed in the reading list in the front of this manual. These training courses serve three purposes: They give you much of the background you need to prepare for a technical rating; they offer a handy refresher course in subjects you may have forgotten; and they are useful throughout your Navy career as a handy reference library. The training courses are organized in such manner that they may be used with a minimum of supervision.

# CHAPTER 2

# NAVAL COMMUNICATIONS

## EARLY HISTORY

In the old days, because of poor communications, naval warfare was largely a matter of guesswork. The commander of a fleet often had trouble trying to figure out not only what the enemy was up to, but also where his own ships were and what they were doing.

Consider what happened when a French fleet slipped through a British blockading squadron off Toulon in 1798. Although the French were discovered and followed by two British observation frigates, Admiral Nelson did not receive news of the French escape until 8 weeks later. He then spent 30 days trying to find the enemy who, meanwhile, had put back into Toulon.

In the American Navy one of the earliest records of a signal system was a set of simple maneuver and recognition signs issued in 1778. An improved system was worked out by Captain Thomas Truxtun in 1797. His system was based on 10 numeral flags from 0 to 9. Orders were relayed by numbers and combinations of numbers having meanings that could be looked up in a decode book.

During the Civil War, when many Federal officers went over to the Confederacy, Union signals had to be revised completely. The Bureau of Navigation, which took charge of naval communications in 1862, decided that the Navy should adopt the Army signal system. As a result, Army-style communications dominated Navy signaling until as late as 1892.

Semaphore came into the Navy in 1861, with a system of hand semaphoric signals somewhat similar to the present ones, but with a limited number of characters.

In 1864 two forerunners of the present-day flashing light system made their appearance. Under one system a lantern, ball, or similar object was exposed, or a flag was lowered and raised, in dit-dah patterns. In fog or mist, the same code could be used for a trumpet blown in long or short blasts. Under the other system a canvas cylinder, with a lantern inside was secured to the rigging in a manner permitting the light to be exposed or screened by pulling or releasing a line attached to the cylinder.

Electricity came into naval communications in 1875, when experiments with electric lights were conducted. In 3 years the range of these lights increased from 6 miles to a distance of nearly 17 miles.

It was not until the "wireless" came along about 1895, however, that naval communications could begin to approach the rapidity and long range it has today. By 1903 radio was operational equipment throughout the United States Fleet. Since then there have been so many improvements in radio that it now is just as easy to send a message to fleets all over the world as it once was to pass the word to a single ship only a shout's range away.

The modern fleet or naval striking force travels faster, is distributed over much greater areas of ocean, and hits harder than any seagoing force in the past. This increased speed of operation by submarines, surface warships, and aircraft requires better and faster means of communications. To meet new requirements, the Navy's communication equipment and methods are changing as rapidly and radically as budgetary limits and operational commitments allow.

No matter how deep into hostile waters a force may penetrate, it never is out of touch with its base of operations. In support is a complex global organization of communication stations with hundreds of radio and landline circuits. Within the force itself are all types of visual and electronic communication facilities. Orders and information that affect the successful outcome of the force's mission are exchanged swiftly and accurately throughout every level of command. The effect is a tightly directed fighting unit—the direct result of reliable communications.

## MISSION OF NAVAL COMMUNICATIONS

Naval communications is the "voice of command" because it is the means by which naval command makes known its will. In performing their duties, Radiomen fulfill the mission of naval communications. This mission, as stated in the effective edition of DNC 5, is "to provide and maintain reliable, secure, and rapid communications, based on war requirements adequate to meet the needs of naval command, to facilitate administration, and to satisfy as directed, JCS-approved Joint requirements and to manage, operate and maintain facilities in the Defense Communications System (DCS) as assigned by JCS."

Communications serves command when it carries battle orders from a fleet commander to his subordinates, forwards docking information from harbor control to an entering vessel, or delivers a storm warning from the senior officer present afloat (SOPA) to all ships in the area. It aids administration when its circuits are used to furnish ship alteration data to an overseas repair facility, or to arrange transportation for a draft of men.

Naval communications is further pledged to assist in such disasters as floods, hurricanes, and earthquakes when normal communication facilities in the disaster area become curtailed or inoperational.

## POLICY OF NAVAL COMMUNICATIONS

The policy of naval communications is to—

1. Cooperate with the military services, Defense Communications Agency, and other departments and agencies of the U.S. Government and Allied Nations.

2. Encourage development of amateur and commercial communication activities of the United States for the enhancement of their military value and for safeguarding the interests of the Nation.

3. Promote safety of life at sea and in the air, maintain facilities for adequate communication with the U.S. merchant marine, aircraft over the sea, and appropriate U.S. and foreign communication stations.

## FUNDAMENTAL COMMUNICATION PRINCIPLES

Naval communications must always be ready to meet wartime requirements. Its peacetime organization, methods, procedures, facilities, and training must be adequate and capable of shifting to an emergency or war status with a minimum of changes.

Through the years naval communications has been guided by certain basic principles that have been proven under war conditions. Foremost among these principles are reliability, security, and speed.

Reliability of communications is always the first requirements. A message must say exactly what the originator means it to say; it must be sent by the best method of communications available; and it must be complete and accurate in every way when finally placed in the hands of the addressee. Reliability cannot be sacrificed to meet conflicting demands of security and speed, or for mere convenience. A variable relationship between security and speed exists, however. Modern operating procedures permit security with speed, but sometimes one must be stressed more than the other. In the planning stages of an operation, secrecy must be preserved at all costs, hence security is more important than speed. During a critical moment in combat, however, very urgent messages may be sent in plain language instead of being delayed for encryption and decryption. Here, security is sacrificed for speed, although security may never be disregarded entirely.

## TELECOMMUNICATIONS

The word telecommunications refers to communications over a distance. Several methods of telecommunications are used by the Navy. Of these methods at least three—radiotelegraph, teletype, and radiotelephone—concern the Radioman as operator. In message-handling duties afloat and ashore, Radiomen also work with traffic sent by other methods, as listed here.

1. Electrical communications:
   a. Radiotelegraph;
   b. Teletype (wire or radio);
   c. Radiotelephone;
   d. Facsimile (wire or radio).
2. Visual communications:
   a. Flaghoist;
   b. Flashing light;
   c. Semaphore.

3. Sound communications:
   a. Whistles, sirens, and bells;
   b. Sonar.

## ELECTRICAL COMMUNICATIONS

Of the various means of communicating, electrical communications is by far the most important to the Radioman. A brief description of the listed methods of electrical communications follows.

### Radiotelegraph

Radiotelegraph (often called CW for "continuous-wave" telegraphy) is a system for transmitting messages by radio waves. In this system an operator separates a radio wave into dits and dahs of morse code by opening and closing a hand key. Radiotelegraph was in use by the Navy as early as 1903, and even today, despite development of faster and more convenient methods of electronic communications, CW still is used.

According to a NATO staff communicator:

> "No technical advances have eliminated the need for the manual radio operator. To date, we have no automatic method that can in size, weight, frequency economy, and simplicity compare with CW telegraphy; we have no system which will discriminate against accidental or intentional interference to the extent possible with a trained operator. There is no electronic substitute for an operator's brain... Under marginal conditions the additional flexibility, simplicity, and reliability of a CW circuit may mean the difference between having and not having communications."

### Teletype

The mental and manual actions performed by an operator in converting letters to Morse code (and vice versa) are replaced in teletype by electrical and mechanical actions. To transmit a message, the operator types on a keyboard similar to that on a typewriter. As each key is pressed, a sequency of signals is transmitted. At receiving stations the signals are fed into receiving machines that type the message automatically.

Teletype signals may be sent either by landline (wire) or by radio. Teletype communication is used both by the military services and by commercial communication companies such as Western Union.

Today the chief shipboard use of radioteletype (RATT) is for receiving fleet broadcast schedules, for which it is well suited. Radioteletype can clear traffic at a rate in excess of 100 words per minute, as compared to the 17- to 29-wpm speed of CW fleet broadcasts. Because a shipboard operator is freed from manual copying, and hundreds of ships may be receiving a singlebroadcast, the total saving in trained manpower is considerable.

Other shipboard uses of RATT are for communications between ships and, if the traffic load warrants, between ships and shore communication stations.

### Radiotelephone

Radiotelephone (sometimes called voice radio) is one of the most useful military communication methods. Because of its directness, convenience, and ease of operations, radiotelephone is used by ships, aircraft and shore stations for ship-to-shore, shore-to-ship, ship-to-ship, air-to-ship, ship-to-air, and air-to-ground communications. The single-sideband (SSB) mode of operation makes it possible to communicate half way around the world by radiotelephone. One of the most important uses of radiotelephone is for short-range tactical communications. Its direct transmission of voice enables a conning officer to have in his hands a means of personal communication with the officer in tactical command (OTC) and with other ships. Little delay results while a message is prepared for transmission, and acknowledgments can be returned instantly. Radiotelephone equipment for tactical use usually is operated on frequencies that are high enough to have line-of-sight characteristics; that is, the waves do not follow the curvature of the earth. These characteristics limit the usual range of radiotelephone from 20 to 25 miles. Radiotelephone procedure can be learned easily by persons with no other training in communications.

With these advantages of radiotelephone go some disadvantages. Transmissions may be unreadable because of static, enemy interference, or high local noise level caused by shouts, gunfire, and bomb or shell bursts. Wave propagation characteristics of radiotelephone frequencies sometimes are freakish, and transmissions may be heard from great distances. Most radiotelephone messages are in plain language, and if information is to be kept from the enemy, users must keep their messages short, stick to proper procedures, and be careful of what they say.

### Facsimile

Facsimile, (FAX) is useful for transmitting such matter as photographs and weather charts. An image to be sent is scanned by a photoelectric cell, and electrical variations in the cell, and electrical variations in the cell output, corresponding to light and dark areas being scanned, are transmitted to the receiver. At the receiver the signal operates a recorder that reproduces the picture. Facsimile signals may be transmitted either by landline or by radio.

## VISUAL COMMUNICATIONS

Visual communication systems have been in use since the beginning of the Navy, and still are the preferred means for communicating at short range during daylight. In reliability and convenience, they are the equal of radio and are more secure.

The types of visual systems are flaghoist, flashing light, and semaphore.

### Flaghoist

Flaghoist is a method whereby various combinations of brightly colored flags and pennants are hoisted to send messages. It is the principal means for transmitting brief tactical and informational signals to surface units. Signals are repeated by addressees, thus providing a sure check on accuracy of reception. Texts of messages that may be sent usually are limited to those contained in signal books.

### Flashing Light

Flashing light is a visual telegraphic system that utilizes either visible or infrared light beams (Nancy), and it may be directional or nondirectional.

Directional flashing light may be pointed and trained so as to be visible only from the viewpoint of the recipient. It makes use of signal searchlights on which an operator opens and closes the shutter to form dots and dashes of Morse code. Smaller portable lights, in which the source of light is switched on and off to form code characters, are used also.

Nondirectional flashing light is sent out from lamps located on a yardarm. An operator forms dots and dashes with a telegraph key that switches lamps on and off. Because the light is visible in every direction away from the ship, this method is well suited for messages destined for several addressees.

In wartime, flashing light communication that must be carried on after dark is usually conducted by means of infrared beams (Nancy). These beams are not visible unless viewed through a special receiver. Infrared is the most secure means of visual communications, and transmissions may be either directional or nondirectional. Directional infrared utilizes standard signal searchlights fitted with special filters. Infrared yardarm blinker lamps are used for nondirectional signaling.

### Semaphore

Semaphore is a communication medium by which an operator signals with two hand flags, moving his arms through various positions to represent letters, numerals, and other special signs. Because of its speed, it is the preferred means of short-range message transmission during daylight. It is not readable much farther than 2 miles, even on a clear day.

## SOUND COMMUNICATIONS

Sound systems include whistles, sirens, bells, and sonar. The first three devices are used by ships for transmitting emergency warning signals such as air raid alerts, for navigational signals prescribed by the Rules of the Road, and, in wartime, for communication between ships in convoy.

Ships equipped with sonar (underwater sound) apparatus may communicate with other ships by this method, although passing messages is not the chief purpose of the equipment. In peacetime it often is used for coordinating exercises between surface vessels and submarines. Sonar communications may be either by voice or by Morse code.

Sound systems normally have the same range limitation as visual methods but are considered less secure.

## ELEMENTS OF NAVAL COMMUNICATIONS

Naval communications is comprised of two major elements, coordinating four operating elements.

- Major Elements
  1. Office of Naval Communications—Assistant Chief of Naval Operations (Communications)
  2. Naval Communications Command Headquarters (Commander, Naval Communications Command) (COMNAVCOMM)
- Operating Elements
  1. Naval Communications System
  2. Naval Security Group
  3. Communication departments of shore (field) activities
  4. Communication organizations of operating forces.

## OFFICE OF NAVAL COMMUNICATIONS

The Office of Naval Communications (a part of the organization of the Chief of Naval Operations) is the headquarters of Naval Communications, and provides communication coordination and planning for the entire Department of the Navy. The staff of the ACNO(COMM) consists of one Deputy Director for Navy Communications who is also the Commander, Naval Communications Command, five special assistants and five communication divisions: plans and policy, programs, operations and readiness, administrative personnel, and radiofrequency spectrum. The work embraces radio and visual communications, landline systems, registered publications, and liaison with other military services and other Government agencies.

## NAVAL COMMUNICATIONS COMMAND HEADQUARTERS

The Naval Communications Command Headquarters (NCC) satisfies the communication needs of ships, air and shore activities Navy-wide, and commands and supports naval communication stations (NAVCOMMSTAS), naval radio stations (NAVRADSTAS), naval communication units (NAVCOMUs), and naval security group activities (NAVSECGRUACTS).

## NAVAL SECURITY GROUP

The Naval Security Group, under direction of the Naval Communication Command, performs special functions in connection with communication security and communication electronic intelligence. Usually, SECGRU functions are handled by security group departments of the Naval Communication System when so assigned in separately established shore (field) activities and by special groups assigned to fleet units.

The Naval Security Group administers the Registered Publication System, which includes Registered Publication Issuing Offices (RPIOs) and a central shipping and accounting office at the Naval Security Station, Washington, D. C. Most RPIOs are located at a communication activity. Occasionally these activities are not readily accessible to ships. Accordingly, independent RPIOs may be established at places where there are large concentrations of naval ships but no communication activity.

Another function of the Security Group is operation of certain courier transfer stations. These stations, combined with Army and Air Force courier stations, make up the Armed Forces Courier System (ARFCOS). The ARFCOS transports mail and material requiring officer handling to meet security requirements.

## COMMUNICATION DEPARTMENTS OF SHORE ESTABLISHMENT ACTIVITIES

Communication departments of shore establishment activities are components of the station or activity they serve. Their mission differs from that of NAVCOMMSTAs and other activities of the Naval Communication System in that, primarily, they furnish local support to the shore station mission. They disseminate information and convey reports and similar data to their own local command, although they may (and often do) work into or connect with the worldwide network of the DCS.

Normally the communication department of a shore activity has a small communication center consisting of a message center and cryptocenter. It may also provide other facilities, depending on the mission of the command it supports. Where radio transmitting and receiving facilities are required, small communication centers usually use equipment installed at radio transmitting and receiving sites of a NAVCOMMSTA and remotely control them from the communication center.

## COMMUNICATION ORGANIZATIONS OF OPERATING FORCES

In the interest of economy and effective utilization of resources, communication departments ashore are consolidated under the naval communication station wherever feasible.

At the level of the operating forces, it is easily seen that communications is the "voice of command." The communication organization aboard ship is under the direct and positive control of the commanding officer. It provides communication services needed to control and employ fleet units. These services include sending and receiving orders, instructions, reports, and various other forms of intelligence. Facilities are provided for rapid ship-shore and air-surface communications as well as for communications between ships.

## NAVAL COMMUNICATION SYSTEM

The Naval Communication System as part of the Defense Communications System (DCS) may be described as the backbone of naval communications. It is a fixed, integrated communication network, which forms the worldwide framework of naval communications. It provides the means for transmission of CNO directives and instructions: Broadcast to the fleet of weather, general messages, orders, and similar message traffic; and for reception of essential intelligence from fleet commanders.

## ORGANIZATION COMPONENTS

Organizational components of the Naval Communication System—as activities of the system—manage, operate, and maintain the facilities, systems, equipment, and devices necessary to provide communications for the command, operational control, and administration of the Navy. Three major types of activities make up the Naval Communication System. These activities are NACOMMSTAs, NAVRADSTAs, and NAVCOMMUs.

### Naval Communication Station

As its name implies, a naval communication station (NAVCOMMSTA) is a naval station that has a primary responsibility for communications. It includes all communication facilities and equipment required to provide essential fleet support and fixed communication services for a specific area.

### U. S. Naval Radio Station

A naval radio station (NAVRADSTA) ordinarily is a component of a NAVCOMMSTA but may be located physically some distance from the NAVCOMMSTA. It is classified either a transmitting station or a receiving station, depending upon the function performed, and is so designated by letter T or R added in parentheses. For example, NAVRADSTA (T) Lualualei, Oahu, is a component of NAVCOMMSTA Honolulu, Hawaii, but is located approximately 15 miles for the NAVCOMMSTA.

### U. S. Naval Communication Unit

Naval communication units (NAVCOMMUs) are assigned limited or specialized missions, which may include some but not all missions assigned a NAVCOMMSTA. For this reason, a NAVCOMMU is much smaller in terms of personnel and facilities than is a NAVCOMMSTA. The NAVCOMMUs are identified by geographical location, as NAVCOMMU Seattle.

### Follow-the-Fleet Concept

The follow-the-fleet concept was organized so that fleet and force commanders will have optimum communications no matter where they operate. Within this concept the commander will have complete control over his forces even when operational and tactical situations are continually changing.

Stations within a given geographical area are organized to operate on a closely coordinated basis under direction of a master station. An area served collectively by each group of stations is known as a Naval Communication Area (NAVCOMMAREA). The master station exercises coordination control of all Naval Communication System fleet broadcast, ship-shore, air-ground, and other tactical circuits within the NAVCOMMAREA. It is known as the Naval Communication Area Master Station (NAVCAMS). Other stations within a NAVCOMMAREA are called Naval Communication Area Local Stations (NAVCALS). They coordinate control of communications under direction of the NAVCAMS.

Operational Components

Facilities provided by the NAVCOMMSTA, transmitting, and receiving stations are operated by a communication center (COMMCEN) (Fig. 2-1). The COMMCEN controls the use of these facilities by connecting them to various circuits used by Naval Communications and provides a connecting link for users of these circuits. It ensures a continuous path by constantly monitoring the circuits and provides for alternate paths when necessary. Normally each COMMCEN consists of several components.

FACILITY CONTROL CENTER.—Essentially the control center is the master switchboard and monitoring station. All equipment of the communication center is wired through switchboards and patching panels of the control center. From the control center landlines branch out to other communication spaces. Landline or radio links lead to remotely located transmitting and receiving stations serving the communication center. Control center personnel connect radio and landline circuits to appropriate equipment in other spaces of the COMMCEN. The control center contains control and terminal equipment and built-in monitoring and test equipment. It ties together, electronically, all spaces of the communication center, and is the electrical outlet from that communication center to other communication centers.

CRYPTOCENTER.—A cryptocenter provides the following services: (1) receives and off-line encrypts messages and routes to message center for rapid transmission, or transmitts to relay center directly; (2) receives and off-line decrypts messages and makes delivery to addressees; (3) receives and transmits messages on circuits authorized for on-line transmission of Top Secret messages without previous off-line encryption; and (4) operates the Top Secret message processing area.

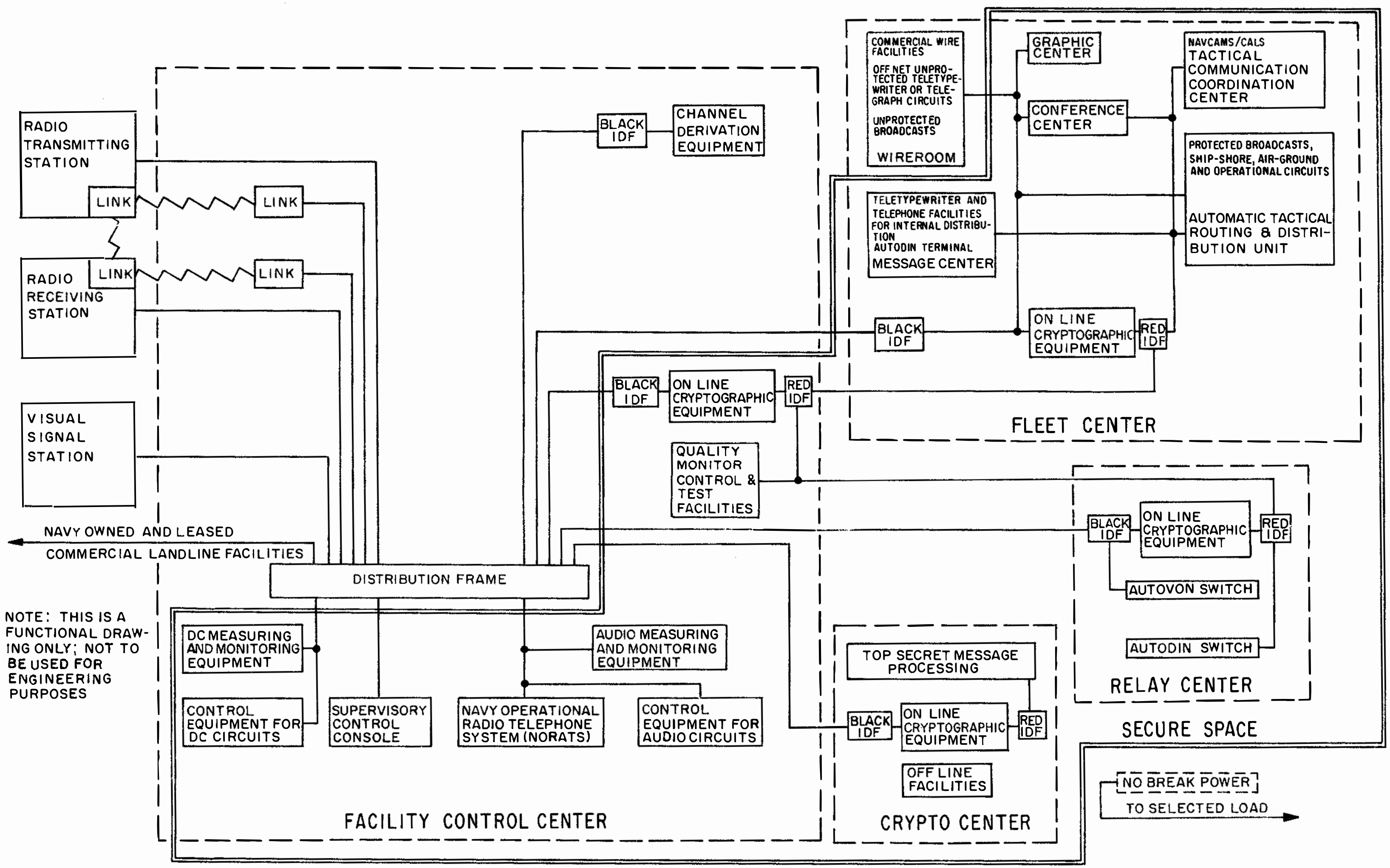
FLEET CENTER.—A fleet center is where keying control of all circuits to and from forces afloat is exercised. A fleet center is the point of interface between naval operating forces afloat and ashore served via Navy tactical or dedicated systems and naval shore (field) activities served via common user facilities of the Defense Communications System (DCS).

The fleet center operates maritime and aeronautical distress and assigned maritime public service circuits, provides specialized message processing service as required for an effective interface of the several communication systems terminated. This service includes but is not limited to—

1. Ensuring message procedural compatibility and formating as required (e. g., codress/plaindress).
2. Conversion between modes, such as CW to TTY and vice versa.
3. Call sign encryption and decryption as required.
4. Off-line encryption as required.

Functionally, fleet centers are subdivided into six smaller centers, a description of which follows.

- Tactical communication coordination center: Operates either a NAVCAM or NAVCAL (mentioned earlier). Further information can be found in OpNavInst 02000. 28.
- Automatic tactical routing and distribution unit: All covered broadcast, ship-shore circuits and other Navy special-purpose operational networks terminate in this section of a COMMCEN. The Navy automatic broadcast processing and routing system (NABPARS) is also located here. An automatic tactical routing and distribution unit is the relay point for Navy special-purpose operational networks, such as the Navy Communication Operating Network (NAVCOMMOPNET). It interfaces with the relay center for entering traffic into the common user networks, such as the DCS teletype network and DCS automatic digital network (AUTODIN). To centralize routing information for the operating forces, a ship location facility that works closely with the movement report system is located in this unit.
- Message center: A message center is the converging point of all messages sent or received by the command it serves. In the message center, messages are logged, placed in proper form for transmission, checked for accuracy and security violations, serviced as necessary, written up, distributed internally, and filed in appropriate reference files. A message center operates circuits with a relay station for reception or transmission of these messages.
- Unclassified communication unit (wire room): A wire room operates those radio or landline circuits that are not cryptographically protected. Included are circuits to commercial companies, circuits to other Government agencies, fleet




76.55

Figure 2-1. —Typical communication center.

and general broadcasts, certain ship-shore circuits, and off-net local circuits.

- Graphics center: A graphics center operates equipment required for sending and receiving pictures, photographs, weather maps, charts, and other material in graphic form. Facsimile traffic is processed in message centers along with regular messages.
- Conference center: A conference center is used for conferences between major commands ashore and afloat when need arises. These conferences may be by teletype, voice radio, or the DCS automatic voice network (AUTOVON).

RELAY CENTER.—A relay center is the communication center's linkage with DCS common user networks. It contains automatic or semiautomatic teletype tape receiving, tape transmitting, and message numbering and monitoring equipment. A relay center also maintains a service section for the purpose of obtaining and making retransmissions, tape corrections, handling misroutes, and other services necessary for final and accurate delivery of messages. A file of monitor tapes is maintained for an appropriate period of time.

## DEFENSE COMMUNICATION SYSTEM

The Defense Communications Agency exercises operational and management direction over the DCS. The DCA consists of a chief (an officer of general or flag rank), a headquarters staff, and such other units as are specifically assigned the Agency by the Secretary of Defense of the Joint Chiefs of Staff.

The DCS includes all Department of Defense circuits, terminals, control facilities, and tributaries (regardless of military department to which assigned) required to provide communications from the President, down the chain of command, to the fixed headquarters of various subordinate commands. This broad inclusion takes in all point-to-point, long-haul Government-owned or -leased circuits that are a part of the Naval Communication System. Fleet broadcasts, ship-to-shore, ship-to-ship, and tactical circuits within a tactical organization normally are excluded from the DCS.

## DCS AUTOMATIC VOICE NETWORK

The DCS automatic voice network (AUTOVON) offers rapid, direct interconnection of Department of Defense and certain other Government installations. Some overseas areas are now connected into the continental United States (CONUS) automatic system. As facilities become available, other overseas areas will be connected. The AUTOVON is intended to be a single, worldwide, general-purpose, direct dialing system. Its goal is to complete connections between two prearranged points, anywhere in the world, in about 2 seconds, and to complete regular connections with pushbutton speed. It is planned eventually to switch every type of information transfer, including voice transmission, teletype, and data.

Several installations, comparable in function to commercial telephone exchanges, constitute the AUTOVON system. An installation in the system is referred to as an AUTOVON switch, or simply a switch. Within individual areas are local command, control, and administrative voice communication systems. These systems can be connected into the worldwide AUTOVON through manually operated telephone switchboards, or automatic dial exchanges, by provision of direct in or out dialing capabilities.

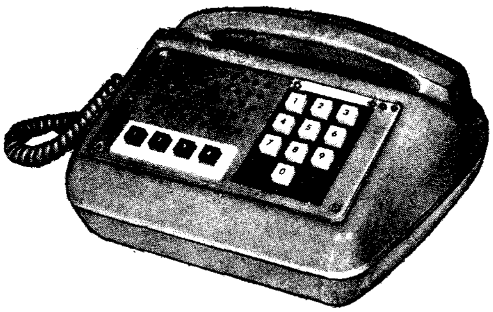
A naval station telephone system may be connected into the AUTOVON by its local private branch exchange (PBX), or private automatic branch exchange (PABX), In this usage the PBX or PABX would be considered the AUTOVON subscriber. Some offices and facilities that have direct access to the AUTOVON system are considered individual AUTOVON subscribers.

### Normal Service

Normal AUTOVON service provides a capability for subscribers to call other subscribers on a worldwide basis for day-to-day nonpreemptive traffic. Depending on the type of service available in each locality, AUTOVON calls may be accomplished either by direct dialing or through a local operator. Where users of this type of service require priority calls to be made, they must place the call with their local operator or the AUTOVON dial service assistance (DSA) operator.

Most military installations are provided connection into the general-purpose AUTOVON through their local PBX or PABX. These local systems are two-wire systems. Inasmuch as AUTOVON is a four-wire system, its terminal equipment must also be four-wire. Where such terminal equipment as two-wire local switchboards are to be interconnected, four-wire/two-wire conversion equipment is used.

Besides general-purpose AUTOVON service through local PBX, certain selected subscribers are authorized direct four-wire access to the general-purpose network through pushbutton four-wire telephone sets (fig. 2-2) installed in their offices. These subscribers are furnished up to four classes of priority. Each level of priority can preempt any lower levels. A four-wire subscriber may employ any level of precedence he desires up to and including the highest level he is authorized. Precedence desired by a four-wire subscriber is selected by pushing one of four buttons on his set.



50. 15

Figure 2-2. —Type AE-023 four-wire subset.

## DCS AUTOMATIC DIGITAL NETWORK

The DCS automatic digital network (AUTODIN) is a fully automatic digital data switching system. This network provides store-and-forward and circuit-switching message service to data and teletype subscriber terminals. It is capable of handling any type of information in digital form, including voice and graphics. The system consists of high-speed, electronic, solid state switching centers, various types of data and teletype subscriber terminals, and interconnecting transmission media.

The AUTODIN system replaces the 82B1 system in the continential United States (CONUS). Eventually it is planned to replace all manual and electromechanical relays overseas.

Administrative and logistic traffic from afloat units enter the AUTODIN system at Navy communication stations and units, which are provided direct access to the nearest AUTODIN switching center. Primary routes for Navy command and control traffic will continue to be through Navy dedicated circuits such as HiCom, ASC, and the NAVCOMMOPNET.

When fully implemented, AUTODIN will afford instantaneous, error-free, and secure communications around the world to more than 4100 directly connected subscriber terminals. Automatic preemption will give immediate service to command and other top-priority users. Daily capacity of the 19-switch AUTODIN system is capable of 60 million data cards or an equivalent of 5 million average-length messages. Worldwide security is furnished by means of the link encryption concept.

Interconnection of AUTODIN switching centers is accomplished through a network of high-frequency radio channels, submarines cables, microwave and tropospheric channels, and a variety of wire lines. These transmission media are available from existing DCS transmission resources, AUTOVON, and from commercial communication facilities. At least one alternate route is held in reserve for each trunk. Activation of this alternate path is controlled from the AUTODIN supervisory position. All d-c digital signals are converted to suitable analog signals by modulators-demodulators (MODEMS) before they are transmitted over interconnecting trunks.

Backbone of the AUTODIN system is the automatic electronic switching center (AESC), which is self-supporting. It included an automatic digital message switch, technical control facility, power generator and distribution equipment, a timing source, cryptographic and cryptoancillary equipment, and maintenance facilities. Basic functions of the AESC are to accept, store, and retransmit digital messages from one location to another, automatically detect and correct errors, and accomplish alternate routing. For locations requiring real-time service. CONUS switching centers provide automatic circuit switching (direct user-to-user) service.

Each switching center has a high degree of reliability resulting from duplicate major units, which can be activiated with a minimum of disrupted service. A standby communication data processor is supplied at each center and is automatically tested for on-line use at regular intervals.

Once a message is accepted in the AESC, which automatically checks for valid control characters, probability of a message not being switched to its proper terminal is 1 in 10 million messages. (Specification for overseas switching centers specifies 1 in 1 billion.)

Routing information, message formats, and operating procedures utilized in the AESC are in accordance with effective editions of ACP 121, JANAP 128, and other applicable operating directives and practices.

Traffic classified higher than the security clearance of its intended destination(s) is not delivered by the AESC. Such messages are intercepted automatically at the last center, and the originator is informed (via service message) of a nondelivery resulting from a security mismatch.

Another special feature of the AESC is the provision of incoming and outgoing journals. These message journals store and present (on demand) synoptic information on each message sufficient to identify it, to record how the message was received, and to determine where and when it was sent to an outgoing line. Journal information is retained for up to 30 days in inactive storage. Sufficient active storage is maintained for a period determined by operating requirements. Current status of the AESC can be checked at any moment by obtaining a printout of exactly how many messages, by precedence and destination, are in the center.

Each overseas AESC is capable of recognizing and routing 3300 single routing indicators for local tributaries terminated in the center, 200 collective routing indicators, and routing indicators for 300 other switching centers. Service is provided to four types of terminal stations, for example, by CONUS AUTODIN. These terminal stations, by types, are (1) low-speed compound terminals (12 cards or 200 teletype wpm); (2) high-speed compound terminal (100 cards or 200 teletype wpm); (3) magnetic tape terminal (2400 baud); and (4) computer interfaces (21 to 2400 baud).

Teletype subscribers are served by a controlled teletype terminal. It provides the following functions:

1. Automatic acknowledgment of end of message.
2. Automatic transmission interruption.
3. Automatic resumption of transmission of messages without rerun or intervention.
4. Automatic rejection and cancellation of messages.
5. Automatic message numbering.
6. Automatic verification of received message numbers.

By reducing manual handling of messages to a minimum, AUTODIN is revolutionizing communications. In the future, message delivery times and delays anywhere in the world will be measured in seconds instead of minutes and hours.

## JOINT COMMUNICATIONS

Need for coordinated and standardized communications among United States military services was clearly apparent during early stages of World War II. Because Army and Navy facilities sometimes were duplicated in one location, differences in procedures made for inefficient interservice communications. Now communication procedures are standardized throughout the Department of Defense, hence the handling of interservice messages creates no special problems. Joint procedures are set forth in Joint Army-Navy-Air Force Publications (JANAPs). Radiomen are expected to become familiar with these publications while studying naval communications.

## ALLIED COMMUNICATIONS

With worldwide cooperation between friendly nations and the United States, again the need arose for coordinated and standardized communications on an Allied basis. To meet this need, Allied Communication Publications (ACPs) were promulgated. The ACP series provides communication instructions and procedures essential to conducting combined military operations and communications in which two or more Allied Nations are involved. A Radioman's work in communications undoubtedly will require familiarity with many of the ACPs.

## NAVY MILITARY AFFILIATE RADIO SYSTEM

The Navy Military Affiliate Radio System (Navy MARS) was established to train amateur radio operators in Navy communication procedures. Through Navy MARS, amateur radio operators maintain an affiliation with the Navy, and provide a source of trained operators for use in local disaster situations or general emergencies.

Navy MARS is a projection of Navy Department policy to encourage and support amateur radio activity among Regular, Reserve, and Retired personnel of the Navy, Marine Corps, and Coast Guard for morale, recreation, training, international goodwill, and public service.

## SHIPBOARD COMMUNICATION ORGANIZATION

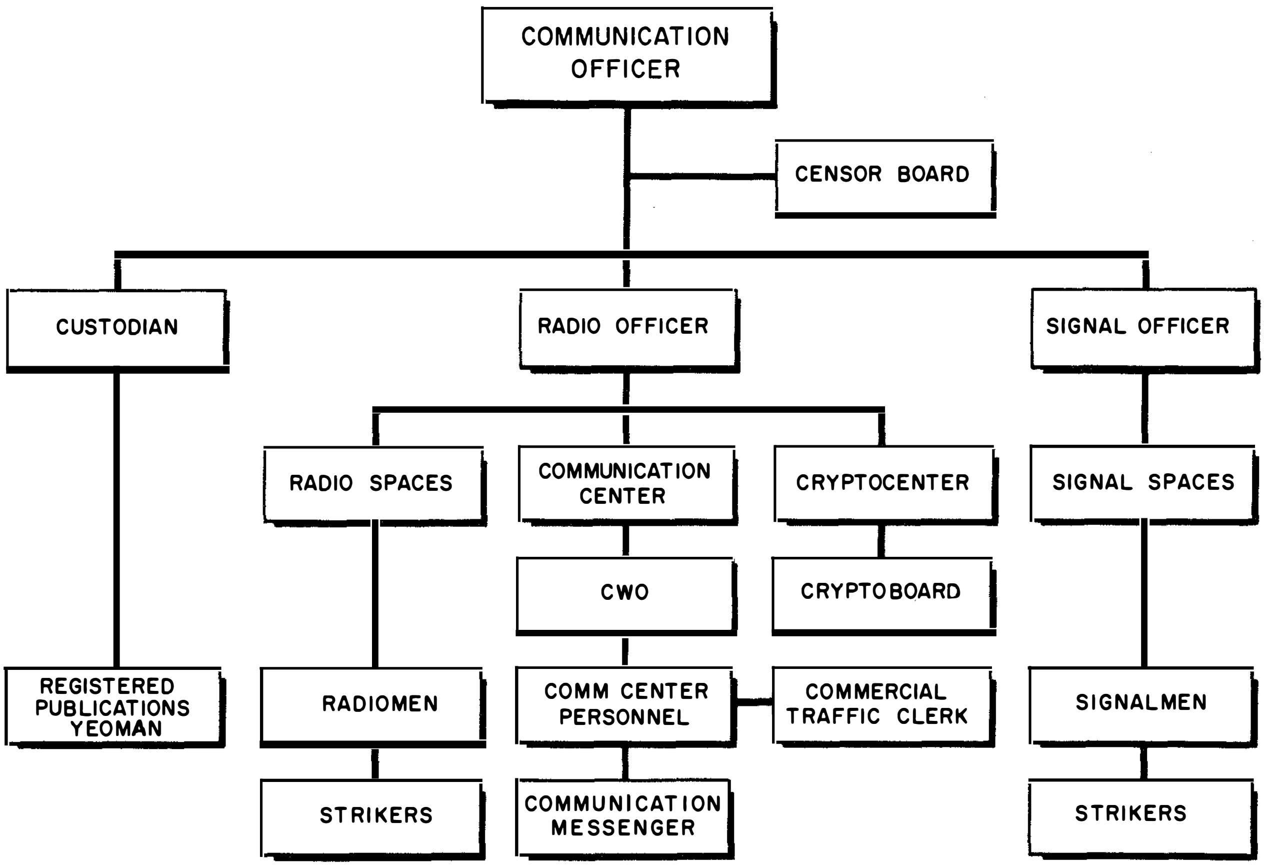
The complexity of shipboard communication organization and the number of personnel assigned vary with the size and mission of a ship. Large ships, such as those with a communication mission have a separate communication department headed by the communication officer. In most ships, however, the communication officer heads a division within the operations department, and is responsible directly to the operations officer.

Figure 2-3 diagrams the functional arrangement of a large shipboard communication organization. It is composed of two divisions—OR (radio), headed by a radio officer, and OS (visual signaling), headed by the signal officer. Also assigned are a custodian of registered publications, communication watch officers, cryptographers, and a cryptosecurity officer. Small ships may have only one division—OC (communications).

In large ships with sufficient personnel, specific duties are clearly defined and standardized. In smaller ships with necessarily less manpower, individuals must accept more varied duties and a heavier workload. In the description of responsibilities that follows, remember that in a small ship the communication officer may have no commissioned assistants, and is himself responsible for duties that in larger ships would be delegated to other officers. Further, he has deck as well as communication duties, and spends many hours on the bridge. Under these conditions, the communication officer relies heavily on his leading petty officers for assistance.

## OFFICER BILLETS

The communication organization is headed by a communication officer, who is responsible




76.4

Figure 2-3. —Shipboard communication organization.

for all external communications sent and received by radiotelegraph, radiotelephone, radioteletype, facsimile, and visual means. He is not liable for the ship's interior communications. The communication officer is responsible also for (1) care and maintenance of communication equipment (including landlines and teletype switchboards on ships equipped with these facilities); (2) preparation of communication reports; (3) procurement, custody, correction, distribution of, and reports on, publications issued to the ship through the Registered Publication System; (4) supervision and training of the cryptoboard; and (5) cleanliness and upkeep of assigned spaces.

The radio officer, the communication officer's principal assistant, is liable for the work of the OR division and for operation and maintenance of assigned equipment. It is his duty to assure reliable, secure, and rapid handling of radio communications. Usually his responsibilities for internal handling routing, and filing of messages are delegated to communication watch officers.

The signal officer, heading the OS division, is charged with operation of a ship's visual signaling facilities. His duties in handling visual messages parallel those of the radio officer for radio messages.

The custodian, sometimes called the registered publications officer or RPS officer, is accountable to the commanding officer for keeping a complete, up-to-date, and corrected allowance of registered publications issued to the ship. He handles the drawing, stowage, correction, destruction reports, and issuance of these publications aboard his ship.

Communication watch officers (CWOs) include junior officers and often experienced Radiomen of the OR division. The CWO on watch is in active and immediate charge of a ship's communications. During his watch, he is the personal representative of the communication officer. He sees that incoming and outgoing messages are placed in correct form, delivered promptly and properly to action and information addresses, and that all rules governing the conduct and security of all forms of communication are observed carefully. Radiomen assist the CWO by routing messages, preparing file and routing copies, or serving as traffic checkers, messengers, or file clerks. Aboard small ships an experienced Radioman may himself act as CWO.

Cryptographers — collectively called the cryptoboard—assist the CWO with encryption and decryption of messages when the traffic load is so heavy he cannot handle it by himself. Members of the cryptoboard are designated in writing by the commanding officer. All cryptoboards have commissioned officers as members but may, in addition to them, include warrant officers and competent and reliable enlisted personnel.

A cryptosecurity officer is assigned full time only on the largest ships. He is charged with the training, assignment, and detailed performance of the cryptoboard. He also serves as advisor to the communication officer and the commanding officer in all matters relating to cryptosecurity and physical security of cryptomaterials. In most ships the custodian, a CWO, or some other communicator is given this responsibility as collateral duty. In small commands the communication officer usually serves as cryptosecurity officer. Other collateral communication duties to which an officer may be assigned include functions of Top Secret control officer, and membership on the censoring board.

## SHIPBOARD COMMUNICATION SPACES

The number, size, and arrangement of communication spaces of a ship depend on her size, type, and mission. Most large warships have communication spaces located fore, aft, and amidships. Besides scattering a ship's antennas, thereby helping to reduce interference, this arrangement minimizes danger of loss of communications in the event of heavy damage to a portion of the ship. Equipment is so distributed that any one space can carry on at least partial communications.

The most essential communication spaces aboard are amidships, where, under normal operating conditions, most radio traffic is handled. Here are located radio central (also called main radio or radio I), message center, and cryptocenter. Communication functions also are carried out in other radio spaces, in other battle control locations, and in visual signal stations.

### Radio Central

Radio central is the largest and most completely equipped radio space on board ship. It contains local operating positions for radiotelegraph, radiotelephone, radioteletype, and facsimile. Usually, it is where transmitters, receivers, and remote speakers and keying positions are selected and tied together to provide communication channels for remote operating stations elsewhere in the ship. Radio central is located close to the message center and cryptocenter. It is the duty station of the watch supervisor and of most of the ship's Radiomen.

### Message Center

Convenient to radio central is the message center, where outgoing traffic is prepared for transmission, and incoming traffic is readied for local delivery. It is the duty station of the CWO and other watch personnel.

An outgoing message is delivered "in rough" to the message center, where it is checked for possible drafting errors. It is then written up "in smooth" and sent to the releasing officer for his approval and signature. In some ships outgoing messages are delivered to the message center in the smooth, already signed and approved by releasing officer. If the message is classified, and there are no on-line facilities aboard, it is passed to the cryptocenter, off-line encrypted, then given to radio central or the signal bridge for transmission. After incoming messages are received from radio central or the signal bridge, they are logged, decrypted if necessary, written up, routed, and delivered by messenger. All messages must clear the message center before internal routing or external transmission. Exceptions to this arrangement include operational messages received and sent direct from the OOD or CIC, and vice versa.

In ships without space allotted for a message center, message center functions are carried out in radio central.

### Cryptocenter

Adjoining the message center is the cryptocenter, where outgoing messages are off-line encrypted and incoming messages are decrypted. Here are located cipher equipment and cryptographic publications (called cryptoaids), safes for stowage of classified messages, and desks and typewriters as necessary. Files kept in a cryptocenter include a file for classified general messages and one for edited plain language copies of encrypted messages. Access to a cryptocenter is strictly controlled. Admittance is limited to designated cryptographers, and an authorized entry list is posted on the door. There is only one entrance, and it connects with the message center. Ordinarily the door is locked, and traffic is passed in and out through a window or slot in the bulkhead.

### Other Radio Spaces

According to a ship's size, there may be one or more additional radio spaces containing special equipment, supplemental equipment, or duplicate facilities. Depending on their arrangement and intended use, they may be designated as transmitter room, emergency radio room, auxiliary radio, or other appropriate titles.

Most transmitters are located in a ship's forward radio space, called the transmitter room or radio II. Usually this space is manned by a Radioman in charge, assisted by watch standers. Duties of the watch are to keep transmitters tuned to prescribed frequencies and connected or "patched" to keys, microphones, teletypes in radio central, and to remote operating positions in CIC, on the bridge, and in other parts of the ship. Receiving equipment includes one or two emergency receivers and the ship's entertainment receivers.

Originally, larger Navy ships kept their emergency radio room (radio III) in readiness for emergency use only. In many vessels increasing demand for radio circuits has turned this space into an active transmitter room. In ships where radio III still serves as an emergency radio room, watches are stood only when the ship is at general quarters.

Other radio spaces are scattered throughout large combatant ships. Many of these spaces are small supplementing the three main stations.

### Remote Control Facilities

Remote control stations, consisting of receiving outlets and transmitter keying positions, are located on the bridge, in CIC, and other battle control spaces where need exists for direct radio communications. Receivers in radio central and transmitters in radio II and radio III can be connected to remote control positions as required. Positions on the bridge and CIC are often paralleled. A tactical maneuvering net for instance, can be controlled from either the bridge or CIC by means of remote control units in these two spaces, which are connected through radio central to the same transmitter and receiver.

### Visual Signal Spaces

Equipment and spaces for visual communications are provided in a ship's superstructure. Signal halyards run from the yardarm to flag bags at the foot of the mast for flaghoist signaling. Signal searchlights and semaphore platforms are positioned where each one has the largest arc of vision, and so that their total coverage is 360°. Remote control keys for operating yardarm blinkers are placed in convenient and protected positions.

## ENLISTED OPERATING PERSONNEL

Specific duties of enlisted personnel assigned to communication duties vary according to ship size, type, and mission. Principal duties of Radiomen are to operate radiotelegraph, radiotelephone, teletype, and facsimile equipment in accordance with prescribed procedures.

The senior Radioman, as leading petty officer, is in direct charge of all enlisted men in the radio division. He prepares watch lists for Radiomen and makes daily checks of message files and logs. Another of his primary duties is the training program, which he must organize and conduct so that his operators will be able to perform efficiently any communication function they may be assigned. Additionally, the leading petty officer has responsibilities for cleanliness and preventive maintenance of all radio and teletypewriter equipment and for compartments and deck spaces occupied by equipment under his cognizance.

The watch supervisor in radio central must be an experienced Radioman. Proper handling of traffic is his main responsibility. Equipment in use and personnel on watch are under his direct supervision. He assists the CWO and, in organizations without a communication watch officer, may be designated to act as CWO insofar as internal routing and delivery of messages are concerned. His other duties include monitoring circuits, enforcing proper circuit discipline, accounting for classified matter in radio central, taking prompt action to prevent disruption of communications if equipment fails, and maintaining a communication status board listing information relative to radio nets and circuits in use.

Operators in radio central are under authority of the supervisor while on watch. They must know and use correct operating procedures for radiotelegraph, radiotelephone, radioteletype, and facsimile circuits; must keep accurate logs; must know how to tune transmitters, receivers, and associated equipment; and must be able to switch receivers and transmitters to remote operating positions. Other duties include message writeup, internal and external routing, delivery, and filing.

Radiomen are placed in charge of each additional radio space, such as the transmitter room and emergency radio room. They must be able to tune and calibrate each transmitter to every frequency within that equipment's range, and be familiar with power panels and switches for both normal and emergency power distribution systems. Other duties include switching transmitters and receivers to remote positions, and keeping records relating to equipment tests and inspections.

## WATCH, QUARTER, AND STATION BILL

When a Radioman—or any other man—reports aboard, he is assigned by his division officer to a watch section, duty station, to battle and other emergency stations, and to a cleaning station. This information is posted in his work spaces on the watch, quarter, and station bill (fig. 2-4).

Normally, watches stood by communication personnel are based on the master bill of the ship or station. Watches of communication personnel, however, cannot always be made to conform to the hours or watches of other personnel of the command. Often, peakload message traffic occurs when other activities of the command are at a comparative lull. Hence, communication personnel often do not stand customary 4-on—8-off watches.

Aboard many ships, midwatch is from midnight to breakfast. Morning watch runs from breakfast to dinner. Afternoon watch is from dinner to supper. The first dogwatch runs from supper to 1800, or until movie call, and the second dogwatch until 2000. Evening watch is from 2000 until midnight.

A variation of this system is to have no dogwatches or perhaps only one. If there are no dogwatches, evening watch may last from supper until midnight. If there is one dogwatch, it usually is from supper to 2000 and is followed by evening watch that runs to midnight.

# WATCH, QUARTER, & STATION BILL

SECTION 1 DIVISION OR

| BILLET | NAME | BUNK NO. | LKR. NO. | RATE | | | CLEAN STATION | BATTLE STATIONS | | | LANDING PARTY | EMERG. GETTING UND'WAY | WATCH DETAIL | | SPECIAL SEA DETAIL | FIRE | | RESCUE & ASSIST. | | COLLISION | ABANDON SHIP | | MAN OVERBD. | SPECIAL DETAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | COMP. | ALL. | ACT'L. | | CONDITION I (GENL. QTRS.) | CONDITION II | CONDITION III | | | AT SEA | IN PORT | | STATION | PROVIDE | PARTY | PROVIDE | | STATION | PROVIDE | | |
| C-101 | H.J. SAYER | 4 | 4 | RMC | RMC | RMC | ← IN CHARGE → | | | | | RAD I | | | | ↑ | | ↑ | | ↑ | 6 | | ↑ | |
| C-102 | R.E.L. CLARK | 7 | 7 | RM1 | RM1 | RM2 | RAD I | SUPVR | SUPVR | SUPVR | | RAD I | | | | | | | | | 4 | | | |
| C-103 | J.D. BUCKNER | 8 | 8 | RM1 | RM2 | RM2 | RAD II | RAD II | RAD II | RAD II | | RAD II | | | | | | | | | 2 | | | |
| C-104 | B.A. JOHNSON | 12 | 12 | RM2 | RM2 | RM3 | RAD III | RAD III | RAD I | RAD I | | RAD II | | | | STANDBY | | STANDBY | | STANDBY | 3 | | QUARTERS | |
| C-105 | M.E. POPE | 14 | 14 | RM3 | RM3 | RM3 | RAD II | RAD I | RAD I | RAD I | PORTABLE RAD/OPR | RAD I | | | | | | | | | 4 | PORTABLE RADIO | | |
| C-106 | W.A. SCRUGGS | 17 | 17 | RM3 | RM3 | RMSN | RAD I | RAD I | RAD I | RAD I | | RAD I | | | | | | | | | 6 | | | |
| C-107 | R.J. GILLETTE | 20 | 20 | CYN3 | CYN3 | CYN3 | RAD I | JX TALKER | RAD I | RAD I | | JX TALKER | | | | | | | | | 5 | | | |
| C-108 | M.L. HAMILTON | 15 | 15 | RM3 | RM3 | RMSA | PSGY. | MSGR. | MSGR. | MSGR. | MSGR. | MSGR. | | | | ↓ | | ↓ | | ↓ | 3 | | ↓ | |

76.6

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

At most shore communication stations the day, evening, and midwatches are approximately 8 hours each. Radiomen usually rotate on a 4-section watch list, and stand a series of three watches in a row before rotating from days to evenings, evenings to mids, and mids to day watches. Certain peakload operators customarily are assigned to work during the busiest hours, and rotate watches differently from the rest of the station.

During general quarters Radiomen are assigned to each radio communication space. Every circuit or net is manned by a battle-efficient operator. Standby men maintain duplicate facilities in other radio spaces, keeping duplicate logs of traffic coming into radio central. A Radioman is placed in charge of the cleaning detail in each communication space. Available personnel are assigned specific areas for cleaning and upkeep.

Detailed information concerning special stations (such as fire, fire and rescue, collision, and abandon ship) is contained in each ship's organization book.

# CHAPTER 3

# COMMUNICATION SECURITY

The security of the United States in general, and of naval operations in particular, depends in part upon the success attained in safeguarding classified information. Every Radioman must be security conscious to the point that he automatically exercises proper discretion in the discharge of his duties and does not think of security of information as something separate and apart from other matters. In this way, security of classified information becomes a natural element of every task and not an additionally imposed burden.

In his daily work routine the Radioman learns information of vital importance to the military and to the Nation. Much of the vast amount of intelligence carried in messages handled by naval communications passes at some point through hands of Radiomen—data that, if available to an enemy, would enable him to learn the strength and intent of U. S. forces, and to gather a wealth of technical information relating to the procedures and operations of the United States Navy.

Radiomen will use many official documents and publications that relate to such communication matters as frequencies, call signs, and procedures. Their content must be protected also, because the more an enemy knows about our communications the better are his chances of deriving intelligence from them.

## CLASSIFICATIONS

Security is a protected condition that prevents unauthorized persons from obtaining information of military value. Such information is afforded a greater degree of protection than other material and is given a special designation: classified matter. This term includes all publications, documents, cipher keys and aids, code books, letters, equipment, and messages in the three security classifications of Top Secret, Secret, and Confidential (including Confidential-Modified Handling Authorized). Following are examples and definitions of each category.

### TOP SECRET

The Top Secret classification is limited to defense information or material requiring the highest degree of protection. It is applied only to information or material the defense aspect of which is paramount, and the unauthorized disclosure of which could result in EXCEPTIONALLY GRAVE DAMAGE to the Nation, such as—

1. A war, an armed attack against the United States or her allies, or a break in diplomatic relations that would affect the defense of the United States.
2. The unauthorized disclosure of military or defense plans, intelligence operations, or scientific or technological developments vital to the national defense.

### SECRET

The Secret classification is limited to defense information or material the unauthorized disclosure of which could result in SERIOUS DAMAGE to the Nation, such as—

1. Jeopardizing the international relations of the United States.
2. Endangering the effectiveness of a program or policy of vital importance to the national defense.
3. Compromising important military or defense plans, or scientific developments important to national defense.
4. Revealing important intelligence operations.

### CONFIDENTIAL

The use of the classification Confidential is limited to defense information or material the unauthorized disclosure of which could be PREJUDICIAL TO DEFENSE INTERESTS of the Nation, such as—

1. Operational and battle reports that contain information of value to the enemy.

2. Intelligence reports.
3. Military radiofrequency and call sign allocations that are especially important, or are changed frequently for security reasons.
4. Devices and material relating to communication security.
5. Information that reveals strength of land, air, or naval forces in the United States and overseas areas, identify and composition of units, or detailed information relating to their equipment.
6. Documents and manuals containing technical information used for training, maintenance, and inspection of classified munitions of war.
7. Operational and tactical doctrine.
8. Research, development, production, and procurement of munitions of war.
9. Mobilization plans.
10. Personnel security investigations and other investigations, such as courts of inquiry, which require protection against unauthorized disclosure.
11. Matters and documents of a personal or disciplinary nature, which, if disclosed, could be prejudicial to the discipline and morale of the armed forces.
12. Documents used in connection with procurement, selection, or promotion of military personnel, the disclosure of which could violate the integrity of the competitive system.

NOTE: Official information of the type described in items 10, 11, and 12 is classified Confidential only if its unauthorized disclosure could in fact be prejudicial to the defense interests of the Nation.

## CONFIDENTIAL—MODIFIED HANDLING AUTHORIZED

The Confidential classification has a subdivision: Confidential–Modified Handling Authorized (CONFMOD). The CONFMOD category may be authorized for matter the originator believes will be protected sufficiently by somewhat less strict storage, however, normally CONFMOD material is stowed in the same manner as other Confidential material.

Material that may be classified CONFMOD includes, but is not limited to—

1. Training manuals, field and technical manuals, and related materials.
2. Photographs, negatives, photostats, diagrams, and the like.
3. Defense procurement plans, including procurement contracts and related matters.
4. Communication materials, publications, and messages.
5. Charts and maps.
6. Information received from or furnished to foreign nations under international exchange of information, agreements, and policies.

## ADDITIONAL MARKINGS

In addition to the four security labels mentioned already, other markings also appear on documents. Among these markings are such designations as "Restricted Data," NOFORN, and "For Official Use Only."

### Restricted Data

All data concerned with (1) design, manufacture, or utilization of atomic weapons, (2) production of special nuclear material, or (3) use of special nuclear material in production of energy bear conspicuous "Restricted Data" markings. Restricted data, when declassified under the Atomic Energy Act of 1954, must be marked "Formerly Restricted Data, Handle as Restricted Data in Foreign Dissemination, Section 144b, Atomic Energy Act, 1954."

### NOFORN Designation

Whenever the handling of classified documents is such that documents are liable to inadvertent disclosure to foreign nationals, originators should stamp the documents thus: "Special Handling Required, Not Releasable to Foreign Nationals." When this term is used in a message, it is abbreviated NOFORN.

### For Official Use Only

The term "For Official Use Only" is assigned to official information that requires some protection for the good of the public interest but is not safeguarded by classifications used in the interest of national defense.

## CLEARANCES

No one may have access to classified matter without proper security clearance. A security clearance is an administrative determination that an individual is eligible, from a security standpoint, for access to classified matter, and that such access is required in the execution of his duties. If duties of a Radioman 3 or 2 require use of classified publications and documents (and they are virtually sure to), the commanding officer is authorized to grant a clearance up to Confidential after ascertaining that the man is trustworthy, discreet, and of unquestionable loyalty. Clearance to handle Secret material can be granted only after an additional check of BuPers records and an investigation by the Naval Investigative Service Headquarters. All clearances are authorized by the CO of a man's present command, and only when there is a "need to know." Notation of a man's clearance is made in his service record.

## COMPROMISE

No one in the Navy is authorized to handle any classified material except that required in the performance of duty. All other persons are unauthorized, regardless of grade, duties, or clearance.

If it is known–or even suspected–that classified material is lost, or is passed into the hands of some unauthorized person, the material is said to be compromised. The seriousness of the compromise depends on the nature of the material and the extent to which the unauthorized person may divulge or make use of what he learns. A Radioman should report any compromise to his communication officer.

## SECURITY AREAS

The shipboard and shore station spaces that contain classified matter are known as security areas. These security areas (sometimes called sensitive areas) have varying degrees of security interest, depending upon their purpose and the nature of the work and information or materials concerned. Consequently, the restrictions, controls, and protective measures required vary according to the degree of security importance. To meet different levels of security sensitivity, three types of security areas have been established: exclusion, limited, and controlled areas.

### EXCLUSION AREA

The cryptocenter, registered publications issuing office (RPIO) vault, classified conference room, and other spaces requiring the strictest control of access are designated exclusion areas. They contain classified matter of such nature that admittance to the area permits, for all practical purposes, access to such matter.

Exclusion areas are fully enclosed by walls or bulkheads of solid construction. All entrances and exits are guarded, and only persons whose duties require access and who possess appropriate security clearances are authorized to enter, after being positively identified. Normally, a list of personnel authorized entry, signed by the CO, is posted in the area.

### LIMITED AREA

Radio central, message center, relay station, transmitter rooms, and other communication spaces usually are designated limited areas.

Operating and maintenance personnel whose duties require freedom of movement within limited areas must have proper security clearances. The commanding officer may, however, authorize entrance of persons who do not have clearances. In such instances, escorts or attendants and other security precautions must be used to prevent access to classified information located within the area.

Entrances and exits of limited areas are either guarded or controlled by attendants to check personnel identification, or they may be protected by automatic alarm systems.

### CONTROLLED AREA

Passageways or spaces surrounding or adjacent to limited or exclusion areas are often designated controlled areas. Although a controlled area does not contain classified information, it serves as a buffer zone of security restriction. Moreover, it provides greater control, safety, and protection for limited and exclusion areas.

Controlled areas require personnel identification and control systems adequate to limit admittance to those having bona fide need for access to the area.

## COMMUNICATION SECURITY PHASES

Communication security (COMSEC) is the protection resulting from all measures designed to deny to unauthorized persons any information of value that might be derived from the possession and study of telecommunications, or to mislead unauthorized persons in their interpretation of the results of such a study. The four phases of communication security are physical security, cryptosecurity, transmission security, and censorship.

## PHYSICAL SECURITY

The physical security of classified material depends upon proper handling on the part of every user, proper stowage when it is not in use, and complete destruction when necessary.

### Handling Precautions

Each individual in the communication organization must take every precaution to prevent intentional or casual access to classified information by unauthorized persons. When classified publications are removed from stowage for working purposes, they must be covered or placed face down when not in use. Unauthorized visitors must not be permitted in communication spaces. Never discuss classified information over the telephone. Rough drafts, carbon paper, worksheets, and similar items containing classified information should be destroyed after they serve their purpose. In the meantime, they must be handled and safeguarded as classified matter.

At the close of each watch or working day, all classified material that must be passed from watch to watch is inventoried properly and that custody is transferred to the relieving watch supervisor. All other classified matter must be locked up. Notes regarding classified matter must not be left on memorandum pads or under desk blotters. Wastebaskets should be checked to see that they contain no classified material such as notes, carbon paper, excess copies, or rough drafts. These items must be placed in burn bags with other classified material. Burn bags are properly stowed until destroyed according to a schedule promulgated by the communication officer or custodian.

Vaults, safes, or lockers used for stowage of classified matter must always be kept locked when not under the supervision of authorized personnel. Cryptographic aids and related classified matter must never be left unguarded by the user. Habitually rotate the dial of all combination locks at least three complete turns in the same direction when securing safes, files, and cabinets. In most locks, if the dials are given only a quick twist, it is possible sometimes to open the lock merely by turning the dial in the opposite direction. Always make sure that all drawers of safes and file cabinets are held firmly in the locked position.

If interrupted by a fire alarm or other emergency, when working with classified material, stow the material in the same manner as at the end of a working day. It is a Radioman's personal responsibility to safeguard all classified material in his possession.

### Stowage

All classified matter not in actual use must be stowed in a manner that will guarantee its protection. The degree of protection necessary depends on the classification, quantity, and scope of the material.

A numerical evaluation system has been developed for determining the relationship between the security interest and the level of protection required. The more secure the stowage facilities, the higher the numerical values assigned.

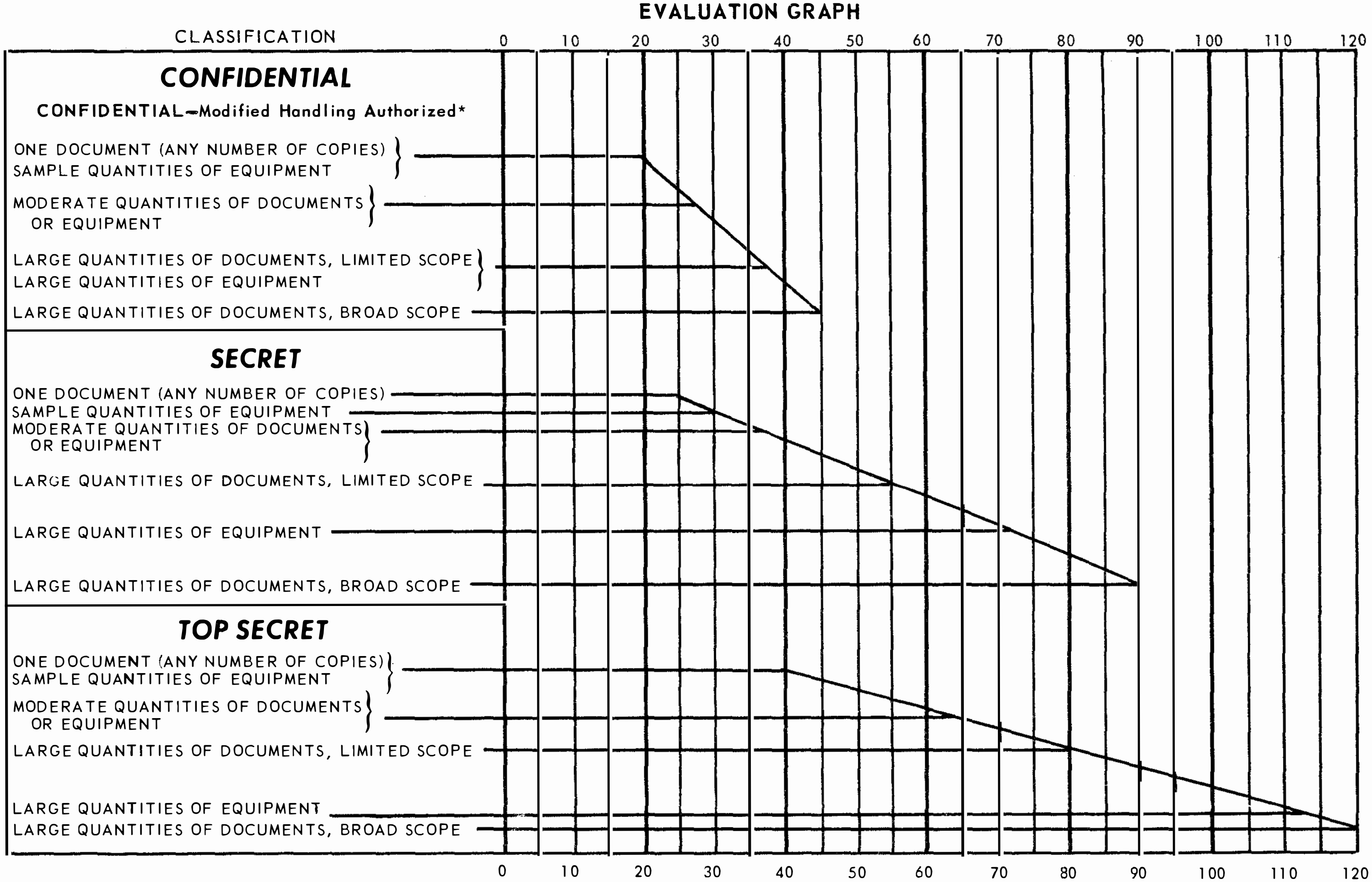
Figure 3-1 shows the numerical values required for quantity and type of documents of each classification. Table 3-1 is a guide for evaluating stowage facilities. Both the table and illustration must be used together.

Assume that a ship stows plain language translations of encrypted messages in a metal container with attached keylock in the cryptocenter. Visitors are not allowed in any of the communication spaces. Only cryptographers may enter the cryptocenter itself or remove anything from its safe. The cryptographer on watch acts as a guard in attendance at the container. From table 3-1 a numerical value may be assigned to these facilities as follows:

| | Value |
|---|---|
| Sheltered aboard a commissioned ship .... | 25 |
| Stowed in metal container with attached keylock .............................. | 5 |
| Military guard in attendance at container... | 60 |
| Total.......................... | 90 |

From the graph in figure 3-1 it can be seen that stowage facilities with a numerical value of 90 are secure enough for everything but large quantities of Top Secret equipment and large quantities of Top Secret documents covering a broad scope.

# SECURITY OF MATERIAL IN STORAGE




*Documents and material designated Confidential-Modified Handling Authorized will normally be stored in the same manner as other Confidential material. When this is not feasible, such documents and material will be stored in a container equipped with a secure locking device or in any other manner determined by competent authority which will afford adequate protection. This does not preclude a more secure means of storage if desired.

31.2

Figure 3-1. —Numerical values required for quantity and type of documents of each classification.

Table 3-1.—Table of Numerical Equivalents

| Element of Security | Value |
|---|---|
| 1. Stowage Areas | |
| a. Security fences | |
| (1) Classified area surrounded by a security fence with all gates secured or controlled | 5 |
| b. Protective lighting | |
| (1) Security areas lighted by protective lighting | 5 |
| c. Building or ship* | |
| (1) Conventional frame or good quality temporary structure | 5 |
| (a) Controlled areas within | 15 |
| (b) Limited areas within | 25 |
| (c) Exclusion areas within | 35 |
| (2) Masonry or steel structure with substantial partitions, floors, and ceilings (included magazines) | 10 |
| (a) Controlled areas within | 20 |
| (b) Limited areas within | 30 |
| (c) Exclusion areas within | 40 |
| (3) Aboard a commissioned ship | 25 |
| (a) Controlled area | 35 |
| (b) Limited area | 40 |
| (c) Exclusion area | 50 |
| (4) "In service' or MSTS chartered vessel | 10 |
| (a) Controlled areas within | 20 |
| (b) Limited areas within | 30 |
| (c) Exclusion areas within | 40 |
| 2. Stowage Containers** | |
| a. Portable, any type | 0 |
| b. Wood, any type | 0 |
| c. Metal, keylock (built-in) | 2 |
| d. Metal, keylock (attached) | 5 |
| e. Metal, combination bar-lock (attached) | 10 |
| f. Metal, combination lock (built-in) | 15 |
| g. Light room vault | 15 |
| h. Heavy room vault | 35 |
| i. Class 3 security filing cabinet, GSA Federal supply schedule | 50 |
| j. Class 2 security filing cabinet, GSA Federal supply schedule | 60 |
| k. Class 4 security filing cabinet, GSA Federal supply schedule | 60 |
| l. Class 5 security filing cabinet, GSA Federal supply schedule | 70 |
| m. Class 5 map and plan filing cabinet, GSA Federal supply schedule | 70 |
| n. Class 6 map and plan filing cabinet, GSA Federal supply schedule | 55 |
| o. Class 8 security filing cabinet, GSA Federal supply schedule | 100 |
| 3. Guarding | |
| a. Support guard force | |
| (1) Civilian supporting guard force | 10 |
| (2) Military supporting guard force | 15 |
| b. Guards | |
| (1) Civilian guards | |
| (a) Civilian guard in general area | 10 |
| (b) Civilian guard check of container each hour | 15 |
| (c) Civilian guard check of container each 1/2 hour | 20 |
| (d) Civilian guard in attendance at container | 30 |
| (2) Military guards | |
| (a) Military guard in general area | 15 |
| (b) Military guard check of container each hour | 20 |
| (c) Military guard check of container each 1/2 hour | 25 |
| (d) Military guard in attendance at container | 60 |
| c. Sentry dog accompanying military or civilian guard | 10 |
| 4. Protective Alarm Systems | |
| a. Area alarm system | |
| (1) Make or break (electromechanical) alarm to detect entry into immediate area | 5 |
| (2) Other alarm system to detect entry into immediate area | 10 |
| (3) Alarm system to detect entry or attempted entry into immediate area | 15 |
| (4) Alarm system to detect entry or attempted entry and approach to immediate area | 25 |
| b. Container alarm systems | |
| (1) Make or break (electromechanical) alarm to detect opening of container | 10 |
| (2) Other alarm system to detect opening of container | 15 |
| (3) Alarm system to detect opening or tampering with container | 20 |
| (4) Alarm system to detect opening or tampering with and approach to container | 25 |

*Buildings must be under U.S. Government control or if not under U.S. Government control the space occupied within the building must be at least a controlled area.
**Evaluate as indicated provided other elements in the security program are available to minimize the possibility of unauthorized access to the container.

31.3

Keys or combinations to safes and lockers containing classified material are made available only to persons whose duties require access to them. At least every 12 months keys or combinations must be changed. They also must be changed whenever any person having knowledge of them is transferred from the organization, and at any time the keys or combinations are suspected of being compromised.

Any time discovery is made of an unlocked and unattended safe or cabinet that contains classified material, report the condition immediately to the senior duty officer. Do not touch the container or contents, but guard them until the duty officer arrives. The duty officer then assumes responsibility for such further actions as locking the safe, recalling the responsible persons, and reporting the security violation to the commanding officer. The custodian must hold an immediate inventory of the contents of the safe and report any loss to the CO.

For further details on stowage of classified matter, consult chapter 6 of the Department of the Navy Security Manual for Classified Information, OpNavInst. 5510. 1C.

## Destruction

Destruction of classified matter falls into two categories: routine and emergency. Destruction, when authorized or ordered, must be complete.

- Routine destruction: Destruction of superseded and obsolete classified materials that have served their purpose is termed routine destruction. Routine destruction of publications, message files, and certain cryptomaterials is carried out when authorized by specific directives. These directives are found in the letter of promulgation of the publication itself, in cryptographic instructions and manuals, and in U. S. Naval Communication Instructions (DNC 5 series). Other materials, such as classified rough drafts, worksheets, and similar items, are destroyed, as necessary, to prevent their excessive accumulation.

The most efficient method of destroying combustible material is by burning. It is likely that a Radioman 3 or 2 will be called upon to assist in burning classified material. Every member of the burn detail should know exactly what is to be burned and should doublecheck each item before it is burned. To facilitate complete destruction of bound publications, tear them apart, crumple the pages, and feed the pages to the fire a few at a time. If burn material is carried in a bag that is not to be burned, turn the bag inside out to make certain every piece of paper is removed and burned. All material must be watched until it is completely consumed. The ashes must be broken up and scattered so that no scraps escape destruction.

When no incinerator is available, which often is true aboard ship, classified material may be burned in a perforated metal drum or container with a cover of wire netting.

- Emergency destruction: Emergency destruction of classified material is authorized any time it is necessary to prevent its capture by an enemy. On board ship, classified material is not subjected to the same risks as on land. If a ship is in danger of sinking or is severely disabled, however, action is taken in accordance with the ship's emergency destruction bill (fig. 3-2), the execution of which is an all-hands evolution from communication officer to striker. This bill details the method and the order of destruction of classified matter. Each man in the communication division is assigned responsibilities by duty and watch instead of by name. The bill provides alternates for each billet to ensure effective action despite personnel casualties.

Destruction plans call for the highest degree of individual initiative in preparing for and in actually commencing the required destruction. It is extremely important for all Radiomen to understand that, in emergencies subjecting classified material to compromise through capture, they must start necessary destruction under the plan without waiting for specific orders.

Cryptographic material has the highest priority for emergency destruction. Insofar as humanly possible, it must not be permitted to fall into enemy hands. After cryptomaterial is destroyed, other classified communication material is destroyed in the order of classification—highest classified material first. Next in importance in the destruction plan is classified (noncryptographic) communication equipment, followed (if time permits) by destruction of unclassified material and equipment.

Destruction by fire is the preferred method for all combustible materials. Oil or chemicals may be used to facilitate burning. If the ship is in deep water, and time does not permit

## USS JOSEPH K. TAUSSIG
## DE-1030
## EMERGENCY DESTRUCTION BILL

The following Emergency Destruction Procedures for Classified Material held by this command are effective this date: 10 October 19_

| Space | Person Responsible | Alternate | Priority of Destruction |
|---|---|---|---|
| Registered publications safe | RPS custodian | Alternate custodian | 1. Emergency keying data.<br>2. TOP SECRET cryptomaterial.<br>3. Superseded } Key lists,<br>4. Reserve } rotors,<br>5. Effective } and strips.<br>6. Reg. cipher equipment. |
| Cryptocenter | General quarters cryptomember | Crypto-security officer | 7. Maintenance documents.<br>8. Operating instructions.<br>9. Remaining cryptomaterial.<br>10. Registered publications.<br>11. Nonregistered classified publications. |
| Radio I | Supervisor | Circuit operator | 1. Aircraft codes; authentication systems; call sign ciphers; recognition signals. |
| Radio II | Circuit operator | Radio I JX talker | 2. Registered publications.<br>3. Classified records; files.<br>4. Classified electronic equipment. |
| Signal bridge | Supervisor | Assistant navigator | 5. Classified nonregistered publications.<br>6. Unclassified publications and electronic equipment. |
| CIC | Supervisor | JOOD | |

1. Method of destruction
   a. Deep water (over 100 fathoms)
      (1) Jettison publications in weighted perforated bags.
      (2) Smash crypto equipment beyond recognition if possible and jettison.
   b. Shallow water (less than 100 fathoms)
      (1) Burn publications completely, break up and scatter ashes.
      (2) Smash crypto equipment beyond recognition or reconstruction, taking care to remove all wiring, and scatter component parts over a wide area. Smash remaining electronic equipments so as to render them useless.
2. Record of destruction
   a. All personnel assisting in the execution of this bill will report in writing to the RPS custodian the degree of completion of such destruction. (Use the last watch-to-watch inventory.)
3. Execution of emergency destruction bill
   a. Emergency destruction will be ordered by the Commanding Officer, or, in his absence, by the next senior line officer present. In the event of an emergency, it may be necessary for the personnel designated above to carry out the provisions of this bill without further orders, if their estimate of the situation admits possibility of the loss of the ship.
4. Location of destruction equipment
   a. Sledges, wire cutters, screwdrivers, and weighted perforated bags are located in each communication space.

Approved:

Tolis Lewie, LCDR USN
Commanding Officer

Submitted:

H. T. Crowley, LTJG USN
Classified Material Control Officer

76.7

Figure 3-2. —Typical emergency destruction bill.

burning classified publications, messages, files, and logs, they may be placed in weighted perforated canvas bags and thrown overboard (jettisoned). Classified equipment may also be jettisoned in water deep enough to preclude any possibility of recovery. Water over 100 fathoms is usually considered deep enough to prevent an enemy from conducting successful salvage operations.

If the ship is in shallow water, combustible classified material must be burned; it may be jettisoned only as a last resort. Classified communication equipment must be smashed beyond recognition before jettisoning in shallow water. Unclassified communication equipment should be demolished beyond repair.

A sufficient number of perforated canvas bags and tools—including sledge hammers, screwdrivers, and wire cutters—are always kept in communication spaces for use in emergency destruction.

## CRYPTOGRAPHIC SECURITY

Cryptography is the science of cloaking information in codes and ciphers. A code is a system in which arbitrary groups of symbols represent units of plain text of varying length—usually syllables, words, phrases, and sentences. A cipher is a system in which individual letters of a message are replaced (letter for letter) by other letters instead of complete words, phrases, or numbers. Cipher texts usually are transmitted in five-letter groups.

A cryptoboard, under the direction of the communication officer, is responsible for proper encryption and decryption of messages. Along with officers, reliable enlisted personnel may be appointed to this board. Members of the board, known as cryptographers, must be proficient in the use of all codes and ciphers held by the command.

Loss of a cryptographic publication or the transmission of faultily encrypted messages endangers the security of the cryptosystem. Such occurrences frequently require the immediate replacement of the key list used, because subsequent transmissions with the same key list might be little better than plain language. Though great, the work and expense of superseding a key list are insignificant compared with the consequences of compromise.

The enemy constantly and painstakingly studies U. S. codes and ciphers in an attempt to discover the keys to our many cryptographic systems. This technique is known as cryptanalysis. The best defense against this type of enemy intelligence is cryptosecurity—the careful use of technically sound cryptosystems.

## TRANSMISSION SECURITY

Transmission security is that component of communication security that results from all measures designed to protect transmissions from unauthorized interceptions, traffic analysis, and imitative deception.

Some methods of transmission are more secure than others. In general, the means and types of transmission, in their order of security, are as follows:

1. Messenger;
2. Registered mail (guard mail, U. S. postal system, or diplomatic pouch);
3. Approved wire circuits;
4. Ordinary mail;
5. Nonapproved wire circuits;
6. Visual (semaphore, flaghoist, flashing light);
7. Sound systems (whistles, sirens, bells);
8. Radio.

### Messenger

Classified matter is transmitted by messenger when security—not speed—is the paramount objective. The principal messenger agency for the Department of Defense is the Armed Forces Courier Service (ARFCOS). This agency is responsible for the safe transmittal of highly classified matter to military addresses and certain civilian agencies throughout the world. The ARFCOS courier transfer stations are located in designated areas. Every item of classified material sent via ARFCOS is in physical custody and control of a military courier from the time of entry into system until the addressee or his authorized representative receipts for it. Classified material that may go by registered United States mail is not transmitted by ARFCOS.

Guard mail is another type of messenger service for transmitting classified material, although unclassified material is also delivered by this means. Reliable petty officers as well as commissioned officers are appointed as guard mail messengers. Guard mail is used, for instance, in a naval district for delivering mail to other military or Government activities located in the same area, and also in conjunction with ordinary mail service to and from ships in port.

Mail

In addition to transmitting unclassified material, the United States postal system is used to transmit classified material except Top Secret matter and cryptographic aids and devices. Secret and Confidential matter must be sent by registered mail instead of by ordinary mail, and must not enter a foreign postal system. The single exception to this is that material addressed to Canadian Government activities is permitted to pass through the Canadian postal system. Material classified CONFMOD may be sent by ordinary first class mail through both United States and Canadian postal systems. The great bulk of the Navy's administrative traffic is sent by mail, thus reserving radio circuits for operational traffic insofar as possible.

Mailable Secret and Confidential matter is double-wrapped, as shown in figure 3-3. Top Secret matter is prepared similarly, but does not, of course, go through the mails. Use of the inner envelope is not required for CONFMOD material.

Wire Circuits

When available, wire circuits invariably are used in preference to radio, because they are less susceptible to interception. Wire systems are of two types: approved and nonapproved.

An approved circuit is specified by proper authority for transmission of classified information in the clear. Messages classified Secret and below may be transmitted on such circuits. Approved telephone circuits are equipped with security devices to minimize the possibility of wiretapping.

A nonapproved circuit is not designated for transmission of classified information in the clear. Telephone circuits normally are considered nonapproved and are not used to discuss classified data unless specifically designated as approved.

Often, wiretapping may be discovered by physical examination or by transmission irregularities. Interception by induction, however, can escape detection completely. Supersensitive devices placed near the wire circuit pick up sounds through a 2-foot wall. Tiny microphones, hidden in telephone receivers, pick up not only telephone conversations but voices anywhere in the room.

Underwater cables also are liable to unauthorized interception, although they are more difficult to tap than landlines. Submarines are able to make successful interceptions through induction. The point where the cable emerges into shallow water is the most vulnerable.

Visual Communications

Visual communication systems are used in preference to radio except at night, when there is a possibility of divulging a ship's position. They are more secure than radio because reception is limited to units in the immediate vicinity of the sender.

In order of security, visual communication methods rank according to the distance from which signals can be seen. In daylight the relative order is semaphore, directional flashing light, panels, flaghoist, pyrotechnics, and nondirectional flashing light. At night the order is infrared, directional flashing light, pyrotechnics, and nondirectional flashing light.

Utmost care must be taken to ensure that signal lights are used only when necessary, and that minimum light is employed. An exception is for recognition signals, which must be sent on a light sufficiently brilliant to be seen.

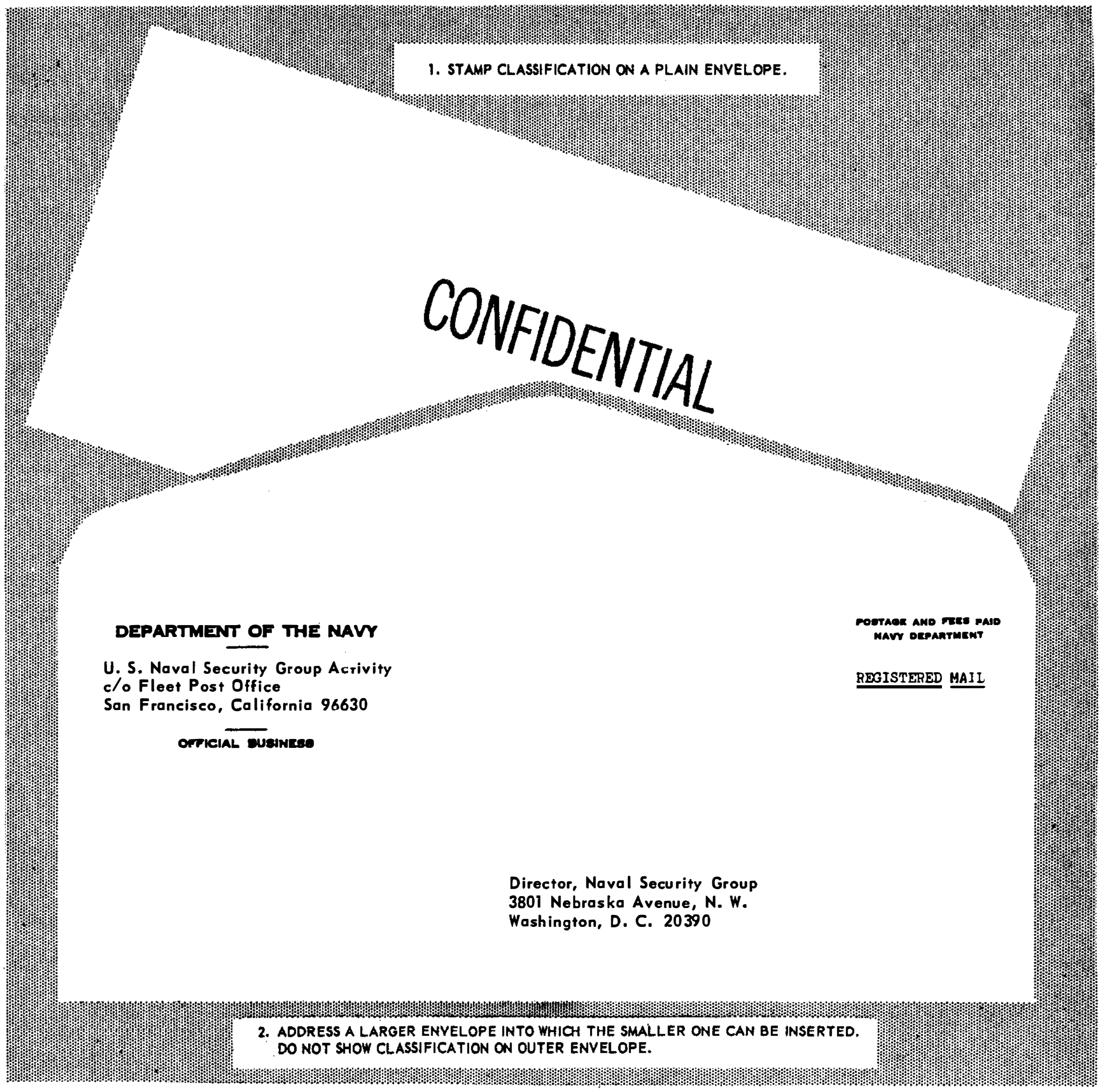
Transmission of plain language messages is kept to a minimum because many persons are adept at reading lights and flags.

Sound Systems

Whistles, sirens, foghorns, bells, and underwater sound devices are common types of sound systems. They are utilized by vessels to transmit emergency warning signals (air raid alerts, mine sighting, etc.) and for signals prescribed by the Rules of the Road. Sound systems have the same range limitations as visual methods and also are less secure. Their use, for the most part, is restricted to maneuvering and emergency situations.

Radio

Radio is potentially the least secure means of communication. A message sent by radio is open to interception by anyone who has the necessary equipment and is within reception range.




6.1

Figure 3-3. —How mailable classified matter is prepared.

Thus, in addition to obtaining intelligence, an enemy may be able to fix the location of operating forces by means of direction finding. By employing deceptive techniques, he could confuse and hamper own communications and, by traffic analysis, forecast the intentions of own forces.

Uses of radio in the ultrahigh frequency (UHF), superhigh frequency (SHF), and extremely high frequency (EHF) ranges normally have security approaching visual means. Experience has proven, however, that transmissions of these frequencies beyond line-of-sight distances have occurred frequently. It is important, therefore, that all users recognize the possibility of interception at distances far beyond the normal usable ranges.

Despite its shortcomings, though, radio still is the primary means of communication. It is fast, reliable, and often the only method of maintaining contact between distant and highly mobile units. A satisfactory degree of security can be obtained only by using it properly and intelligently.

The following five topics describe the ways by which radio communications may be sabotaged by an enemy, and countermeasures that may be applied.

• Interception and direction finding: Strict radio silence is the best defense against enemy intelligence efforts by interception and direction finding. It is apparent that an enemy cannot gain intelligence from radio transmissions if none are sent. Radio silence is placed in effect when it is reasonable to assume that an enemy is unaware of the location or impending movements of a ship or force. If it is impractical to maintain radio silence, the following defensive measures make interception and direction finding more difficult.

1. Avoid unauthorized transmissions and unnecessary testing.
2. Use combinations of transmitter, antennas, and power to produce minimum wave propagation and emission intensity consistent with reliable communications.
3. Use the broadcast method of transmitting traffic in preference to the receipt method.
4. Conceal instructions to shift frequency by using an encrypted message in the absence of a prearranged plan.
5. Adjust transmitters accurately and adhere to frequency tolerances, thereby preventing the need for repeating messages or parts of messages.
6. Maintain strict circuit discipline.

• Traffic analysis: By traffic analysis an enemy may gain valuable information from his study of U.S. communications. Traffic analysis includes studying message headings, receipts, acknowledgments, relays, routing instructions, and service messages; tabulating the volume, types, and directional flow at each point; and correlating information taken from unclassified messages, noting departures from normality.

Assume that within a short time a radio message is transmitted from point Bravo to Romeo, another to Victor, another to a unit of the fleet operating off Whiskey, and a fourth to a unit off Oscar. Enemy traffic records show that messages rarely are transmitted to these four addressees simultaneously. They also reveal that previous transmissions of this type were followed by arrival of a convoy at point Romeo. An enemy logically may conclude that a convoy from Bravo to Romeo is planned, and that these transmissions probably are arranging for an escort.

Some measures that can be taken to render traffic analysis by an enemy more difficult and less reliable include—

1. Minimum use of radio.
2. Maintenance of strict circuit discipline.
3. Rotation of frequencies.
4. Rotation of call signs and address groups for encryption.
5. Minimum use of service messages, correction requests, and repetitions.
6. Concealment of originator and addressees in the text of an encrypted message.
7. Avoidance of long, easily associated messages of a recurrent nature.
8. Control of the timing and volume of test transmissions to avoid revealing information about pending operations.
9. Keeping external routing instructions to a minimum.
10. Use of Encrypt for Transmission Only (EFTO) procedure. (See OpNav Instruction 2220.3 for complete details.)

• Imitative deception: An enemy may attempt to enter communication nets used by the Navy in order to confuse and deceive U.S. forces. This practice is known as imitative deception. There are many deceptive techniques an enemy might use to obstruct radio communications. He may, for example—

1. Remove a message from one circuit and introduce it on another circuit to waste time, create confusion, and produce service messages.
2. Intentionally garble the text of a genuine message and combine it with the heading of another, then introduce it on a different radio net.
3. Originate and transmit false plain language messages.
4. Call a unit in the hope of taking bearings on the answering transmission.
5. Partly obliterate a false message to conceal lack of knowledge of authenticators or call signs.

Proper authentication is the best defense against imitative deception. This security measure is intended to protect communication systems against fraudulent transmissions. An authenticator is a group of characters (usually two randomly selected letters) inserted in a message to prove its authenticity. Any authentication system has accompanying instructions specifying the method of use and transmission procedures. By its correct use, an operator can distinguish between genuine and fraudulent stations or transmissions. A station may include authentication in a transmitted message. This security measure is called transmission authentication. Another use is known as challenge and reply authentication. In this method the sending station transmits a challenge from which the receiving operator must ascertain the correct reply authenticator. A challenging station must determine the reply to be correct before any exchange of message commences.

- Authentication is mandatory when—

1. Suspecting imitative deception on a circuit.
2. Challenging or requesting any station to authenticate.
3. Directing radio silence or requiring a station to break an imposed radio silence.
4. Transmitting a plain language cancellation of an encrypted message by radio or by other methods when sending stations cannot be recognized.
5. Transmitting to a station that is under radio silence.

- Authentication is advisable when—

1. Making contact and amplifying reports in plain language or brevity code.
2. Transmitting a plain language cancellation by radio or visual means when the sending station cannot be recognized.
3. Transmitting operating instruction affecting the military situation; for example, closing down a station or shifting frequency.
4. Making initial radio contact or resuming contact after prolonged interruption. Authentication should be exchanged to prevent an unauthorized station from opening a circuit by asking a legitimate station to authenticate.
5. A station, having for any reason failed to obtain an answer to its calls, is forced to transmit its messages blind; that is, without getting a receipt from the intended receiving station.

Good judgment sometimes dictates that an operator accept a message instead of arguing over authentication, even though he may doubt its genuineness. Such a message should be delivered promptly to the addressee with the operator's notation that it was not authenticated properly. A decision regarding its authenticity is made by the addressee.

- Other effective defenses against imitative deception are—

1. Thorough training in operating procedures.
2. Alertness of operators to recognize irregularities in procedure and the minor implausibilities that often characterize enemy deceptive efforts.
3. Direction finding on transmissions of questionable origin.
4. Minimum use of plain language and procedure messages.

Maintaining a high degree of circuit discipline on the part of operators also lessens chances of enemy deception. Circuit discipline can be attained only through net control, monitoring, and training. It includes adherence to prescribed frequencies and operating procedure. Negligence, inaccuracy, and laxity—as well as lack of circuit discipline and operator training—are some of the common causes of violations that endanger radio transmission security.

- Jamming: Jamming is another method an enemy may use in his efforts to disrupt communications. It is accomplished by transmitting a strong signal on the victim frequency. A Radioman 3 or 2 must be able to recognize jamming, cope with it, and simultaneously prevent an enemy from knowing the effectiveness of his efforts. Common forms of jamming are—

1. Several carriers adjusted to the victim frequency, each carrier modulated by an audiofrequency.
2. Simulated traffic handling on the victim frequency.
3. Random noise amplitude-modulated carriers.
4. Continuous-wave carrier (keyed or steady).
5. Several audio tones in rapid sequence, modulating a carrier (called bagpipe, from its characteristic sound).
6. Electrical spark, consisting of numerous jagged peaks of noise of short duration having high intensity and a high repetition rate. Spark jamming is encountered more frequently than any other type because it is fairly easy to generate, and its broad radiofrequency characteristics enable an enemy to cover a number of communication channels with one jammer.

Many measures can be used to counter and minimize the effects of jamming. Some of these measures are to—

1. Route messages via alternate circuits, meanwhile continuing live traffic on the jammed circuit to create the impression that jamming is ineffective.

2. Use different receivers to take advantage of differences in selectivity. Selectivity is the ability of a receiver to discriminate between signals close together.
3. Make maximum use of directional effects of available antennas.
4. Request sending station to increase power or to shift frequency.
5. Take advantage of split-phone reception by copying signals keyed simultaneously on two frequencies.
6. Keep receiver volume at a low level when copying through jamming. One's hearing is better able to discriminate between signals that aren't too loud.

Each occurrence of jamming must be reported promptly to cognizant authorities. Information concerning these reports is found in NWP 33.

• Security of radiotelephone: Radiotelephone transmissions are the least secure method of radio communication. Anyone within range, who speaks the language used, can understand the transmissions. Circuit discipline and procedure often are poor on radiotelephone circuits because the equipment can be, and often is, operated by someone besides trained radio personnel. Poor circuit discipline and improper procedure slow communications, cause confusion, and may divulge information to an enemy.

Probably the best defense against enemy intelligence efforts is strict adherence to prescribed radiotelephone procedures. With this knowledge in mind, here are a few precautions to observe when communicating by radiotelephone:

1. Use each circuit for its intended purpose only.
2. Keep number of transmissions to a minimum.
3. Write message before transmission, if possible.
4. Keep transmissions brief, concise, and clear.
5. Transmit no classified information in plain language.
6. Avoid linkage between radiotelephone call signs and other types of call signs.

## CENSORSHIP

Censorship is an essential form of protecting military information. It includes censorship of personal communications as well as official communications. Personal censorship should be cultivated until it becomes second nature.

In the course of his duties, a Radioman 3 or 2 may possess highly classified information, the knowledge of which is shared oftentimes only by the commanding officer, communication officer, and himself. Always be alert against a slip of the tongue that might reveal this information to someone not authorized to know. The Navy Security Manual states that "indiscreet conversation and personal letters constitute great menaces to security." The only safe policy to pursue, concerning classified information, is: Keep your MOUTH SHUT and your PEN DRY. When on duty, discuss classified subjects only as necessary to accomplish a job. When off duty, don't discuss classified matters with anyone—not even family or close friend. Usually the desire to impress others with the importance of one's job is quite strong. Divulging classified information is an unwise way of trying to impress anyone, particularly when by doing so a man may be endangering his country and many lives.

Loose talk in public places is even more dangerous. Conversation in restaurants, hotel lobbies, railroad stations, elevators, taverns, and other public places can be overheard easily. Foreign agents are trained scientifically to collect from such conversations particles of seemingly harmless information. Once pieced together and analyzed, these "innocent" bits of talk sometimes reveal military information of incalculable value.

Mail likewise is subject to interception by an enemy. The following topics must not be mentioned in personal correspondence:

- Location, identity, or movement of ships or aircraft.
- Forces, weapons, military installations, or plans of the United States or her allies.
- Casualties to personnel or material by enemy action.
- Employment of any naval or military unit of the United States or her allies.
- Criticism of equipment or morale of the United States or her allies.

Personal censorship also extends to telephone conversations. To repeat, telephone wires can be tapped, and conversations can be overheard at the switchboard and other points along the circuit. Never discuss classified information over a nonapproved telephone line.

Diaries can be fruitful sources of information for an enemy. They sometimes reveal secrets the enemy laboriously is attempting to extract through cryptanalysis. Even in peacetime, lost and stolen diaries can cause serious damage to the prestige of the United States.

## CALL SIGN ENCRYPTION

Call signs and address designators are encrypted to conceal the identity of the originator and addressees of certain types of messages. Encryption and decryption of these call signs is part of a Radioman's job, hence RMs must become proficient in using the call sign cipher device. Operating instructions for the device may be obtained from the registered publications custodian. More likely, though, a supervisor will know how to operate the device, and can instruct in its use.

An operator must exercise extreme care when transmitting a message containing encrypted call signs. From force of habit he may use the unencrypted international call sign in establishing communications, then send the encrypted version in the message. This blunder results in a compromise of the call sign, and gives enemy intelligence a lever with which to break the entire system.

## EMISSION CONTROL (EMCON)

Emission control (from which EMCON is derived) is the regulation or restriction of equipment capable of emitting radio waves to reduce likelihood of interception by an enemy. Included in EMCON are radio communication equipment, radar, navigational aids (beacons), identification devices (IFF), and aerological devices (radiosonde).

The EMCON program, which encompasses control of electromagnetic radiation, is Navy-wide in scope. In peacetime, EMCON restrictions are imposed only if required for operational purposes or for training. The various degrees of restriction are found in NWP 16.

## SECURITY VERSUS SPEED

A variable relationship exists between security and speed in communications. In the planning stages of an operation, for example, when only a few should know what is planned, security considerations are paramount. As time of execution approaches, additional persons must know the plan, and preparations cannot be concealed so effectively. Then, speed is increasingly important. In actual combat, plain language transmission of classified information may be authorized, although even then security cannot be totally disregarded.

## ADDITIONAL SECURITY INFORMATION

Security precautions mentioned in this Navy Training Course do not guarantee complete protection. Nor do they attempt to meet every conceivable situation. Anyone who adopts a commonsense outlook can, however, solve most security problems, in addition to gaining a knowledge of basic security regulations. For information on local security rules, study ship or station security regulations. Effective editions of the following publications contain additional information on security.

- Department of the Navy Security Manual for Classified Information, OpNavInst 5510.1C
- U.S. Navy Physical Security Manual, OpNavInst 5510.45
- Security, Armed Forces Censorship, OpNavInst 5530.6
- U.S. Navy Regulations, 1948, chapter 15
- Naval Communications Bulletin, published quarterly by DNC (with classified supplement)
- Navy directives in the 2200-2260 series (communication security) and in the 5500-5599 series (administrative security)
- DNC 5, ACP 122, NWP 16, and RPS 4 (the last three are classified)

# CHAPTER 4

# INTERNATIONAL MORSE CODE

The international Morse code is a telegraphic alphabet, with letters and numbers represented by sound patterns.

If you are a graduate of a Class A Radioman School, you were taught the Morse code, consequently much of this chapter may be of little interest to you. But, if this is your first acquaintance with the code—if you are striking for Radioman from the deck force, or changing to Radioman from another rating—you have many hours of hard work ahead. Do not be discouraged on this account. Many fine Radiomen learn the code for themselves.

The letters in Morse code are represented by dots and dashes; radio operators, however, substitute the expressions "dits" and "dahs," which closely resemble the sounds of the telegraphic hand key. The groups of dits and dahs representing each letter must be made as one unit, with a clear break between each dit and each dah, and a much more distinct break between the letters. A dit is one-third the length of a dah.

You must never try to count the dits and dahs. Do not let yourself get in the habit of doing so. It is a temptation at first, but you won't be able to count fast enough when the code speed picks up. Learn sound patterns instead. To understand what a sound pattern is, rap out the pattern beginning "Shave and a haircut." You recognize this from its characteristic rhythm, not because it has a certain number of beats in it. You must learn the code the same way. There are 36 Morse sound patterns for the letters and numbers, plus a few others representing prosigns and punctuation marks. With study and drill you can learn to recognize each pattern as fast as you now recognize "Shave and a haircut." The accent always falls on dahs, and you should pronounce each rhythmical combination with that emphasis in mind.

Go through the alphabet several times to get the sound "feel" of the dit and dah combinations.

## MORSE ALPHABET

In the pronunciation guide for sounds of letters that follows, sounds are written as phonetically as possible. In the middle of a group, the short sound "dit" actually takes on the sound "di." The phonetic alphabet is included in parentheses after the letters. Acquire the habit of referring to the letters phonetically.

| Letter | Pronunciation |
|---|---|
| A (ALFA) -------- | di-DAH |
| B (BRAVO) ------- | DAH-di-di-dit |
| C (CHARLIE) ----- | DAH-di-DAH-dit |
| D (DELTA) ------- | Dah-di-dit |
| E (ECHO) -------- | dit |
| F (FOXTROT) ---- | di-di-DAH-dit |
| G (GOLF) -------- | DAH-DAH-dit |
| H (HOTEL) ------- | di-di-di-dit |
| I (INDIA) -------- | di-dit |
| J (JULIETT) ----- | di-DAH-DAH-DAH |
| K (KILO) --------- | DAH-di-DAH |
| L (LIMA) -------- | di-DAH-di-dit |
| M (MIKE) -------- | DAH-DAH |
| N (NOVEMBER)--- | DAH-dit |
| O (OSCAR) ------- | DAH-DAH-DAH |
| P (PAPA) -------- | di-DAH-DAH-dit |
| Q (QUEBEC) ----- | DAH-DAH-di-DAH |
| R (ROMEO) ------ | di-DAH-dit |
| S (SIERRA) ------ | di-di-dit |
| T (TANGO) ------- | DAH |
| U (UNIFORM)----- | di-di-DAH |
| V (VICTOR) ------ | di-di-di-DAH |
| W (WHISKEY) ----- | di-DAH-DAH |
| X (XRAY) -------- | DAH-di-di-DAH |
| Y (YANKEE) ----- | DAH-di-DAH-DAH |
| Z (ZULU) -------- | DAH-DAH-di-dit |

| Number | Pronunciation |
|---|---|
| 1 | di-DAH-DAH-DAH-DAH |
| 2 | di-di-DAH-DAH-DAH |
| 3 | di-di-di-DAH-DAH |
| 4 | di-di-di-di-DAH |
| 5 | di-di-di-di-dit |
| 6 | DAH-di-di-di-dit |
| 7 | DAH-DAH-di-di-dit |
| 8 | DAH-DAH-DAH-di-dit |
| 9 | DAH-DAH-DAH-DAH-dit |
| Ø | DAH-DAH-DAH-DAH-DAH |

| Punctuation Mark | Pronunciation |
|---|---|
| Hyphen (dash) | DAH-di-di-di-di-DAH |
| Parenthesis l | DAH-di-DAH-DAH-di-DAH |
| Parenthesis r | DAH-di-DAH-DAH-dit |
| point | di-DAH-di-DAH-di-DAH |
| Slant | DAH-di-di-DAH-dit |
| Apostrophe | di-DAH-DAH-DAH-DAH-dit |
| Colon | DAH-DAH-DAH-di-di-dit |
| Comma | DAH-DAH-di-di-DAH-DAH |
| Question mark | di-di-DAH-DAH-di-dit |

## STUDYING CODE

If you have any trouble learning Morse code, the following method may be helpful. Go through the three groupings of short, medium and long sounds with their accompanying practice words. Make up words of your own if you wish to give yourself further practice. Speak the practice words in code. Say "tee: DAH dit dit;" "mine: DAH-DAH di-dit DAH-dit dit.

If you can speak words in code rapidly and distinctly, you will have an easier time when you learn to receive code on the receiver. The sounds are very similar.

You probably have noticed by now how numerals slow your speech in oral transmission. That is understandable—they also slow the speed of radio transmission. Headings containing procedure signs, calls, and numerals are transmitted at a slower rate of speed than straight alphabetical characters.

| Short sounds | Practice words |
|---|---|
| E dit | TEE ATE EAT TEA MEAT |
| T dah | MEET MINE TIME MAINE |
| A di-DAH | TEAM AIM NITE TAME TEA |
| I di-dit | MATE TAME NAME MITE |
| M DAH-DAH | MIAMI MAMA MEAN MAN MAT |
| N DAH-dit | EMIT MINT MANE TAN ITEM TINT |

| Medium length sounds | Practice words |
|---|---|
| D DAH-di-dit | MUST SAME MAMA SUIT AUTO |
| G DAH-DAH-dit | MUSS OUST MUSE MUTE ATOM |
| K DAH-di-DAH | TAUT MAST MASS SUET SAM |
| O DAH-DAH-DAH | WIND SEA TUM SAW OAT |
| R di-DAH-dit | SUE SAT WED SUM MUD IOU |
| S di-di-dit | USE SEAM WOOD DARK |
| U di-di-DAH | GEORGE DOWN KIND SORT |
| W di-DAH-DAH | DOOR MASK WORK GROW WOMAN EDGE GAGE WIGS WORM WAGER WAKE KEG |

| Long sounds | Practice words |
|---|---|
| B DAH-di-di-dit | VAT VET VIM HAM SIX |
| C DAH-di-DAH-dit | SAY |
| F di-di-DAH-dit | HAS HAT EVE CUT |
| H di-di-di-dit | CAM VEST |
| J di-DAH-DAH-DAH | HEAT HAVE MUCH |
| L di-DAH-di-dit | THAT EACH |
| P di-DAH-DAH-dit | COAT ACHE SAVE HUSH |
| Q DAH-DAH-di-DAH | ACME |
| V di-di-di-DAH | CUTE BAKER CHARLIE |
| X DAH-di-di-DAH | FIVE |
| Y DAH-di-DAH-DAH | HOW JIMMY LIKE |
| Z DAH-DAH-di-dit | PAPA QUICK QUILL VICTORY XRAY YOUNG ZERO BUZZ GARGLE FIZZLE LYNX OXYGEN WAX QUAY JERKY WHIP QUEBEC |

Figure sounds

1. di-DAH-DAH-DAH-DAH
2. di-di-DAH-DAH-DAH
3. di-di-di-DAH-DAH
4. di-di-di-di-DAH
5. di-di-di-di-dit
6. DAH-di-di-di-dit
7. DAH-DAH-di-di-dit
8. DAH-DAH-DAH-di-dit
9. DAH-DAH-DAH-DAH-dit

Ø. DAH-DAH-DAH-DAH-DAH

## RECEIVING

If you have carried out the recommendations made up to this point, you are ready to receive code transmitted to you on an oscillator. The ship or station to which you are attached is almost certain to have practice oscillators for your use.

An experienced Radioman will key code groups to you for your training. The sound produced by an oscillator closely resembles the sound of code from the radio receiver. The operator keying to you for practice should transmit each individual character at the standard rate of 20 words per minute. He should maintain a fairly long interval between characters. As you progress, you gain speed by shortening spaces between characters.

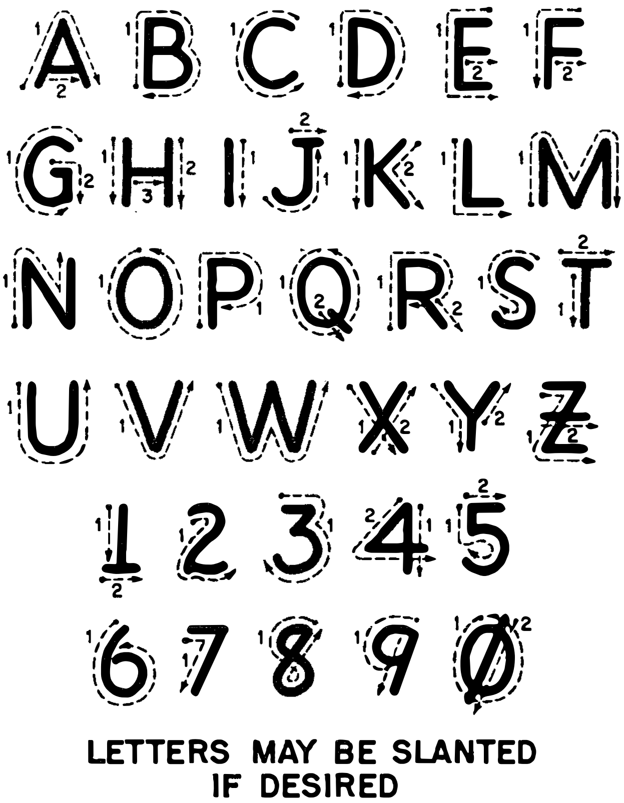
The standard character speed is shown in figure 4-1. Note that the characters themselves may be keyed at 20 words per minute, but that the longer intervals between characters and words materially decrease the beginner's overall speed. Note also that the code, compared against time in the 20-words-per-minute transmission, is in the proper form of having the dit as a unit. There is one unit between each element of a character, three units between each character, and seven units between each group or word.

After learning the sound of each character at this rate of speed, it is not difficult to reduce the time between characters and to copy code at a much faster speed.

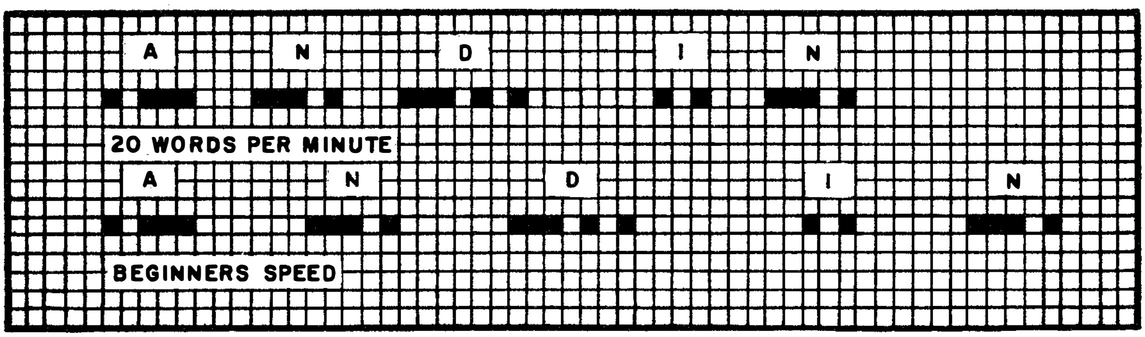
As you advance in rating, you will be required to increase your transmission and reception speed. If you learn the fundamentals well, it will be fairly easy for you to increase your speed. When copying code, if you miss a character, don't stop to worry about it; get the next character and let the one missed go by. Be a competent operator. Make every transmission and every reception accurately. Do not place speed before accuracy.

PRINTING CLEARLY

Learn to print clearly and rapidly. The messages you handle are important, and someone must read what you have written without puzzling over it. Examine figure 4-2 and compare the printed letters with your own. Notice that the sequence of strokes for some letters may be




45.207(76)
Figure 4-2.—How to form printed characters.




51.5
Figure 4-1—Correct keying of Morse characters.

different from the way you customarily form them. As an aid to rapid printing, the more of the letter you can form with a single stroke, the better. Use this illustration as a guide to avoid confusions between printed letters and printed numerals. Especially watch the letter Z and the numeral 2. If you wish, write Z with a line through the stem (Ƶ). Even more important is the distinction between the capital letter O and the figure zero. In communication work, zero is always written with a slant through it (Ø). Exercise care to avoid confusion between letter I and figure 1, and also letter S and figure 5.

As your code speed increases, you will find it impossible to print rapidly enough to keep up; therefore, typewriting is a skill also required of all Radiomen. Use of a good commercial text can help you master touch-typing. A typing course for beginners also is offered by USAFI.

## SENDING

Your ability to send well depends mainly upon two capabilities. First, you must know the correct sound of the character you are attempting to transmit. Second, you must know the proper method for keying with perfect control. Practicing the code aloud, as well as receiving it by oscillator, has given you a good knowledge of code sound. The proper method for keying is your next concern.

## HAND KEY

The first key you will use is the hand key. The hand key is widely used on radiotelegraph circuits and with practice oscillators. It must be adjusted properly before you can send clear-cut characters. Figure 4-3 shows a hand key, with parts labeled.

### KEY ADJUSTMENT

The spring tension screw, behind the key button, controls the amount of upward tension on the key. The tension desired varies with operators. Too much tension forces the key button up before the dahs are completely formed; spacing between characters is irregular, and dits are not clearly defined. If the spring tension is very weak, characters run together and the space between characters is too short.

The gap between the contacts, regulated by the space adjusting screw at the back of the key, should be set at one-sixteenth inch for beginners. This measurement does not apply to every key

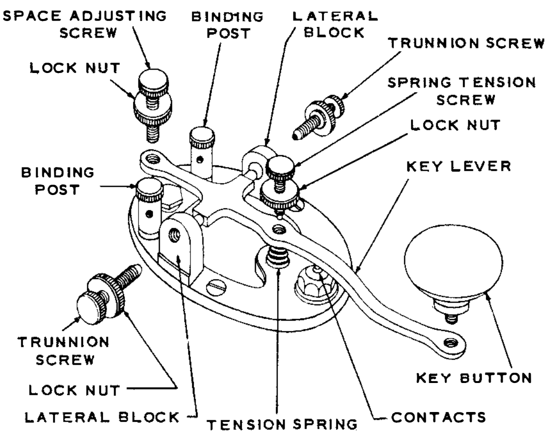



Figure 4-3. —Hand key. 76.8A

and operator; it is a matter of personal preference. Some operators like a closed key, others an open key. "Closed" and "open" are terms for a short and a long gap. As the student progresses, further gap adjustment may be made to suit his sending speed. Contacts that are too close have an effect similar to weak spring tension. Contacts that are spaced too far have the same effect as too much spring tension.

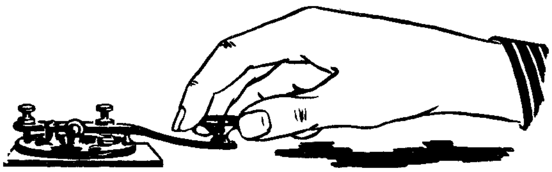
The final adjustment of the key is the sidewise alignment of the contact points. This alignment is controlled by the trunnion screws at either side of the key. If they are too tight, the key lever binds. If they are too loose, the contacts have sidewise play. Usually, when the sidewise alignment is correct, no further adjustment is required.

### POSITION OF HAND ON KEY; WRIST MOVEMENT

Learn from the beginning the correct way to grasp the key. Do not hold the key tightly, but let your fingers rest lightly on the key knob. Your thumb rests against the side, your forefinger rests on top of the key, your other fingers are bent slightly in a relaxed position. Check figures 4-4 and 4-5 for the correct method of keying. To ensure correct movement of your wrist and forearm, your arm should lie on the operating desk. The muscle of your forearm—not your elbow—should support the weight of your arm. Your elbow should not extend over the edge of the table, because the pressure of the underside of your forearm will partly block circulation and tire you. Sit upright, with your arm in line with the key.

76.8B

Figure 4-4. —Grasping the key.



76.8C

Figure 4-5. —Your thumb rests against the side.

Your ability to transmit depends to a great extent on acquiring the proper movements of your wrist and hand while operating the key. To close the key, your wrist moves upward and your hand rocks downward toward your fingertips. To open the key, these two movements are reversed—your wrist comes down and your hand rocks back.

Make your wrist flexible. Limber it up. Correct wrist action may be developed by moving your wrist up and down like a hinge. Another exercise is rotating your hand in clockwise circles, with your wrist held in a stationary position. These exercises will relieve any undue tension you may experience when first beginning to transmit.

## SEMIAUTOMATIC KEY

The semiautomatic key, also known as the bug or speed key, is used chiefly when operators are required to send for relatively long periods of time. It is designed to make sending easy instead of fast. Hence, perfect control of the key is far more important than speed.

### OPERATION

In sending with the bug, the thumb presses the dit paddle (fig. 4-6) to the right, and the index finger forms dahs by pressing the knob to the left. The key sends successive dits when the paddle is held to the right. One dit or a series may be sent, depending on how long the thumb pressure is maintained against the paddle. One dah is formed every time the knob is pressed to the left. Dahs must be sent individually. While sending, the hand pivots at the wrist; the hand and arm motion is horizontal.

### KEY ADJUSTMENT

Best operation of the semiautomatic key is obtained when it is adjusted to send dits and spaces of equal length. Adjust the key as follows, locating the parts in figure 4-6 when adjusting the key:

1. Adjust the back stop screw until the reed lightly touches the deadener. Tighten the locknut.
2. Adjust the front stop screw until the separation between the end of the screw and the reed is approximately .015 inch. Tighten the locknut.
3. Operate the dit paddle to the right. Hold the lever in this position and stop the vibration of the reed. Adjust the dit contact adjusting screw until the dit contacts barely touch. Tighten the locknut. This adjustment determines whether the dits will be too heavy, too light, or perfect. The adjustment must be made without flexing the contact spring.
4. If the dits are too fast, move the weights, located on the reed, in the direction of the deadener. If the dits are too slow, move the same weights in the opposite direction.
5. Adjust the dah contact adjusting screw to a clearance of approximately .030 inch.
6. Adjust the dit retractive and dah tension springs for the most comfortable operation.

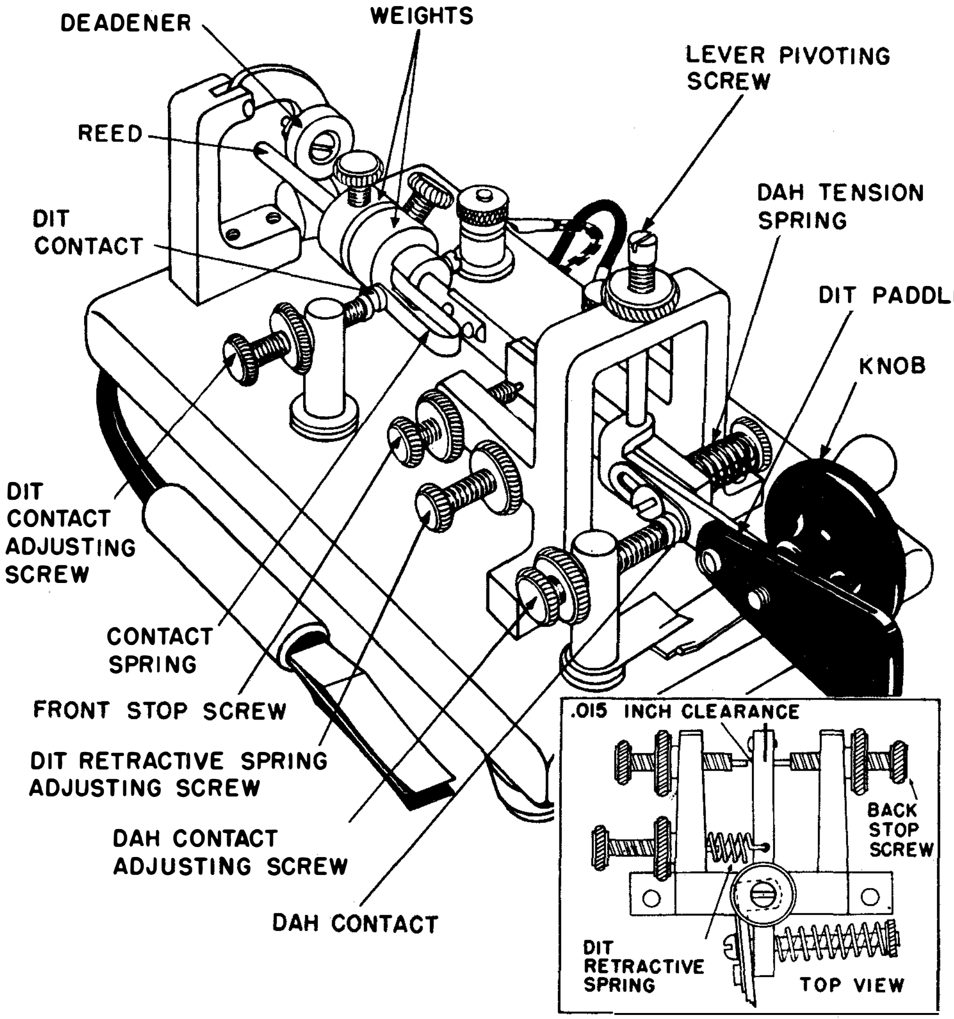
If the adjustment instructions are followed carefully, the bug makes 25 or more dits before stopping. The first 12 to 15 dits will be practically perfect, with the dits and spaces equal.

## SENDING EXERCISES

Good operators have sending rhythm, and you can acquire it in just one way: by practice.

It may be difficult for you to key correctly at first, because your wrist is unfamiliar with the type of movement required for sending telegraphic code. Your wrist will be stiff, and you'll have to get rid of that stiffness by a lot of practice. Don't favor the stiffness of your wrist. If you do, your sending will be choppy.

The following exercises have been prepared carefully. Use them as an instruction guide.




76.9

Figure 4-6. —Semiautomatic key.

• Character E: The dit characters require a "goodfist." They must be transmitted quickly and rhythmically. Make a series of Es (dits). They are made with a pronounced movement of your wrist upward, returning to the normal position after each dit. At first, maintain a fairly long interval between dits. To assist you in limbering your wrist, exaggerate the movement upward. To prevent tenseness and tiredness of your wrist, remove your hand from the key periodically and flex your wrist. After practicing Es for 15 or 20 minutes, decrease the interval between dits until you are making them rather rapidly. Each sound should continue to be a definite dit, however. Keep at it until you can control each dit.

• Character I: When you feel that your wrist is limbering up, make the character I (di-dit). Start with your wrist in the normal relaxed position, raise it for the first dit, lower it quickly halfway back, and make the second dit with another quick movement of your wrist upward. Your transmission, made slowly, produces the sound di-dit. As you practice and develop more rhythm, this character acquires the sound of di-dit.

• Character T: Send a series of Ts (DAH) with a good interval between them. Instead of a quick movement of your wrist upward, make a slower, more definite movement of your wrist and exert more pressure on the key. Send dahs for a few minutes, gradually shortening the interval between characters.

• Character M: Now try sending strings of Ms (DAH-DAH). As with the character I, you don't return your wrist to the beginning position at the end of the first dah, but bring it to the halfway point and then make the last dah. With practice, you'll soon change the hesitant DAH DAH sound to the snappy DAH-DAH. Don't forget the correct wrist movements. If you find that your sending requires exertion of forearm muscles or that your shoulder is moving, stop and recheck your wrist motions.

Try these practice groups several times, backward and forward. Make them clearly and distinctly, spending more time on characters that cause you any trouble.

MEET EMIT MITE ITEM

• Character A: The character A (di-DAH) gives you practice in making a dit and a dah together. Sending motions, in their proper order, are (1) slight pressure of your fingers alongside the key, (2) a quick surge upward of your wrist, (3) a slight relaxing of your wrist to the halfway point, and (4) a final definite upward movement of your wrist. This technique produces the sound dit DAH when you begin to practice it. But keep at it—you'll soon have the proper di-DAH sound. Avoid tenseness; relax your forearm muscles when sending.

• Character U: You're now ready for the character U (di-di-DAH). Start slowly, sending dit dit DAH. Practice it until you get a di-di-DAH sound.

• Character N: The character N (DAH-dit) requires only slight pressure on the sides of the key, a strong wrist movement upward, a half return, and a quick, short, upward motion for the dit. Practice for several minutes until you are able to send DAH-dit easily and with complete relaxation.

• Character D: Try the letter D (DAH-di-dit). At first, with the correct wrist movement, it will be DAH dit dit. But the sound you want to hear is DAH-di-dit—with a swing. Send Ds until you can transmit them with perfect control. Check yourself on the following groups. You should have less difficulty than you did with the first groups.

MINED UNITED READY MAUDE TEAMED

• Character S: Go back to the dits for S (di-di-dit). Get a good position on the key and put your wrist to work. See how quickly you can change the dit dit dit sound to di-di-dit. Relax your forearm.

• Character V: The letter V is di-di-di-DAH, so you'd better learn how to send it that way. Relax. If your wrist is tied up in a knot, you'll be sending dit dit dit DAH. Move your wrist up and down easily until you are sending di-di-di-DAH with perfect control. Practice this letter carefully. It is used in every radio test.

• Character O: Correctly sent, character O is DAH-DAH-DAH. Keep at it until it stops sounding like three Ts. Test your skill with these words:

DOOM MOST ROAD MOTOR WORST MOTION WOKE ANCHOR DOMO

• Character H: Character H is di-di-di-dit. Send one. If it sounds similar to four Es, your wrist is too stiff. Develop the di-di-di-dit sound.

• Character B: Send DAH-di-di-dit. It is the Morse code equivalent of B. Practice for perfect control, then try these groups:

SOB BASSINET BIND BESTED BEAUTY SNOB BABBITT BURST

• Character K: At this point you should be prepared to tackle the other characters. They are mostly combinations of the letters you have practiced. Each one has a distinct overall sound. For instance, K should not have the sound DAH-dit-DAH. It should be DAH-di-DAH. Think of the tune "Over There." You will realize that DAH-di-DAH has the same rhythm as OH-ver THERE—DAH-di-DAH.

• Character Q: The letter Q (DAH-DAH-di-DAH) has the same rhythm as the words "Payday today." Say in a monotone "payday today," then say DAH-DAH-di-DAH. When transmitted, the same swing is given these combinations as when speaking or chanting them.

• Remaining letters and numerals: The preceding 15 characters have taught you proper wrist movement. You know the remaining 11 letters and 10 figures. Following are 14 practice exercises. Use these exercises for self-drill.

## PRACTICE EXERCISES

Practice the remaining letters of the alphabet and the numerals. When you think you're ready for it, practice the code exercises that follow.

1. E E E T T T A A A N N N I I I S S S H H H M M M O O O E E E T T T A A A N N N I I I S S S H H H M M M O O O E E E T T T I I I M M M A A A N N N S S S O O O H H H E E E T T T E E E T T T I I I M M M I I I M M M A A A N N N A A A N N N S S S O O O S S S
2. U U U V V V D D D B B B K K K C C C W W W J J J P P P U U U V V V D D D B B B K K K C C C W W W J J J P P P W W W J J J P P P U U U V V V K K K C C C B B B D D D U U U D D D V V V B B B P P P J J J C C C K K K W W W D D D B B B V V V U U U W W W J J J
3. R R R L L L F F F G G G Z Z Z X X X Y Y Y Q Q Q R R R L L L F F F G G G Z Z Z X X X Y Y Y Q Q Q G G G Z Z Z F F F L L L R R R Y Y Y Q Q Q R R R X X X Z Z Z R R R F F F L L L Q Q Q Y Y Y G G G Q Q Q Y Y Y R R R
4. 1 1 1 2 2 2 3 3 3 4 4 4 5 5 5 6 6 6 7 7 7 8 8 8 9 9 9 Ø Ø Ø 1 1 1 2 2 2 3 3 3 4 4 4 5 5 5 6 6 6 7 7 7 8 8 8 9 9 9 Ø Ø Ø 1 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 Ø Ø 1 1 2 2 3 3 4 4 5 5 6 6 7 7 8 8 9 9 Ø Ø Ø 1 2 3 4 5 6 7 8 9 Ø 1 2 3 4 5 6 7 8 9 1 2 3 4 5 6
5. V U I Y Q Z C X G R S L K J P Q X Z R I F C V B W F K D S H Q Z A L K F B V R S T U O T M E G Y Z X V E G N I W S L H M U A E V U A E W Q G H V C I X Z L N R Y U K V U
6. E 8 Y 7 B 6 X 1 W Ø Z 2 A 3 C 5 S 4 I 2 F U 1 F 5 D 8 Q 4 T 6 U 9 Q 2 E Ø S 5 U 1 Y G 2 J 4 S 3 E 5 T 7 Z 8 K 6 M 9 R 1 A 2 R S 7 W 8 E 9 R 2 A 3 Z 3 X 6 U 8 B 7 C 6 T
7. MI AN SY NL TY CE DO PS CX ZW QA PK LN HU WC VN BM ZS CD QA IU SD LM UH GY TR DC VT AR YU FD SA IG WQ XT ZI NY OT ED BM LP YU GH BY RE DF LS WQ XS ZI TY BG NH JV KL MD MI AN SY NL TY CE DO PS
8. EF TS 16 29 83 ZJ 45 Ø7 WR ND KW IC UX 91 Ø2 IB LO FG 84 63 XW AC TM SU 5Ø 72 XR RJ ZM 43 65 VH 97 LM 12 46 7Ø FC FE EY 34 56 27 FT FY JU IT 98 76 75 52 DE WE QT 13 36 57 KF RI YT 19 93 35 41 FK YU 96 Ø1 MC AR TH 19 25 3Ø UR BO UL 32 Ø5 21
9. NDT EGH RTS LYB FCC ZEX PIH CWE LKJ QIE NUG CVT EPL SZW QAU SH GBT VRT GIK GYO DCM XSD ZAU YER DLN URG HNB VDX ZWS QTA GHI PT MBY PLK RDC ESX IUP PKJ NYH GHT DFR VED SWN VBT XFZ RDA SEN FU GBC YRF DSE WNJ GVA SWQ QIX ZOT MEH GKD BGV CFI ATA RUR SAC LT NVR DAB BLM INY EGB LKO MWD SKZ QLD YGB NDT EGH RRS FLM FCC ME
10. OVLH MYBL URXO HIZO VICT FINX SCXS HTYV IQNT UBML ABLB EJLN CYZB ZWCN JNDZ UTLZ KLAB DEFZ VNUW KFRE
11. JICOY TXSTY 38Ø95 RDIHA JXTDZ OXYDW XPZSY RSPHD 897Ø6 CUSPI RNBRJ 65289 ZONIG FYEQU ARQNV RNLPT KAKOZ 8784Ø BVGAN WKOQT SRQMT UJVWN 45872 YXBCX AFKOZ OGLCT NIHGP 12349 ATUSK SLEWQ
12. OLMX MVNH UWQR NVUT KUXF CDEH LYHE DIPA ZQWI AYSK QIQA WMNW ZIHZ CAKD BTGW WNLI PWBU OXAD XFRJ IQCA
13. ZMJXI URYNC 9347Ø PQAZM DEGVM NCBVG HUGHY 13267 PHRAN QUECC 1289Ø MCNDH EUIRY WQAZX IRSVZ MCURI 72439 OYTRW PIQAW CNJWO OWQAJ OISKM 1Ø7Ø6 DGFHG KSBOU
14. UTHA VNCB RFDS EDCD CXVD RWQI MNJF STRO TNBL UJHK NIOQ JUYR GBNX VCXT RJTU BCDV CGFH 5781 JGVX HGJD

## PRACTICE MAKES PERFECT

Continue sending to yourself with the practice key and oscillator. If you can operate with another striker, so much the better. Sit down at an unused operating position and tune in some slow code. It is not hard to find, especially on amateur frequencies. Copy as best you can. Don't worry too much about missing letters. Get what you can, no matter how little it is. As your speed picks up, tune in faster code. If you find you are copying a certain speed solidly, the code is too slow. Keep it faster than you can copy comfortably.

You will need lots of practice. Class A Radioman Schools ashore run a full day, and for months a man copies code several hours daily. Make the transition from pencil copying to the typewriter as soon as possible.

As you gain skill, try copying the 18-wpm to 20-wpm fleet broadcasts. Devote as much time as possible—15 or 20 hours per week—not just an hour now and then. Do not be afraid to use some of your off-duty time. Simultaneously, begin to learn how to hold down a circuit. One of the best ways to do this is to spend several watches logging circuits that other operators are manning. At the end of every watch, compare your log with that of the regular operator, and question him about anything you do not understand. That way you see procedure in use and gain practice in copying many fists.

Learn to copy behind. If you are recording B as D, S as I, J as W, and so on, you are copying too close. The farther behind the better. At first, listen to one character while setting down the previous one. Try to fall back one letter more. Listen for the character while carrying one in your head and setting down the one before that. Once you have the knack, you will find copying behind is easier, faster, and more accurate. The faster the code, the farther you must stay behind. Watch an oldtimer copy press at 35 or 40 wpm. You will find he is carrying anywhere from 5 words to a sentence in his head.

One further word of advice: It is common for a student learning code to hit a plateau. The regular progress to higher speeds stops, and for a time the student finds himself unable to copy faster than a certain speed. If this happens to you, just stay with it until your speed picks up. Never lose confidence in the knowledge that any may of ordinary ability can learn the code if he puts in the necessary time and work.

# CHAPTER 5

# THE MESSAGE

A message is a thought or idea expressed briefly in plain or cryptic language, and prepared in a form suitable for transmission by any means of communication.

## CLASSES OF MESSAGES

Messages are of five classes: A, B, C, D, and E. Classes A, B, and C are Government messages, and D and E are non-Government (or private) messages. The purpose of this classification system is to aid administration and accounting.

By far the largest volume of message traffic handled by the Navy is class A. Class A messages consist of official messages and replies thereto, originated by the Department of Defense (including the U.S. Coast Guard when operating as part of the Navy).

Class B is made up of official messages of U.S. Government departments and agencies other than the Department of Defense. (The U.S. Coast Guard is included under class B except when operating as a part of the Navy.)

Class C messages consist of broadcast traffic in special forms, available to ships of all nationalities. Class C messages are concerned with special services, such as hydrographic data, weather, and time.

Class D is composed of private messages for which the Navy collects tolls. This group includes radiotelegrams and press messages sent by correspondents aboard ship.

Class E messages are personal messages to and from naval personnel, handled free of charge over naval circuits. Charges are collected from the sender only when a commercial communication company, such as Western Union, handles the message over part of its route. Suppose your ship is in the Atlantic and has a class E message addressed to a man at the Naval Air Station, Guantanamo Bay. Your ship transmits the message to Radio Washington, which relays it via San Juan, P.R., to a station at Guantanamo Bay, from which point delivery is made to the Naval Air Station. The message never leaves Navy channels, and the originator pays nothing. If the message were addressed to Louisville, Ky., Western Union would handle it out of Washington, and the ship would collect tolls from the originator for the distance between Washington and Louisville. Your ship would forward the money to the Navy Finance Center, Washington, D.C., for payment to Western Union in accordance with instructions found in the effective edition of DNC 26.

The class E message privilege is mainly for purposes of morale. It affords naval personnel at sea a means of communication of urgent personal matters without incurring prohibitive expense. It is unavailable between points on shore within the United States. In general, the privilege is used sparingly. Subjects ordinarily acceptable for transmittal or delivery are matters of grave personal concern, such as serious illness of a close relative, birth announcements, important nonrecurring business communications, matters of life and death, and occasional greetings on important anniversaries. Not acceptable are trivial or frivolous messages, those of unnecessary length, and ordinary congratulations.

## ORIGINATOR; DRAFTER; RELEASING OFFICER

An originator of a message is the command by whose authority the message is sent. The drafter—usually a department head—is the person who actually composes the message for release. A releasing officer authorizes transmission of the message for and in the name of the originator. Ordinarily the commanding officer is releasing officer, but he may delegate releasing authority.

A Radioman charged with accepting locally originated messages must know who has releasing authority. He also should check every message for the releasing officer's signature.

## ADDRESSEES

Most messages have at least one addressee responsible for taking action on the contents and for originating any necessary reply. Other addressees with an official concern in the subject of a message, but who do not have primary responsibility for acting on it, receive the message for information. Do not be confused by the term "information addressee." Even though an information addressee usually is concerned only indirectly with a message, frequently he must take action of some nature within his own command. Some messages have only information addressees.

Messages may be divided into types, according to the way they are addressed, as (1) single-address, (2) multiple-address, (3) book, and (4) general.

A single-address message is sent to one addressee only.

A multiple-address message is sent to two or more addressees, each of whom is informed of the others. Each addressee must be designated either as action or information.

A book message is sent to two or more addressees. It is of such a nature that no addressee needs to know who the others are—although each addressee is informed whether he receives the message for action or for information. Any station sending a book message divides addressees into groups according to relay stations serving them. A separate message is prepared and transmitted to each relay station; the message is changed only to drop addressees that are the concern of some other station. Upon receiving a book message, a relay station may further reduce the number of addressees by repeating the process or by making up single-address messages for each of its tributaries addressed. Because many book messages are intended for dozens of addressees, and because some addressees may require delivery by Western Union or other commercial teletypewriter services, substantial time and expense are saved by shortened headings.

General messages are of sufficient importance that they are discussed fully in the next topic.

## GENERAL MESSAGES

A general message has a wide standard distribution. General messages are of many types. Each type carries an identifying title and is intended for a certain standard set of addressees. (See table 5-1.) All messages of a given general message title are numbered serially through a calendar year. The first general message of the year usually provides information on effective and canceled or superseded general messages of the same type of the previous year.

You will see other general messages with titles not listed in table 5-1. These messages are originated by sea frontier commanders, commandants of naval districts, and fleet, force, and ship type commanders for the purpose of publishing information within their respective commands.

Maintenance of general message files is often part of a Radioman's duties. General messages are grouped according to type, and are filed in order of serial numbers. Copies of general messages are kept in a general message file until canceled or superseded.

## RED CROSS MESSAGES

The American Red Cross is permitted free use of naval communication facilities for sending and receiving messages regarding emergency welfare in the interest of armed forces personnel. Red Cross messages are handled as class B messages. They normally are in plain text.

The Red Cross messages you are most likely to see concern personal hardship, or death or serious illness of relatives of naval personnel. You will copy from the fleet broadcast many such messages addressed to ships at sea.

When emergencies or disasters occur involving Red Cross relief work, Red Cross messages may be handled over naval circuits whether they are in the interest of armed forces personnel or not.

Red Cross messages normally are not accepted for transmission unless delivery can be effected entirely by naval communications.

## SPECIAL-PURPOSE MESSAGES

A number of messages are named for the purpose they serve. They usually contain reports or information of a recurring nature and

Table 5-1.—General Messages

| Originator | Title of Series | Description |
|---|---|---|
| SECNAV | ALNAV | Messages intended for wide distribution throughout the entire Naval Establishment, including the Marine Corps. They deal with administrative matters, such as fiscal policies, changes in personnel allowances, legislation affecting the Navy, promotions of officers, etc. |
| | NAVACT | Similar in content to ALNAV, but of no interest to the Marine Corps. |
| | ALNAVSTA | Administrative information requiring wide dissemination to the shore establishment of the Navy—including shore-based elements of the operating forces—and to the Marine Corps. |
| | ALSTACON and ALSTAOUT | Similar to the above but of interest, respectively, to activities inside and activities outside the continental United States. |
| CNO | NAVOP | Similar in content to ALNAV but distribution list does not include attaches, missions, observers, or minor shore activities. |
| | ALCOM | Usually used for, but not restricted to, promulgation of communication information throughout the Navy. |
| | ALCOMLANT and ALCOMPAC | Subdivisions of the ALCOM series for, respectively, Atlantic-Mediterranean areas and Pacific area. |
| | MERCAST | The merchant ship equivalent to an ALNAV. Distribution includes ships guarding MERCAST (merchant ship broadcast) schedules, naval port control and naval control of shipping officers, and MSTS commands. |
| CINCPAC | JANAFPAC | Messages pertaining to the Pacific commands on matters of joint interest. |
| CINCPACFLT | ALCOMPAC(P) | May be originated by CINCPACFLT when coordination unnecessary with CNO. Numbered sequentially and suffixed by letter P. |
| | ALPACFLT | Messages for general distribution to commands under CINCPACFLT. |
| | MERCASTPAC | The merchant ship equivalent to an ALPACFLT. |
| COMMANDANT, MARINE CORPS | ALMAR | Messages for general dissemination to all Marine Corps activities. |
| | ALMARCON | Messages for Marine Corps activities within the continental United States. |
| CINCLANTFLT | ALCOMLANT(A) | May be originated by CINCLANTFLT when coordination with CNO is unnecessary. Numbered sequentially and suffixed by letter A. |
| | ALLANTFLT | Messages for general distribution to commands under CINCLANTFLT. |
| | MERCASTLANT | The merchant ship equivalent to an ALLANTFLT. |
| | LANTFLTOPS | Designates general messages concerning fleet units and their operational commanders within commands under CINCLANTFLT. |
| JCS (MCEB) | JAFPUB | Designates general messages that promulgate information pertaining to all branches of the Armed Forces. |
| COMMANDANT, COAST GUARD | ALCOAST | Messages for general dissemination within the Coast Guard. The Coast Guard equivalent of ALNAV. |
| | ALDIST | Provide Coast Guard district commanders with policy instructions and other information. |
| COMMANDER, MSTS | ALMSTS | Messages for all MSTS commands and offices. |

76.41

may follow a specific format. A few of the more common types of special-purpose messages are explained in ensuing topics.

## CONTACT AND AMPLIFYING REPORTS

A contact report is a message reporting the first contact with an enemy force. Speed of handling such a message is of the utmost importance. Contact reports have priority over every other type of traffic handled by naval communications.

An amplifying report follows up a contact report. It contains further data about an enemy force, such as number, type, position, course, speed, and distribution. A contact report may be followed by many amplifying reports as information becomes available and the enemy shows his intentions. Often it is possible to transmit some amplifying data with the contact report.

## MOVEMENT REPORTS

The Navy has hundreds of fleet units always on the move. It is necessary, for command purposes and for efficient administration, to have an up-to-the-hour knowledge of the location of every vessel. Dissemination of movement information is a function of the movement report system.

The controlling agency of the entire movement report system is the Movement Report Control Center at Washington, D. C. (MRCC WASHDC). For reporting purposes the world is divided into five zones, of which only four presently are assigned. Each zone is controlled by a movement report center (MRC). Each zone is further subdivided into areas controlled by movement report offices (MROs). An MRC may receive information on movements all over the world, but MROs have information only on movements in their own areas of responsibility.

Before getting underway, a ship sends a movement report message stating the time of departure, destination, route, speed of advance, and any other information the ship may be directed to furnish. The message enters the movement report system through the MRO or MRC controlling the area the ship is in. It then is the responsibility of the MRO or MRC to relay the information to military and civilian activities that have an official interest in the location of the vessel. Included are such activities as supply centers, fleet post offices, fleet broadcast stations, and customs authorities.

Movement report messages are prepared in accordance with the movement report supplement to NWIP 10-1.

## HYDRO MESSAGES

The U. S. Navy Oceanographic Office originates notices or messages concerning navigation warnings. These messages are given wide distribution on special hydrographic broadcasts (hydro messages), of which there are two subdivisions. Hydrolants contain navigational information relating to the Atlantic, Mediterranean, and Indian Oceans. Hydropacs furnish like information for the Pacific Ocean areas.

## NOTICES TO AIRMEN

Notices to airmen (NOTAMs) are originated by military activities and civil agencies concerned with safety of aircraft. The NOTAMs are composed of data relating to aerological facilities, services, and hazards.

## Q MESSAGES

The classified portions of the navigational warning systems of Allied Nations are known as Q messages. They contain information affecting navigation that an enemy would find difficult to obtain on his own. Do not confuse Q messages with Q signals, which are explained later in this chapter.

## ALL SHIPS PRESENT MESSAGES

All ships present messages are originated by the senior officer present afloat (SOPA), and relate to such matters as storms, port security regulations, and local liberty policy. The SOPA prescribes local instructions governing initiation, transmission, and relay of all ships present messages.

## MINIMIZE MESSAGES

In an emergency—either actual or simulated—it may be necessary to reduce message and telephone traffic to prevent delay in handling vital messages. This reduction in traffic is accomplished by promulgation (usually by message) of the word MINIMIZE, which has the following meaning: "It is now mandatory that normal message and telephone traffic be reduced drastically in order that vital messages connected with the situation indicated shall not be delayed." A message ordering minimize consists of the word minimize followed by scope (area affected), reason, and duration of its imposition (when known). Messages imposing minimize must be brought to the immediate attention of the communication officer.

## STATION AND ADDRESS DESIGNATORS

Station and address designators are formed of combinations of characters or pronounceable words for use in message headings to identify originators and addressees. Station and address designators are of four kinds: call signs, address groups, routing indicators, and plain language address designators.

## CALL SIGNS

Call signs are letters, letter-number combinations, or one or more pronounceable words, used chiefly to identify communication activities and for establishing and maintaining communications. They are applicable in both civil and military communications. Call signs are of several categories, with some calls belonging to more than one category. They are described in the ensuing eight topics.

### International Call Signs

International call signs are assigned radio stations of all countries—civil and military, afloat and ashore—according to international agreement. The first letter or first two letters of an international call indicate the nationality of the station. The United States has the first half of the A block (through ALZ) and all of the K, W, and N blocks. The United States reserves A calls for the Army and Air Force. The K and W blocks are assigned to commercial and private stations, merchant ships, and others. The N block is only for use by the Navy, Marine Corps, and Coast Guard.

Naval shore communication stations have three-letter N calls. If necessary, these calls may be expanded by adding numerical suffixes. Thus, additional call signs are provided for radio transmitting and receiving facilities located remotely from the parent station. Examples:

NAM . . . . . . . . . . NAVCOMMSTA Norfolk.
NAM1 . . . . . . . . . Headquarters, CINCLANTFLT, Norfolk.
NAM2 . . . . . . . . . Naval Shipyard, Norfolk.

Call signs for fixed and land radio stations are listed in ACP 100 (Allied Call Sign and Address Group System—Instructions and Assignments) and U.S. Supplement 1 thereto.

International call signs assigned to U. S. naval vessels are four-letter N calls, which are to be used unencrypted only. They have no security value, hence they are utilized for all nonmilitary international communications. Example:

NWBJ . . . . . . . . . USS Renshaw (DD 499).

International call signs for USN, USMC, and USCG aircraft are composed of the service designator N, NM, or NC, respectively, followed by the last four digits of the serial or bureau number of the aircraft.

### Military Call Signs

Most ships of the Allied Nations are assigned military call signs in addition to their international call signs. From these military call signs are derived encrypted call signs for CW and RATT communications. Likewise, military call signs form the basis for both encrypted and unencrypted call signs for voice communications. They are never used in their basic form to address messages, consequently military call signs are assigned only to ships capable of encrypting call signs. Both international and military call signs are listed in ACP 113 (Call Sign Book for Ships).

### Indefinite Call Signs

Indefinite call signs represent no specified facility, command, authority, or unit. They may, however, represent any one or any group of the four activities. Examples:

NERK . . . . . . . . . (To) any or all U.S. Navy ship(s).
NA through NZ . (From) any U.S. Navy ship.
NQO . . . . . . . . . . Any or all U.S. Navy shore radio station(s).

Indefinite call signs are used in codress message headings to conceal identity of originators and addressees. In such instances this information is placed in the encrypted text.

The call NQO might be sent by a ship unable to raise a particular shore station. Any Navy shore station hearing the transmission would answer and accept the traffic.

### Collective Call Signs

Collective call signs pertain to two or more facilities, commands, or units. Examples:

NATA. . . . . . . All U. S. Navy ships copying this broadcast.
NIMK. . . . . . . All U. S. submarines copying this broadcast.

### Net Call Signs

Net call signs represent all stations within a net. (A net is a group of stations in direct communication with each other on a common channel.) Examples:

NQN. . . . . . . . All U. S. Navy radio stations in the Pacific guarding the ship-shore high-frequency calling series.
OVERWORK . . All U. S. Navy stations on this (radiotelephone) circuit.

### Tactical Call Signs

Tactical call signs, with the exception of task organization and aircraft call signs, are limited in application. They normally are used in tactical communications only, to identify tactical commands or communication facilities. Tactical call signs are composed of four-letters, which are letter-number combinations. They are listed in ACP 110, Tactical Call Sign Book with supplements, and ACP 112, Task Organization Call Sign Book.

### Voice Call Signs

Voice call signs are words or combinations of words–such as SUNSHINE or HIGH HAT–limited to radiotelephone communications. Call signs in JANAP 119, Joint Voice Call Sign Book and in ACP 119, Allied Tactical Voice Call Sign Book are only for tactical circuits. On ship-shore administrative circuits, phonetically spelled international call signs are given as ships' voice calls. Under certain conditions, ships' names are used as voice call signs on local harbor circuits. All the various types of voice call signs and the rules for their application in radiotelephone communications are treated in detail in chapter 7.

### Visual Call Signs

Visual call signs are groups of letters, numerals, special flags and pennants, or any of these combinations, for use in visual communications. They are listed in ACP 118.

## ADDRESS GROUPS

Address groups are four-letter groups assigned to represent a command, activity, or unit. They are used mainly in the message address. In military communications, though, they can be used in the same manner as call signs to establish and maintain communications. In general, call signs and address groups are used by the Navy in exactly the same way. Address groups never start with the letter N, hence they are easily distinguished from naval radio call signs. Unlike international call signs, address groups follow no distinctive pattern. For example, you learned the difference in call signs for naval ships and shore radio stations. In address groups, however, arrangement of the four letters conveys no significance whatsoever.

All commands afloat (except individual ships) are assigned address groups. They are assigned also to shore-based commands, authorities, or activities not served by their own communication facilities. For example, (1) senior commands and commanders ashore, such as the Secretaries of Defense and of the Navy, bureaus, system commands, and offices of the Navy Department, and district commandants; (2) fleet, type, or force commanders ashore; (3) elements of operating forces permanently ashore who are in frequent communication with forces afloat; and (4) elements of the shore establishment (such as weather centrals) having a need for direct addressing and receipt of the messages.

Among other uses, address groups facilitate delivery of messages when a communication center serves so many activities that its own callsign is insufficient to identify the addressee. Address groups are contained in ACP 100 and its U.S. Supplement 1.

Address groups, like call signs, are divided into types. They are individual activity, collective, conjunctive and geographic address groups, address indicating groups, and special operating groups.

### Individual Activity Address Groups

Individual activity address groups are representative of a single command or unit, either afloat or ashore. Examples: DTCI, COMPHIBLANT; SSMW, CNO.

### Collective Address Groups

Collective address groups represent two or more commands, authorities, activities, units, or combinations of these four. Included in the group are the commander and his subordinate commanders. Examples: DSWN, DESRON 16; AMGK, SIXTHFLT.

### Conjunctive Address Groups

Conjunctive address groups, remember, have incomplete meanings. It is always necessary to complete the meaning by adding other address groups denoting a specific command or location. It is for this reason that conjunctive address groups are used only with one or more other address groups. The conjunctive address group XZKW, for example, means "All ships present at ________." To complete the meaning, this particular group must be followed by a geographic address group.

### Geographic Address Groups

Geographic address groups are the equivalent of geographical locations or areas. They are always preceded by conjunctive address groups. Assuming the geographic address group for Newport, R. I., to be DEXL, all ships present at Newport would be addressed XZKW DEXL.

### Address Indicating Groups

Address indicating groups (AIGs) represent a specific set of action and/or information addressees. The originator may or may not be included. The purpose of AIGs is to increase the speed of traffic handling. They shorten the message address by providing a single address group to represent a number of addressees, thus eliminating individual designators for each addressee. For example, BIOQ is an AIG used to address air defense messages originated by COMEASTSEAFRON to 24 action addressees and 37 information addressees. By using a single AIG in this example, 61 call signs and address groups are eliminated from the heading of the message.

### Special Operating Groups

Special operating groups (SOGs) are utilized for passing special instructions in message headings. They are four-letter groups that are identical in appearance to address groups. Special operating groups are not used by the Navy unless specifically authorized by CNO. When they are authorized, they must always be encrypted. A list of SOGs, together with their meanings, is in ACP 100.

## ROUTING INDICATORS

Routing indicators are groups of letters whose purpose is to identify stations in a teletypewriter tape relay network. Depending on the type of station, routing indicators vary in length from four to seven letters. It is easy to distinguish routing indicators from call signs on address groups because routing indicators always begin with either letter R or U. Routing indicators are never encrypted. A complete discussion of routing indicators and their usage in teletypewriter tape relay operation is included in chapter 11.

## PLAIN LANGUAGE ADDRESS DESIGNATORS

Plain language address designators are the official, abbreviated, or short titles of commands or activities, used instead of call signs or address groups in headings of messages. Some abbreviated titles are written as single words. Others have conjunctive titles and geographical locations. Examples: CNO; NAVCOMMSTA GUAM.

Plain language address designators have wide application in messages originated and addressed within the shore establishment. They also are used in communications with the Army, Air Force, and the armed forces of Allied Nations. They are not used in headings of codress messages, nor in radiotelegraph messages originated by U. S. naval forces afloat.

## TIME IN MESSAGES

For reckoning time, the surface of the earth is divided into 24 zones, each extending through 15° longitude. Each zone differs by 1 hour from the zone next to it.

The initial time zone lies between 7-1/2° E. and 7-1/2° W. of zero meridian, which passes through the town of Greenwich, England. The time in this zone–zone zero–is called Greenwich mean time (GMT). You may hear some old-timers call it Greenwich civil time (GCT); both names mean the same. Each zone, in turn, is indicated by the number that represents the difference between local zone time and Greenwich mean time.

Zones lying in east longitude from zone zero are numbered from 1 to 12 and are designated minus, because for each of them the zone number must be subtracted from local time to obtain Greenwich mean time. Zones lying in west longitude from zero zone are numbered from 1 to 12 also, but are specified plus, because the zone number must be added to local zone time to obtain GMT. In addition to the time zone number, each zone is further designated by letter. Letters A through M (J omitted) indicate minus zones; N through Y, plus zones. (See fig. 5-1.) The designating letter for GMT is Z.

The 12th zone is divided by the 180th meridian, the minus half lying in east longitude and the plus half in west longitude. This meridian is the international date line, where each world-wide day begins and ends. A westbound ship crossing the line loses a day, whereas an eastbound ship gains a day.

The number of a zone, prefixed by a plus or a minus sign, constitutes the zone description. Often zones crossing land areas are modified to agree with boundaries of countries or regions using corresponding time.

The approved method of expressing time in the 24-hour system is with hours and minutes expressed as a four-digit group. The first two figures of a group denote the hour; the second two, minutes. Thus, 6:3Ø a.m. becomes Ø63Ø; noon is 12ØØ; and 6:3Ø p.m. is 183Ø. Midnight is expressed as ØØØØ–never as 24ØØ–and 1 minute past midnight becomes ØØØ1. The time designation 1327Z shows that it is 27 minutes past 1:ØØ p.m., GMT. Numbers are prefixed to the time to indicate the day of the month; in other words, to form a date-time group (DTG). The DTG 171327Z Nov 67 means the 17th day of November plus the time in GMT. Dates from the 1st to the 9th of the month are preceded by the numeral Ø.

A date-time group is assigned to a message by the message center at the time a message is prepared for transmission. For standardization, time expressed by a date-time group normally is GMT. The date-time group is a message heading serves two purposes: It indicates time of origin of the message, and it provides an easy means of referring to the message.

In addition to the external DTG, an encrypted message has a DTG buried within the text. This time is called the true date-time group (TDTG), and it is inserted by the cryptocenter. The TDTG is used when referring to a message that has been encrypted.

The DTG assigned to a general message always has a slant sign (/) and additional digits added to the DTG. Additional digits represent the general message sequential serial number. Example: 1Ø2347Z/35 Nov 67.

Local time is used sometimes to indicate date and time in the text of a message, but must be accompanied by the zone designating letter–as in 17Ø812Q. When local time is referred to frequently in the text, the suffix may be omitted if a covering expression is used, such as ALL TIMES QUEBEC.

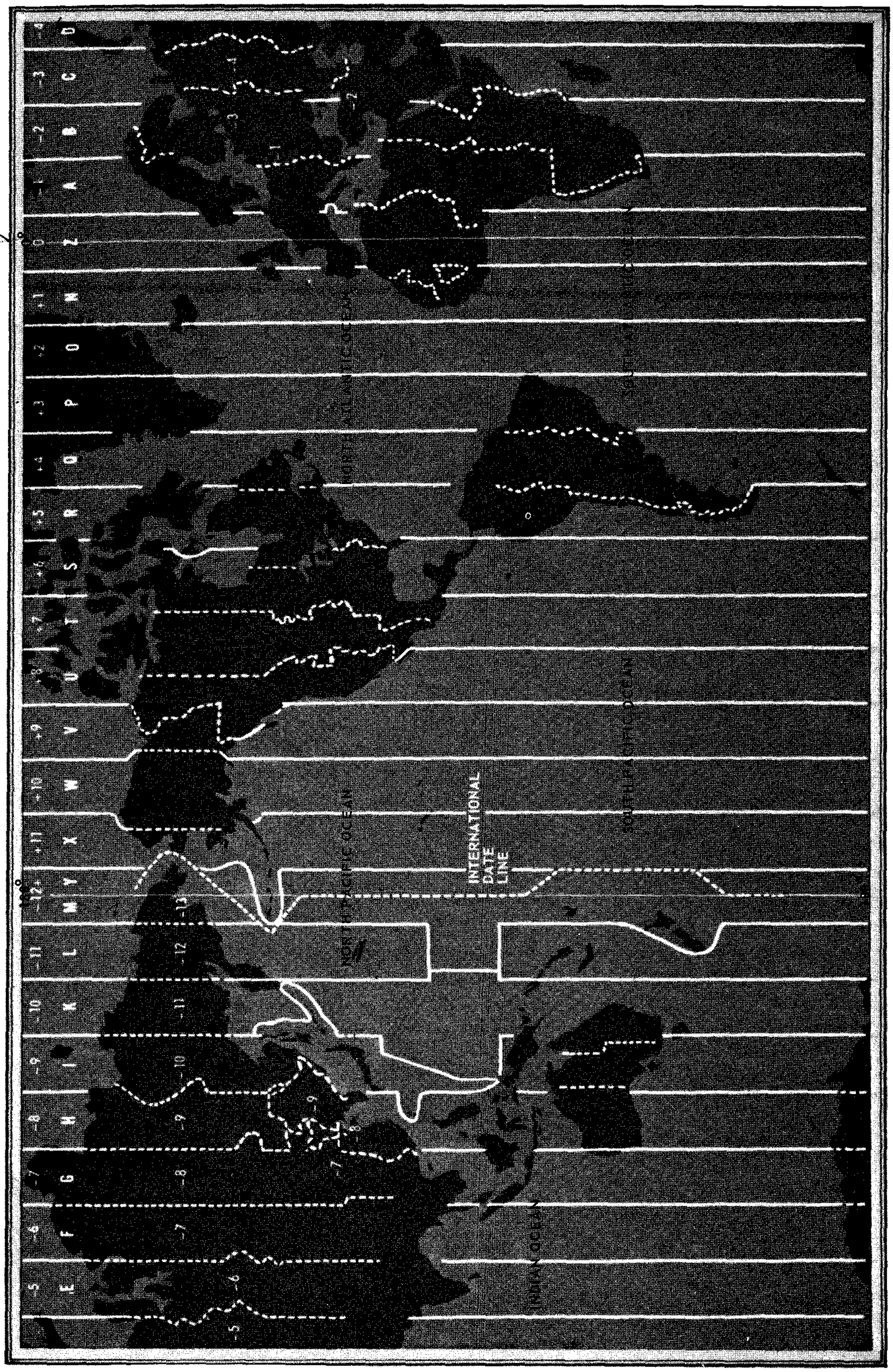
### TIME CONVERSION TABLE

The time conversion table (table 5-2) is useful for converting time in one zone to time in any other zone. Vertical columns indicate time zones. Zone Z is GMT. Time in each successive zone to the right of zone Z is 1 hour later, and to the left of zone Z is 1 hour earlier. Time in each successive shaded area to the right is 1 day (24 hours) later; to the left it is 1 day (24 hours) earlier.

To calculate time in zone U when it is Ø5ØØ hours in zone I, for example, proceed as follows: Find Ø5ØØ in column I and locate the time (12ØØ) in the corresponding line in column U. Inasmuch as 12ØØ is not in the shaded area, the time is 12ØØ hours yesterday.

## PRECEDENCE

Precedence is an important concept in naval communications. To communication personnel,




76.41

Figure 5-1. —Time zone chart of the world.

Table 5-2.—Time Conversion Table

| | Y +12 | X +11 | W +10 | V +9 | U +8 | T +7 | S +6 | R +5 | Q +4 | P +3 | O +2 | N +1 | Z 0 | A −1 | B −2 | C −3 | D −4 | E −5 | F −6 | G −7 | H −8 | I −9 | K −10 | L −11 | M −12 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PREVIOUS DAY | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | SAME DAY |
| | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | |
| | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | |
| | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | |
| | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | |
| | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | |
| | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | |
| SAME DAY | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | NEXT DAY |
| | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | |
| | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | |
| | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | |
| | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | |
| | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | |
| | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | |
| | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | |
| | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | |
| | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | |
| | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | |
| | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | |
| | 1300 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | |
| | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | |
| | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | |
| | 1600 | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | |
| | 1700 | 1800 | 1900 | 2000 | 2100 | 2200 | 2300 | 2400 | 0100 | 0200 | 0300 | 0400 | 0500 | 0600 | 0700 | 0800 | 0900 | 1000 | 1100 | 1200 | 1300 | 1400 | 1500 | 1600 | 1700 | |

it indicates the relative order in which a message must be handled and delivered. To the addressees, precedence shows the relative order in which the contents are to be noted. Precedence is assigned by the originator on the basis of message content and how soon the addressee must have it. No message is assigned a precedence higher than that required to ensure that it reaches all addressees on time.

Multiple-address messages having both action and information addressees are often assigned two precedences, called dual precedence. One precedence is for the action addressees, and a lower precedence is for information addressees.

Use of higher precedences is limited to certain types of urgent traffic, and standards for handling each precedence are prescribed by the Director of Naval Communications (DNC). The rules governing precedence are set forth in table 5-3.

## PROSIGNS

Procedure signs, or prosigns, are letters or combinations of letters that convey in short, standard form certain frequently sent orders, instructions, requests, reports, and the like relating to communications. In radiotelegraphy, an overscore means that the prosign is sent as one character, that is, without a normal pause between letters. Overscores are ignored in teletypewriter work.

Although some prosigns seem to be abbreviations of their assigned meanings, prosigns are never referred to as abbreviations.

Following is a complete list of authorized prosigns. Memorize them now. It may be helpful to prepare a number of small cards, with the prosign on the front and its meaning on the back. Use the cards for self-drill.

1. Precedence prosigns:
   - Z. . . . . . . . . . . FLASH.
   - O. . . . . . . . . . . IMMEDIATE.
   - P. . . . . . . . . . . PRIORITY.
   - R. . . . . . . . . . . ROUTINE.
2. Prosigns that identify portions of a transmission:
   - AA. . . . . . . . . . All after.
   - AB. . . . . . . . . . All before.
   - WA . . . . . . . . . Word after.
   - WB . . . . . . . . . Word before.
3. Ending prosigns:
   - K. . . . . . . . . . . Go ahead; or, this is the end of my transmission to you and a response is necessary.

Table 5-3.—Precedence of Messages

| Prosign | Designation | Definition and Use | Handling Requirements |
|---|---|---|---|
| Z | FLASH | FLASH precedence is reserved for initial enemy contact messages or operational combat messages of extreme urgency. Brevity is mandatory.<br>Examples:<br>(1) Initial enemy contact reports.<br>(2) Messages recalling or diverting friendly aircraft about to bomb targets unexpectedly occupied by friendly forces; or messages taking emergency action to prevent conflict between friendly forces.<br>(3) Warnings of imminent large-scale attacks.<br>(4) Extremely urgent intelligence messages.<br>(5) Messages containing major strategic decisions of great urgency. | FLASH messages are hand-carried, processed, transmitted, and delivered in the order received and ahead of all other messages. Messages of lower precedence will be interrupted on all circuits involved until handling of the FLASH message is completed.<br><br>Time Standard:<br>Not fixed. Handled as fast as humanly possible with an objective of less than 10 minutes. |
| O | IMMEDIATE | IMMEDIATE is the precedence reserved for messages relating to situations that gravely affect the security of national/allied forces or populace, and require immediate delivery to the addressee(s).<br>Examples:<br>(1) Amplifying reports of initial enemy contact.<br>(2) Reports of unusual major movements of military forces of foreign powers in time of peace or strained relations.<br>(3) Messages that report enemy counterattack or request or cancel additional support.<br>(4) Attack orders to commit a force in reserve without delay.<br>(5) Messages concerning logistical support of special weapons when essential to sustain operations.<br>(6) Reports of widespread civil disturbance.<br>(7) Reports or warnings of grave natural disaster (earthquake, flood, storm, etc).<br>(8) Requests for, or directions concerning, distress assistance.<br>(9) Urgent intelligence messages. | IMMEDIATE messages are processed, transmitted, and delivered in the order received and ahead of all messages of lower precedence. If possible, messages of lower precedence will be interrupted on all circuits involved until the handling of the IMMEDIATE message is completed.<br><br>Time Standard: 30 minutes to 1 hour. |
| P | PRIORITY | PRIORITY is the precedence reserved for messages that require expeditious action by the addressee(s) and/or furnish essential information for the conduct of operations in progress when ROUTINE precedence will not suffice.<br>Examples:<br>(1) Situation reports on position of front where attack is impending or where fire or air support will soon be placed.<br>(2) Orders to aircraft formations or units to coincide with ground or naval operations.<br>(3) Aircraft movement reports (messages relating to requests for news of aircraft in flight, flight plans, or cancellation messages to prevent unnecessary search/rescue action).<br>(4) Messages concerning immediate movement of naval, air, and ground forces. | PRIORITY messages are processed, transmitted, and delivered in the order received and ahead of all messages of ROUTINE precedence. ROUTINE messages being transmitted should not be interrupted unless they are extra long and a very substantial portion remains to be transmitted. PRIORITY messages should be delivered immediately upon receipt at the addressee destination. When commercial refile is required, the commercial precedence that most nearly corresponds to PRIORITY is used.<br>Time Standard: 1 to 6 hours. |
| R | ROUTINE | ROUTINE is the precedence to use for all types of messages that justify transmission by rapid means unless of sufficient urgency to require a higher precedence.<br>Examples:<br>(1) Messages concerning normal peacetime military operations, programs, and projects.<br>(2) Messages concerning stabilized tactical operations.<br>(3) Operational plans concerning projected operations.<br>(4) Periodic or consolidated intelligence reports.<br>(5) Troop movement messages, except when time factors dictate use of a higher precedence.<br>(6) Supply and equipment requisition and movement messages, except when time factors dictate use of a higher precedence.<br>(7) Administrative, logistic, and personnel matters. | ROUTINE messages are processed, transmitted, and delivered in the order received and after all messages of a higher precedence. When commercial refile is required, the lowest commercial precedence is used. ROUTINE messages received during nonduty hours at the addressee destination may be held for morning delivery unless specifically prohibited by the command concerned.<br><br>Time Standard:<br>3 hours—start of business following day. |

76.44

$\overline{\text{AR}}$ . . . . . . . . . End of transmission; no receipt required.

4. Pause prosigns:

   $\overline{\text{AS}}$ . . . . . . . . . . I must pause for a few seconds.

   $\overline{\text{AS}}$ $\overline{\text{AR}}$ . . . . . . . I must pause longer than a few seconds; will call you back.

5. Separation prosigns:

   $\overline{\text{BT}}$ . . . . . . . . . . Break. (Separates text of message from heading and ending.)

   II (written in messages as a short dash) . . . . Separative sign. (Used to separate parts of message heading. Not to be used as punctuation to represent a hyphen or dash in message texts.)

6. Prosigns always followed by one or more call signs and/or address groups:

   DE . . . . . . . . . . From (in call).

   FM . . . . . . . . . Originator's sign.

   TO . . . . . . . . . . The addressee designations immediately following are addressed for action.

   INFO . . . . . . . The addressee designations immediately following are addressed for information.

   XMT . . . . . . . . Exempt. (Used to exempt addressees from a collective call or address.)

7. Prosigns used in transmission instructions of a message:

   T . . . . . . . . . . . Transmit this message to all addressees or to the addressee designations immediately following.

   G . . . . . . . . . . . Repeat this entire transmission back to me exactly as received.

   F . . . . . . . . . . . Do not answer.

8. Group count prosigns:

   GR plus numerals . . . . . . . . Group count.

   GRNC . . . . . . . . The groups in this message have not been counted.

9. Prosigns used with the executive method:

   $\overline{\text{IX}}$ . . . . . . . . . . Action on the message or signal that follows is to be carried out upon receipt of "Execute."

   $\overline{\text{IX}}$ plus 5-second dash . . . "Execute"—carry out the purport of the message or signal to which this applies.

10. General:

    $\overline{\text{AA}}$ . . . . . . . . . . Unknown station.

    B . . . . . . . . . . . More to follow.

    C . . . . . . . . . . . Correct.

    EEEEEEEE . . . Error

    EEEEEEEE $\overline{\text{AR}}$ . This transmission is in error. Disregard it.

    $\overline{\text{HM}}$ $\overline{\text{HM}}$ $\overline{\text{HM}}$ . . . . Emergency silence sign.

    $\overline{\text{IMI}}$ . . . . . . . . . Repeat.

    $\overline{\text{INT}}$ . . . . . . . . . Interrogative.

    J . . . . . . . . . . . Verify with originator and repeat.

    NR . . . . . . . . . . Station serial number.

    R . . . . . . . . . . . I received your last transmission satisfactorily.

## OPERATING SIGNALS

Radio and teletype operators frequently exchange routine advice and operating information. They occasionally relay emergency communication instructions or reports to other ships and stations and to aircraft. Traffic of this nature is transmitted in condensed standard form by means of operating signals consisting of three-letter groups beginning with Q or Z. These signals—of which there are several hundred—represent words, phrases, or complete sentences. In effect, they are a form of shorthand, eliminating time-consuming plain language transmissions. The Q signals are employed in both military and civil communications, and are understood by ships and shore stations of any nationality. The Z signals are for use only in the United States and Allied military communications, and represent meanings not found in the Q code. Both Q and Z signals can be used together, when necessary, in military communications. Operating signals are published in ACP 131. It has decode sections for both Q and Z signals, indexed alphabetically, and an encode section tabbed by subject matter.

## USE OF OPERATING SIGNALS

Operating signals are prescribed for every form of electrical telecommunication except radiotelephone. Instead of using customary operating signals, a radiotelephone operator transmits operating information in brief spoken phrases. An exception to this rule is made when a message containing an operating signal is relayed by radiotelephone; then the operator transmits the group phonetically.

Many operating signals may be used in either of two ways–as a question or as a statement. The prosign INT before a signal places it in the form of a question. Example: USS Epperson (DD 719) asks USS Renshaw (DD 499): NWBJ DE NTGT INT QRU K, meaning "Have you anything for me?" Renshaw replies: NTGT DE NWBJ QRU AR, meaning "I have nothing for you."

When communicating with nonmilitary stations, the prosign IMI, after the Q signal, is employed instead of INT ahead of the Q signal to give an interrogatory meaning.

Some signals must be accompanied by a numeral suffix that completes, amplifies, or varies the basic meaning. Example: A teletype operator checks circuit operation with the query INT ZBK, meaning "Are you receiving my traffic clear?" The receiving station has a choice of replies: ZBK1 means "I am receiving your traffic clear," or ZBK2, "I am receiving your traffic garbled."

Many operating signals contain blank portions in their meanings that are filled in to convey specific information. To illustrate, INT ZRE means "On what frequency do you hear me best?" In ACP 131 the declaratory meaning listed for ZRE is "I hear you best on ______ kc (mc)." The operator fills in the necessary information thus: NTGT DE NWBJ ZRE A2C, which means "I hear you best on A2C." The circuit designator from JANAP 195 is used instead of the frequency.

Other signals, in their meanings, have blanks enclosed in parentheses. Filling in such a blank is optional. For example, INT ZHA means "Shall I decrease frequency very slightly (or _____ kc) to clear interference?" The operator receiving the signal INT ZHA without the frequency added knows it means "Shall I decrease frequency very slightly?"

During wartime, operating signals often are encrypted, especially those revealing–

1. Specific frequencies.
2. Cryptographic data.
3. The organization of networks.
4. Ship movements (estimated times of arrival, departure, and kindred data).

Unless they are encrypted, operating signals possess no security and must be regarded as the equivalent of plain language.

Some of the most commonly used operating signals are listed in table 5-4. Remember that the Q code is used internationally, and speaks of "telegrams" where a U. S. Navy communicator would say "messages."

## BASIC MESSAGE FORMAT

With a few exceptions, military messages sent by electrical telecommunications are arranged according to a standard joint form called the basic message format. The form is substantially the same whether the message goes by radiotelegraph, radiotelephone, manual teletype, or by automatic tape equipment. The format exists in four versions, one of which is adapted to special requirements of each of these primary transmission media. The radiotelegraph message format is studied here. You will read about the other formats in later chapters, but if you learn the one given here you will have little trouble understanding any message.

All messages in joint form have three parts: heading, text, and ending. (Of the three parts, the most complex is the heading, which often uses as many as 10 of the format's 16 lines.) Heading, text, and ending are divided into components. Each component, in turn, contains one or more elements. From left to right, in table 5-5, the message is divided into its parts, components, and elements. The heading for example, consists of the following components: beginning procedure, preamble, address, and prefix. Elements of the beginning procedure (see "Elements" column) consist of the call, transmission identification, and transmission instructions. Contents of the call are station(s) called, prosign XMT and exempted calls (if required), and the prosign DE and designation of calling station.

It is well to consider each item in the heading separately. Each has a special meaning, and its relative position is significant. Prosigns, call signs, address groups, and other contents that make up a typical heading must

Table 5-4.—Operating Signals

| Signal | Question | Answer, Advice, or Order |
|---|---|---|
| QRK | What is the readability of my signals (or those of________)? | The readability of your signals (or those of________) is__ _______(1 to 5). |
| QRM | Are you being interfered with? | I am being interfered with. |
| QRO | Shall I increase power? | Increase power. |
| QRP | Shall I decrease power? | Decrease power. |
| QRU | Have you anything for me? | I have nothing for you. |
| QSA | What is the strength of my signals (or those of________)? | The strength of your signals (or those of________) is___ _______(1 to 5). |
| QSV | Shall I send a series of Vs on this frequency [or_______kc (or mc)]? | Send a series of Vs on this frequency [or______kc (or mc)]. |
| QSY | Shall I change to transmission on another frequency? | Change to transmission on another frequency [or on______ ___kc (or mc)]. |
| ZAR | . . . . . . . . . . . . . . . . . . . . . . . . . . | This is my_____request (or reply). [(1) First, (2) second, (3) third, etc.] |
| ZBK | Are you receiving my traffic clear? | I am receiving your traffic_______[(1) clear; (2) garbled]. |
| ZDK | Will you repeat message__________(or portion __________)? Or, rerun No._______? | Following repetition (of_______) is made in accordance with your request. |
| ZEC | Have you received message_____________? | Message____________[(1) not received, (2) unidentified, give better identification data]. |
| ZEN | . . . . . . . . . . . . . . . . . . . . . . . . . . | This message has been delivered by other means or by a separate transmission to the addressee(s) immediately following this operating signal. |
| ZEX | . . . . . . . . . . . . . . . . . . . . . . . . . . | This is a book message and may be delivered as a single address message to addressees for whom you are responsible. |
| ZFH | . . . . . . . . . . . . . . . . . . . . . . . . . . | This message (or message________) is being (or has been) passed to you (or_____) for________[(1) action, (2) information, (3) comment]. |
| ZFI | Is there any reply to message_____________? | There is no reply to message__________. |
| ZIA | . . . . . . . . . . . . . . . . . . . . . . . . . . | This message (or message_______) is being (or has been) passed out of proper sequence of station serial numbers. |
| ZII | What was____of your (or_____'s) number_____? [(1) date-time group, (2) filing time]. | My (or____'s) number______had following_____ [(1) date-time group, (2) filing time]. |
| ZKP | Are you (or is _____) radio guard for__________ [on______kc (or mc)]? | I am (or______is) radio guard for________ [on______kc or mc)]. |
| ZNB | What is authentication of______ [(1) message__ _____, (2) last transmission, (3) _______]? | Authentication (of____) is_______ [(1) message______, (2) last transmission, (3) __________]. |
| ZOC | . . . . . . . . . . . . . . . . . . . . . . . . . . | Station(s) called relay this message to addressees for whom you are responsible. |
| ZON | . . . . . . . . . . . . . . . . . . . . . . . . . . | Place this message (or message______) on broadcast indicated by numerals following_______(numeral may be followed by specific broadcast designator) [(1) NSS; (2) NPG; (3) NPM; (4) NBA; (5) NPN; (6) NPO; (7) NHY; (8) NAM; (9) NAF; (10) NPL; (11) NDT]. |
| ZOV | . . . . . . . . . . . . . . . . . . . . . . . . . . | Station designation preceding this operating signal is the correct routing for this message rerouted by______. |
| ZUE | . . . . . . . . . . . . . . . . . . . . . . . . . . | Affirmative (Yes). |
| ZUG | . . . . . . . . . . . . . . . . . . . . . . . . . . | Negative (No). |
| ZUI | . . . . . . . . . . . . . . . . . . . . . . . . . . | Your attention is invited to ____________________. |
| ZUJ | . . . . . . . . . . . . . . . . . . . . . . . . . . | Standby. |

76.42

**Table 5-5.–Radiotelegraph Message Format**

| Parts | Components | Elements | Format Line | Contents |
|---|---|---|---|---|
| HEADING | Beginning procedure | Handling instructions | 1 | Not used in radiotelephone and radiotelegraph. |
| | | a. Call | 2 | Station(s) called; prosign XMT (exempt) and exempted calls. |
| | | | 3 | Prosign DE (from) and designation of station calling. |
| | | b. Transmission identification | | Station serial number. |
| | | c. Transmission instructions | 4 | Prosign T (relay); G (repeat this transmission back to me exactly as received); F (do not answer); operating signals; call signs, address groups, plain language. |
| | Preamble | a. Precedence; date-time group; message instructions | 5 | Precedence prosign; date-time group and zone suffix; operating signals; prosign $\overline{IX}$ (execute to follow). |
| | Address | a. Originator's sign; origniator | 6 | Prosign FM (orignator of this message is); originator's designation expressed as call sign, address group, or plain language. |
| | | b. Action addressee sign; action addressee(s) | 7 | Prosign TO; action addressee designation(s) expressed as call signs, address groups, address indicating groups, or plain language. |
| | | c. Information addressee sign; information addressee | 8 | Prosign INFO (this message addressed for information to); information addressee designation(s) expressed as call signs, address groups, or plain language. |
| | | d. Exempted addressee sign; exempted addressee(s) | 9 | Prosign XMT; exempted addressee designation(s) expressed as call signs, address groups, or plain language. |
| | Prefix | a. Accounting information; group count; SVC | 10 | Accounting symbol; group count; SVC (this is a service message). |
| SEPARATION | | | 11 | Prosign $\overline{BT}$ (break). |
| TEXT | Text | a. Subject matter | 12 | Internal instructions; basic idea of originator. |
| SEPARATION | | | 13 | Prosign $\overline{BT}$. |
| ENDING | Ending procedure | a. Time group | 14 | Hours and minutes expressed in digits and zone suffix, when appropriate. |
| | | b. Final instructions | 15 | Prosigns B (more to follow); $\overline{AS}$ (I must pause); C (I am about to correct a transmission error in some foregoing part of this message); operating signals. |
| | | c. Ending sign | 16 | Prosign K (go ahead and transmit), or $\overline{AR}$ (end of transmission). |

76.43

always appear in the order specified for the means of transmission.

It should be understood that there is no relationship between format lines and types or handwritten lines. Format line 12, for example, is the text of the message and may consist of many written lines.

The form of the message and its transmission requirements dictate which components, elements, and contents will be used in the heading. Format line 1 is used only in teletype and tape relay work; it is omitted in radiotelephone and radiotelegraph. The abbreviated plaindress heading (discussed later) may omit any or all of the following elements: precedence, DTG, and group count. Many messages not in abbreviated plaindress omit such elements as transmission instructions, information addressee data, and final instructions because there is no need for them. For this reason, the messages themselves are much simpler than the basic message format, which must provide for all components and elements. You seldom see a message with every format line, and you may never see one that uses all the contents. Remember that the sequence actually appearing in any one message must be in accordance with the proper message format.

It is impossible in a training course such as this to show how to construct headings to meet every eventuality. Your Chief or senior Radioman has handled thousands of messages, and can explain a greater variety of message examples for you. Make it your rule to read every message you handle. Take a good look through the message files in your ship or station. Doctrinal communication publications, which are available on the job, provide you with valid, up-to-date sources of operational communication information.

## PRELIMINARY CALL

A preliminary call is for the purpose of establishing radiotelegraph communications before transmitting a message. A preliminary call also alerts the receiving operator to prepare to copy a message.

A simple preliminary call consists of the station called, prosign DE, calling station, and the prosign K. If desired, precedence of the message may be included. Two examples of a preliminary call are (1) NCFX DE NAUC K and (2) NCFX DE NAUC P K.

From earlier discussion of call signs, it is apparent that transmission of a preliminary call is sent from one U. S. Navy ship to another. A check of the call sign book shows that NCFX is USS Radford (DD 446) and NAUC is USS Philip (DD 498). In the second example, Philip's operator indicates that he has a priority message for Radford. When ready to copy the message, Radford's operator gives the go-ahead by transmitting: NAUC DE NCFX K.

## RADIOTELEGRAPH MESSAGE ANALYSIS

With communication established, Philip commences clearing traffic. The message is analyzed as follows:

| Format line | Transmission | Explanation |
|---|---|---|
| 2 and 3 | NCFX DE NAUC | Radford from Philip. |
| 5 | -P- 222345Z Nov 67 | PRIORITY precedence. DTG, indicating that this message was originated at 2345 GMT, on the 22d day of the month. |
| 10 | GR8 | Group count. This message has 8 groups in the text. (A plain language word counts as 1 group.) |
| 11 | $\overline{\text{BT}}$ | Break. Separation between heading and text. |
| 12 | UNCLAS GUARD MAIL FOR YOU AT FIRST LIGHT. | Text. |
| 13 | $\overline{\text{BT}}$ | Break. Separation between text and ending. |
| 16 | K | Go ahead and transmit. |

On receiving prosign K, Radford's operator checks the message and counts the groups in the text. If he missed some of the message, or doubts that he received a portion correctly, he requests and obtains a repetition of the missed or doubtful portions. When certain that he has the message complete and correct, he so informs the Philip by transmitting: NAUC DE NCFX R AR. This transmission is called a receipt.

In the preceding example, two ships were in direct communication, and Radford's call sign served to address the message to that ship. A message that must undergo relay to reach the addressee requires a somewhat longer and differently constructed heading.

Every station handling the message must realize (1) who originated the message, (2) who receives the message for relay, and (3) to whom the message ultimately is destined.

Assume that USS Ranger (CVA 61), steaming off Cristobal, Panama, completes her mission of qualifying carrier pilots and wishes to so report to COMNAVAIRLANT (in Norfolk) and to Jacksonville (Fla.) Naval Air Station. Communication is established with NAVCOMMSTA Balboa, the nearest U. S. Naval shore radio station, and transmission of the message commences. Note use of the information addressee prosign.

| Format line | Transmission | Explanation |
|---|---|---|
| 2 and 3 | NBA DE NHKG - | NAVCOMMSTA Balboa from Ranger. |
| 4 | T - | Relay this message to all addressees. |
| 5 | R - Ø11324Z Nov 67 - | ROUTINE precedence. DTG. |
| 6 | FM NHKG - | Originator, USS Ranger. |
| 7 | TO YONA - | Action to COMNAVAIRLANT. |
| 8 | INFO OJWN | Information to NAS Jacksonville. |
| 10 | GR6 | Group count of text groups. |
| 11 | BT | Break. |
| 12 | UNCLAS CARQUALS COMPLETED. ETA GTMO Ø314ØØZ | Text. Certain authorized abbreviations, standard throughout the services, are used in messages for sake of brevity. The version as sent is 60 percent shorter than the expanded text, which reads: CARRIER QUALIFICATIONS COMPLETED. ESTIMATED TIME OF ARRIVAL GUANTANAMO BAY Ø314ØØZ. |
| 13 | BT | Break. |
| 16 | K | Go ahead and transmit. |

Radio Station NBA gives Ranger a receipt for the message, and by doing so assumes responsibility for relay.

Here is an example of a type of message you will see often. This is a fleet broadcast message from NAVCOMMSTA Washington, originated by CNO. Note the exempted addressee prosign. Fleet broadcast messages via CW repeat each element of the heading, except when the addressees are designated by plain language. Plain language designators are transmitted only one time.

| Format line | Transmission | Explanation |
|---|---|---|
| 2 and 3 | NERK NERK NERK DE NSS NSS NSS | Any or all U.S. Navy ships from NAVCOMMSTA Washington. (This call is sent with the first message of each hourly schedule, omitted thereafter.) |
| 4 | W NR 522 W NR 522 - | NAVCOMMSTA Washington broadcast serial number 522—that is, the 522d message placed on this broadcast schedule since the beginning of the current month. |

| Format line | Transmission | Explanation |
| --- | --- | --- |
| 5 | PP - | PRIORITY precedence to action addressees. |
| 5 | RR - | ROUTINE precedence to information addressees. |
| 5 | 11Ø847Z Nov 67 11Ø847Z Nov 67 | DTG. |
| 6 | FM FM | Originator's prosign. |
| 6 | CNO - | Originator. |
| 7 | TO TO | Action addressee prosign. |
| 7 | All ships NAVAIRLANT - | Action addressee(s). |
| 8 | INFO INFO | Information addressee prosign. |
| 8 | NAS GTMO - | Information addressee. |
| 9 | XMT XMT | EXEMPTED addressee prosign, meaning that stations or addressees that follow are exempted from foregoing collective address–in this instance, the action addressee. |
| 9 | USS Saratoga | Exempted addressee. |
| 10 | GR156 GR156 | Group count. |
| 11 | $\overline{\text{BT}}$ | Break. |
| 12 | (156 groups text) | Text. |
| 13 | $\overline{\text{BT}}$ | Break. |
| 16 | $\overline{\text{AR}}$ | This is the end of this transmission and no receipt is required or expected. |

## PLAIN LANGUAGE TEXT

A standard textual format is prescribed for plain language messages. The format is designed to make maximum use of capabilities of teletypewriter equipment, thereby eliminating much of the processing formerly required for incoming messages. It also decreases originator's preparation time and addressee's comprehension time.

Exempt from the standard format are messages with very short texts, such as tactical messages, and messages employing a firmly established format, such as standard "reporting type" messages that use letters of the alphabet to indicate a prearranged subject matter. For messages received for relay by other means than teletype (for example, those received via a CW circuit), the communication center accepting the message is responsible for assuring that the elements are in proper sequence before relaying. If all of the elements are required, they must appear in the following order.

1. Classification or abbreviation UNCLAS.
2. Special category markings (EXCLUSIVE, COSMIC, and the like).
3. Special handling security markings (NOFORN, RESDAT, and so on).
4. Exercise identification (EXERCISE MAIN BRACE).
5. Code name or nickname of special projects or operations.
6. Flag word (EXPRESS, REDLINE, etc.).
7. Passing instructions and other indications of message distribution (FOR________).
8. Subject line, concise and untitled.
9. References, identified by letter(s).
10. Text:
    a. Paragraphs are numbered.
    b. Subparagraphs are indented and lettered or numbered as appropriate.
    c. In a one-paragraph message, any subparagraphs are lettered.
    d. If a message is classified, proper downgrading/declassification markings are included.

Following is an example of a message employing most of the elements of the standard text format.

CONFIDENTIAL NOFORN
COMTWELVE PASS TO FADM SMITH
REVISED CONFERENCE SCHEDULE
A. MY Ø917ØØZ Nov 67
B. COMTHIRTEEN 13153ØZ Nov 67
1. REQUEST DESIGNATED COMMITTEE ARRIVE COMTWELVE 24 HOURS PRIOR CNO
2. AGENDA:
A. ADD "LOGISTICS OF PROJECT."

B. DELETE "POSSIBLE LOCATION FACILITIES."
3. CNO ITINERARY, 19 AUG, TIMES UNIFORM:

| ETA | ETD | LOCATION |
|---|---|---|
| ORIG | 13ØØ | NAS SEATTLE |
| 1515 | 18ØØ | NAS ALAMEDA |
| 23ØØ | TERM | CHICAGO-OHARE |

GP 4

If a message does not require all of the elements, the format is adjusted accordingly by omitting nonessential elements. Certain other exceptions are allowed when using the standard format.

The subject line may be omitted if it necessitates that an otherwise unclassified message be classified, noticeably increases the length of what would be a brief message, or increases commercial charges when the message is addressed to activities served by commercial communication facilities.

If a short message consists of only one paragraph, the paragraph is not numbered. When there is only one reference, the reference identification is included in the body of the paragraph. Example:

UNCLAS
YOUR 1ØØ915Z Nov 67. BUDGET APPROVED SUBJECT CNO CONCURRENCE

The number of characters and spaces on each teletypewriter line is limited to 69.

## MESSAGE PARTS THAT MAY NOT BE CHANGED

Certain portions of a message are fixed by the originator, and may not be changed by anyone else. This rule is necessary to ensure the reliability of communications. No one knows better than the originator what the message should say, to whom it should be delivered, or what precedence it should carry. Changes in these message components are forbidden: (1)-preamble, (2) address, (3) prefix, and (4) text.

## MESSAGES BETWEEN COMMUNICATION PERSONNEL

Procedure messages and service messages between communication personnel are for the purpose of expediting the handling of message traffic. Both types of messages make maximum use of prosigns and operating signals to shorten message length and transmission time. Although procedure messages and service messages are in everyday usage in handling messages, you are likely to hear friendly argument among Radiomen about differences in the two types.

### PROCEDURE MESSAGES

Procedure messages obtain and provide corrections, verifications, and/or repetitions. The text of a procedure message contains only prosigns, operating signals, address designations, identification of messages or parts of messages, and any necessary amplifying data. A procedure message may contain any of the components shown in the basic format, except that the break prosign ($\overline{\text{BT}}$) is used only if the DTG is included. The DTG, in turn, is employed only when it is necessary to show time of origin, or when further references may be made to the procedure message. You will find the most common use of procedure messages in radiotelegraph circuit operation. Examples are given in chapter 6.

### SERVICE MESSAGES

Service messages pertain to any phase of traffic handling (including requesting and giving corrections and repetitions of messages), communication facilities, or circuit conditions. Most service messages are concerned with the handling of messages. Less frequently they deal with communication facilities or circuit conditions, which accounts for the occasional confusion between procedure messages and service messages. The majority of both types are used to obtain corrections and repetitions of messages or parts of messages. Service messages, however, are prepared and transmitted as regular messages, and contain all the necessary format lines, including DTG and $\overline{\text{BT}}$. They may even be encrypted, but in an encrypted service message, you cannot recognize it as a service message–purposely so, for security reasons. It is identified as a service message only within the encrypted text. You can recognize plain language service messages easily by one or more of the following characteristics:

1. Reference to another service message;

2. Abbreviation SVC in the prefix or as the first word of the text;
3. That it is addressed specifically to a communication center.

In teletypewriter tape relay operations, if the tributary station is not in direct communication with any station but its own relay station, service messages are used when necessary to question the originating station about a message. Examples are given in chapter 11.

## BASEGRAM SYSTEM

The basegram system of delivery is for general messages of insufficient operational importance to warrant immediate delivery to ships by the fleet broadcast method. Originators of general messages decide which messages may be designated basegrams. The purpose of basegram delivery is to keep the fleet broadcast free for operational traffic. Strategically located shore stations, acting as basegram delivery authorities, furnish copies of basegrams to ships in ports from which U.S. Navy ships normally operate.

Basegrams and all other general messages are delivered by teletypewriter throughout the shore communication system. Broadcast stations, although they receive basegrams by rapid means, normally do not broadcast the actual basegrams. Instead, they originate and broadcast a procedure message, indicating that the general message is being delivered as a basegram. Operating signal ZFO (Message_______ is being delivered as a basegram) is transmitted, along with the message identification. Example:

WR NR34Ø4
R 11Ø254Z Nov 67
FM NSS
TO NERK
BT
UNCLAS
ZFO ALNAV 1Ø192ØZ/Ø5 Nov 67
BT
AR

Broadcast stations are permitted to send basegrams on the fleet broadcast if all other traffic is cleared and free circuit time exists.

All ships are required to keep a general message receipt log. Usually, a standard ledger-type book is used for this purpose, with columns ruled and labeled to indicate general messages that were received and basegrams for which only procedure messages (ZFOs) were received. The ZFO procedure message is always placed in the appropriate general message file until it is replaced by the actual general message basegram.

Aboard ship, your leading Radioman will send you ashore to pick up basegrams as soon as you arrive in port, at frequent intervals while in port, and immediately before getting underway. Be sure to take along the general message logbook, because the basegram office has no other way of knowing which general messages your ship lacks.

When you obtain copies of basegrams from the basegram office, you will notice the word BASEGRAM near the beginning of the text. Additionally, the message heading bears the operating signal ZFP, meaning BASEGRAM, after the DTG.

Upon receipt, basegrams are written up and routed the same as any other general message.

## FORMS OF MESSAGES

A military message may be drawn up in any one of the following forms: plaindress, abbreviated plaindress, or codress.

### PLAINDRESS MESSAGES

A plaindress message has originator and addressee designations in the heading. Unless the call serves as the address, the message contains all components (but not necessarily the elements) prescribed by the message format –with one exception: The prefix may be omitted. All foregoing examples of radiotelegraph messages are in plaindress form. Call signs and address groups in plaindress messages may be encrypted for a degree of security.

### ABBREVIATED PLAINDRESS MESSAGES

Operational requirements for speed of handling–of contact reports, for example–may dictate the abbreviation of plaindress message headings. At such times, any or all of the following elements may be omitted from the heading: precedence, date, DTG, and group count.

CODRESS MESSAGES

Codress is an encrypted message form in which originator and addressee designations (as well as additional passing instructions, if any) are buried in the encrypted text. Codress is a valuable security device in that it conceals the identity of units and prevents an enemy from making inferences from originator-addressee patterns.

Plaindress and codress forms may be compared from the following message prepared in both versions. Assume that Task Group (TG) 66.1 is conducting exercises in the Mediterranean. Commander Task Group (CTG) 66.1 wishes to order the beginning of a new phase of operations, the message to be addressed action to TG 66.1, and information to COMCRUDESLANT and COMASDEFORLANT. The USS Joseph K. Taussig (DE 1030), although a part of the task group is on detached duty and not participating. Following are the call signs and address groups.

| | |
|---|---|
| CTG 66.1 | E2L4 |
| TG 66.1 | K3M3 |
| COMDESLANT | HAPA |
| COMASDEFORLANT | SNDS |
| USS Joseph K. Taussig | NFFN |

1. For the plaindress version, call signs are encrypted in accordance with current instructions. Example:

K3M3 - XMT - NFFN DE E2L4 -
P - 18Ø934Z Nov 67 - FM E2L4 -
TO K3M3 -
INFO HAPA
SNDS -
XMT NFFN
GR35
BT
15268 ALFA BRAVO CHARLIE DELTA
ECHO MNPTX WQLTP . . . etc. (code groups–1Ø groups in each line)
BT
K

The message will also go, with a slightly different heading, on a separate circuit to the nearest shore radio station, for relay to the information addressees.

2. In the codress version, NERK and NA are indefinite ships' call signs. Example:

NERK DE NA -
P - 18Ø934Z Nov 67
GR57
BT
15268 ALFA BRAVO CHARLIE DELTA
ECHO RLPZC . . . etc. (code groups–1Ø groups in each line)
BT
AR

The only information an enemy might recover from the codress message is that it (1) was sent from one U. S. Navy ship to another; (2) is of PRIORITY precedence; and (3) originated at 18Ø934Z. Moreover, this is the only information available to bona fide recipients, who must decrypt the message to learn for whom it is intended. (The Joseph K. Taussig needs to break the message only far enough to learn she is exempted.)

Codress message texts are somewhat longer than their plaindress counterparts, because the originator and addressees are in the text. The originator and addressees are designated within the text by plain language, not by call signs or address groups.

READDRESSING MESSAGES

At times an originator or an addressee wants to readdress a message to other ships or activities not included in the original address. The following rules apply:

1. All format lines preceding line 5 (precedence, DTG) of the original message heading are deleted.
2. No alteration can be made to the original message from the precedence to the end of the text.
3. A supplementary heading is inserted in front of the original heading.
4. The precedence indicated in the supplementary heading pertains to the supplementary address only.
5. The DTG of the original message is used for purposes of reference, reply, and filing.

Assume that, on receipt of the following plaindress message, NTAA readdresses it to NUYO for information. Here is the original message received from NTSY:

NTAA DE NTSY -
P - 281634Z Nov 67 -

FM NTSY -
TO NTAA -
INFO NBFJ
GR32
$\overline{BT}$
TEXT
$\overline{BT}$

Station NTAA adds his supplementary heading and transmits to NUYO the following message:

NUYO DE NTAA -
R - 281832Z Nov 67 -
FM NTAA -
INFO NUYO -
P - 281634Z Nov 67
FM NTSY -
TO NTAA -
INFO NBFJ
GR32
$\overline{BT}$
TEXT
$\overline{BT}$

## ADDITIONAL MESSAGE EXAMPLES

Additional message examples are described in later chapters of this manual. Radiotelegraph operating procedure is explained in chapter 6. Radiotelephone messages and operating procedure are treated in chapter 7. Chapter 11 is devoted to teletypewriter communications.

# CHAPTER 6

# RADIOTELEGRAPH

Radiotelegraph operating procedure explained in this chapter is important to a Radioman. Teletype and radiotelephone procedures described in later chapters really are adaptions of this basic communication procedure and are easily understood by an operator versed in radiotelegraph procedure.

Radiotelegraph procedure is used also to establish and maintain communications on facsimile circuits. A brief discussion of facsimile procedure is included in this chapter.

The effective edition of ACP 124 contains operating instructions for radiotelegraph communications. Chapter 9 of DNC 5 (effective edition) presents an expansion of the material and modifications, where necessary, for Navy and Marine Corps usage. Another publication, Supplement 1 to ACP 124, details procedures followed by the United States, the British Commonwealth nations, and France on their naval broadcast, ship-shore, and intercept circuits.

The previous chapter explained call signs, prosigns, and operating signals. The purpose of the present chapter is to show how they are employed in circuit operation.

## CIRCUIT DISCIPLINE

It was learned in chapter 3 that radio is potentially the least secure of all the various means of communication. One way in which a Radioman can improve transmission security is by his observance of strict circuit discipline.

Circuit discipline is the part of transmission security that includes the proper use of radio equipment, net control, monitoring and training, adherence to prescribed frequencies and operating procedure, and remedial action. Lack of circuit discipline and lack of operator training, as well as negligence, inaccuracy, and laxity, are responsible for violations that endanger radio transmission security.

Although circuit discipline is discussed here in connection with radiotelegraph procedure, Radiomen must understand that any requirement for circuit discipline applies as well to operating teletype and radiotelephone.

Every operator must recognize and avoid the following malpractices that endanger communication security:

1. Linkage or compromise of classified call signs and address groups by plain language or association with unclassified call signs.
2. Linkage or compromise of encrypted call signs and address groups by association with other call signs, address groups, or plain language. (Example: use of encrypted call signs in the call and unencrypted call signs in the message address.)
3. Misuse and confusion of call signs, routing indicators, address groups, and address indicating groups. This practice may result in the nondelivery of an important message, a compromise, or the linking of classified and unclassified call signs and address groups.
4. Violation of EMCON conditions of radio silence.
5. Unofficial conversation between operators.
6. Transmitting in a directed net without permission.
7. Transmitting the operator's personal sign.
8. Excessive repetition of prosigns or operating signals.
9. Individual mannerisms in transmitting. The peculiar style of an operator's sending may frequently identify a unit or station even when frequency and call signs are changed. This usage applies to both transmitting and procedural peculiarities.

10. Use of plain language in place of applicable prosigns or operating signals.
11. Use of unauthorized prosigns.
12. Unnecessary transmissions.
13. Incorrect and unauthorized procedure.
14. Identification of unit locations.
15. Identification of individuals belonging to an organization.
16. Excessively long calls. When a station is called and does not answer within a reasonable time, presumably because a condition of radio silence prevails, the message should be transmitted blind or put on the appropriate broadcast schedule. When a unit afloat calls a shore station on a ship-shore circuit and receives no answer within a reasonable time, the ship should deliver the message via any available station, using an indefinite shore station call sign if necessary.
17. Failure to maintain radio watches on designated frequencies and at prescribed times.
18. Transmitting at speeds beyond the capabilities of receiving operators.
19. Use of excessive transmitting power.
20. Tuning transmitters with antenna connected.
21. Excessive time consumed in tuning, testing, changing frequency, or adjusting equipment.
22. Use of profane, indecent, or obscene language.

Radiomen may be surprised at such a long list of incorrect ways of performing on circuits. Yet, each error must be avoided if transmission security is to be attained. A recent monitor study of transmission errors revealed that unnecessary transmissions alone accounted for over 17 percent of all errors noted. Transmitting too fast, with resulting improper spacing and character formation, accounted for another 10 percent of the errors. In circuit operating, as in most other work, there is no substitute for commonsense.

A competent operator always observes proper circuit discipline. Here is a guide to the general qualifications of a qualified radio operator.

1. Receives hand sending at prescribed speed and does not receipt (ROGER) for a message until he checks the group count and message indicators, and understands the transmitting instructions.
2. Sends accurately, at moderate speed, both letters and numbers.
3. Knows the executive method.
4. Makes up, pads, and encrypts any call sign.
5. Logs everything he hears on the frequency he is guarding.
6. Knows when and how to authenticate.
7. Uses only prescribed procedure.
8. Is familiar with the communication plan for his own force and for the operating area.
9. Uses accurate operating signals.
10. Tunes any transmitter on board his ship within 3 minutes with calibrated settings or with frequency meter, and with no radiation from the antenna until the last stage and coupling are given final adjustment.
11. Patches any receiver or transmitter to remote positions for single- or multiple-control operation.

## NETS

A net is an organization of two or more stations in direct communication on a common channel. One station in the net—the net control station (NCS)—is in charge. Usually the station serving the senior commander is designated as net control. It may be another station if that station is in better position to control the net.

Duties of the net control station are to speed flow of traffic on the net, maintain circuit discipline, limit transmissions to the essential minimum, settle disputes incident to traffic handling, and monitor the net so that corrective action can be taken against poor operating practices. When deemed advisable, the NCS prescribes the speed of transmission, or the qualifications of the operators to be employed during specific periods. Net control may authorize the use of speed keys (bugs) if traffic conditions warrant and if operators hold speed key certificates. (The effective edition of DNC 5 lists the qualifications for speed key operators.)

An alternate net control station ordinarily is designated to take charge of the net when the normal NCS is inoperative for any reason. When in control of the net, the alternate NCS assumes all the responsibilities of the NCS.

## DIRECTED AND FREE NETS

Large nets and nets handling many messages usually operate as directed nets, which means that no station may transmit a message without calling and obtaining permission from net control. Nets not requiring strict control may operate as free nets. As such, the controlling station authorizes member stations to send their messages without obtaining prior permission

## COMMAND, OPERATIONS/ADMINISTRATION, AND FUNCTIONAL NETS

Nets are classified into three types according to mission or purpose: (1) command, (2) operations/administration, and (3) functional.

A command net links a commander with his immediate subordinates in the chain of command, and with any other units that may be designated. A task force command net, for example, is activated by the task force commander and is guarded by the task group commanders.

An operations/administration net is one linking all ships or troop units of a designated task organization.

A functional net is for direct communication between personnel in charge of the specific task for which the net is provided. An example of a functional net is a picket reporting net guarded by anti-air warfare (AAW) picket vessels and controlled by a sector AAW ship.

## TYPES OF RADIO WATCHES

Radiomen stand four types of radio watches. Requirements of each type are prescribed in the effective communications plan as follows:

1. Guard: A continuous receiver watch is required with a transmitter ready for immediate use. A complete log must be kept.
2. Cover: A continuous receiver watch is kept, with transmitter calibrated and available, but not necessarily for immediate use. Requires a complete log.
3. Copy: A continuous receiver watch is maintained, and a complete log is kept.
4. Listen: A continuous receiver watch is maintained. A complete log is optional.

The four types of watches do not, however, provide a Radioman with a choice. The communication plan under which a ship or station is operating directs the type of watch to be stood.

## SPLIT-PHONE WATCH

Owing to a shortage of Radiomen, there may be times when an operator must guard two frequencies at the same time. This method, called a split-phone watch, requires the operator to listen on both frequencies. Obviously, he cannot receive two messages simultaneously. If he is called on both frequencies at the same time, he tells one station to wait until the message is received from the other. This procedure is done by either using the prosign $\overline{AS}$, meaning "Wait," or the operating signal ZKF, meainng "Station leaves net temporarily." If desired, the operating signal may be followed by the time in minutes that the operator expects to be off the circuit, the call sign of the station working, and the circuit frequency designator.

When establishing a split-phone watch, the operating signal ZKV, meaning "I am standing split-phone watch on ___ kc (or mc)" may be sent to advise other ships or stations in the net. Circuit designators from JANAP 195 (effective edition) normally are used instead of figures to designate the frequency.

## METHODS OF RADIO TRANSMISSION

Three principal methods of handling traffic by radio are employed. They are the receipt method, intercept method, and broadcast method.

## RECEIPT METHOD

In the receipt method of radio transmission, the receiving station sends a receipt to the transmitting station for each message or sequence of messages. This method is the normal way of handling radiotelegraph point-to-point, ship-to-ship, ship-to-shore, and aircraft traffic. The receipt method is the most reliable, because there is no doubt of the addressee's receipt of the message. Repetitions and corrections may be obtained as necessary at the time of transmission.

A disadvantage of the receipt method in wartime is that it requires the use of transmitters by both stations. The presence of both stations is thereby disclosed, and their positions can be determined by direction finding.

INTERCEPT METHOD

In the intercept method of radio transmissions, the transmitting station sends to a second station. The second station is not the addressee but, under the plan, obtains necessary repetitions to ensure correct reception then repeats the message. Messages thus transmitted are actually intended for other stations that copy the transmissions but do not receipt for them nor use their transmitters in any way. The chief advantage of this method of radio transmission is that the locations of the addressees are not disclosed.

Currently, the intercept method is not used by the Navy.

BROADCAST METHOD

In the broadcast method, shore stations transmit serially numbered messages at scheduled times. Receiving stations maintain a complete file of the messages but do not receipt for them. The main advantage of the broadcast method is that stations addressed do not answer, thus avoiding disclosure of their positions.

The broadcast method has attained such a high degree of reliability that it is the primary means of delivering traffic to the fleet. Reliability is increased by using tremendously high-powered transmitters, simultaneous keying of several different frequencies, and serially numbered messages so that ships can tell if any messages are missed.

Automatic keying for CW broadcasts is at speeds between 16 and 29 words per minute. The slower speed affords an excellent opportunity for strikers to improve their code speed.

The fleet broadcast areas and their identifying designator letters were illustrated in chapter 2. Most naval ships are now equipped to copy radioteletype broadcasts. A ship copying the RATT broadcast is not required to copy the CW broadcast. This exception does not mean, however, that the CW broadcast is unimportant, because RATT broadcasts are closed down periodically for equipment maintenance. During these periods it is necessary for the RATT-equipped ships to shift to CW broadcast. A prompt shift to CW broadcast is also necessary if the RATT broadcast cannot be copied because of equipment failure or poor receiving conditions.

For many years the broadcast method was commonly called the "Fox broadcast" owing to the former phonetic meaning of the prosign F, which means "Do not answer," Since the latest revision of the phonetic alphabet, which changed Fox to Foxtrot, the single title Broadcast is officially preferred. Oldtimers, however, have been copying "Fox Skeds" for so many years that one seldom hears them called otherwise.

Broadcast Operator Periods

Because of a shortage of Radiomen, it has become necessary to establish one- and two-operator periods for guarding CW broadcasts. Ships having only one Radioman are required to copy only the one-operator periods. This schedule consists of 5 hourly increments each day, beginning at 0000, 0600, 1200, 1600, and 2200 GMT.

Ships carrying two Radiomen copy the two-operator periods. This schedule includes all periods of the one-operator period, plus those beginning at 0200, 0800, 1000, 1400, 1800, and 2000 GMT.

Ships having three or more Radiomen maintain full coverage of all hourly schedules.

The one- and two-operator periods apply only to the CW broadcasts. The RATT broadcasts run continuously and are not broken up into hourly schedules or operator periods.

SIGNAL STRENGTH AND READABILITY

Signal strength and readability of a transmission are questioned and answered by means of operating signals. Unless notified otherwise, assume that your station has good strength and readability. You do not exchange strength of signals and readability with another station unless you cannot hear him clearly or he cannot hear you.

Operating signal QSA preceded by prosign $\overline{\text{INT}}$ means "What is the strength of my signals (1 to 5)?" The reply calls for the same signal (QSA) with an appropriate number affixed. The meaning of signal strength numerals is as follows: (1) scarcely perceptible; (2) weak; (3) fairly good; (4) good; and (5) very good.

In general, use of the signal strength report is limited to occasions in which actual signal strength instead of readability is an important consideration. It is particularly applicable when changes are made in equipment, power, location, or other conditions making a test report on signal strength desirable.

Readability is indicated by means of the operating signal QRK followed by a numeral. The meaning of the numeral is —

1. Unreadable;
2. Readable now and then;
3. Readable but with difficulty;
4. Readable;
5. Perfectly readable.

For example, NAU informs NHDY as follows that NHDYs readability is poor: NHDY DE NAU QRK2 K

After adjusting his equipment, NHDY transmits: NAU DE NHDY $\overline{\text{INT}}$ QRK K

Assuming now that NHDY's readability is good, NAU transmits: NHDY DE NAU QRK4 $\overline{\text{AR}}$

Recent circuit monitor studies show too many unnecessary or excessive requests for signal strength and readability. A few operators add to the list of transmission errors by using the figure Ø in signal strength and readability reports. With the range of signal strength and readability figures limited 1 to 5, reports of QSAØ or QRKØ are therefore incorrect and unauthorized.

## SEPARATIVE SIGN

A short dash appears between certain letters in the message examples in this chapter. This symbol is known as the separative sign. It is one of the prosigns and is transmitted as the Morse code characters II (letter I repeated). Although the operator sends the separative sign as di-DIT di-DIT, it is recorded by typewriter as a hyphen (-). Its main purpose is to separate portions of the heading to prevent mistakes in reception that might occur if characters of adjacent groups are run together.

The separative sign is used in radiotelegraph but not in teletype or radiotelephone procedures. Here are the rules governing the use of the separative sign:

1. Before and after all prosigns in the procedure and preamble components of the message heading, except DE, $\overline{\text{AA}}$, NR, and $\overline{\text{IX}}$.
2. To separate each element of the address; that is, between the preamble and the prosign FM, between originator's call sign and prosign TO, between the call sign of the last action addressee and prosign INFO, and between the call sign of the last information addressee and prosign XMT.
3. Between the call and the beginning of the repetition of a message to be repeated back.
4. To separate the address from the prefix (GR count line) when an accounting symbol is used.
5. To separate call signs belonging to adjacent message components or adjacent multiple transmission instructions.
6. In procedure messages to separate portions of the text.

Even though the separative sign is written as a hypnen (-), it must not be used to represent a hyphen or dash in a message text. Instead, the Morse code equivalent for a hyphen or dash (DAH-di-di-di-di-DAH) must be used to represent this punctuation mark.

## COUNTING GROUPS

The group count of a message is the number of groups in the text, and is found in the message prefix, just before the first break prosign ($\overline{\text{BT}}$). In a message, GR followed by numeral(s) means "This message contains the number of groups indicated." In a message containing a text of six words, the group count is written GR6. If the message is encrypted, the group count indicates the number of code groups in the text. Rules to follow when counting groups are —

1. Count groups between $\overline{\text{BT}}$ and $\overline{\text{BT}}$.
2. Each sequence of characters uninterrupted by a space is counted as one group.
3. Punctuation is not counted unless abbreviated or spelled out.
4. Count every word and every group of letters, figures, and symbols as one group.
5. Hyphenated words and hyphenated names, when transmitted as one word, count as one group.

A numerical group count must always be used in encrypted messages. Its use in messages having plain language text is not necessary unless an accounting symbol is used.

When the accounting symbol is used, and the groups have not been counted, the prosign GRNC must be employed.

The break prosign $\overline{BT}$ is placed before and after the text of a message, but is not a part of the text. It is the prosign separating the heading from the text and the text from the ending. The test of a message is always between the two break prosigns.

## RELAY

If all stations could communicate directly with all other stations (called direct communications), there would be no need for relay instructions. Often, though, a station originating a message cannot communicate directly with the addressees. For this method, called indirect communication, one or more relays are required to get the message to its destination. This transmission is accomplished by either a specific or a general relay. In many instances both a specific and a general relay are needed to effect delivery of the message to all addressees.

When the originator and the addressee are in direct communication, the originator may use the call as the address; then, the address component is unnecessary. Remember, however, that the originator must be in direct communication with all addressees. A message requiring relay must have a complete address and must contain appropriate transmission instructions.

The specific relay requires prosign T in the transmission instructions (format line 4). When a message is received with prosign T alone, it means "Station called transmit this message to all addressees." Suppose NTSY sends a message to NUYO with instructions for NUYO to relay to all addressees—in this example, NUYO and SQFK.

NUYO DE NTSY —
T —
R — 311615Z AUG 67 —
FM NTSY —
TO NUYO
SQFK
GR6
$\overline{BT}$ (Etc.)

Prosign T, followed by one or more address designations, means "Station called transmit this message to addressee(s) whose address designation(s) follows." To illustrate, NTSY transmits a message to NUYO with instructions for NUYO to relay to one of the addressees (SQFK).

NUYO DE NTSY —
T — SQFK —
R — 161813Z AUG 67 —
FM NTSY —
TO SQFK —
INFO NUJC
GR18
$\overline{BT}$ (Etc.)

Station NTSY made other arrangements to get the message to NUJC (perhaps by mail, messenger, or separate transmission on another circuit), so this station is not included in the relay.

Prosign T, preceded by a call sign, and followed by one or more address designations, means "Station whose call sign precedes T, transmit this message to addressee(s) whose address designation(s) follow(s) T." Station NWFD sends a message to NUBJ and NUYO, requesting NUBJ to relay the message to NTFJ.

NUBJ NUYO DE NWFD —
NUBJ — T — NTFJ —
R — 181927Z AUG 67 —
FM NWFD —
TO NTFJ
NUBJ
NUYO
GR29
$\overline{BT}$ (Etc.)

When this relay is accomplished, all addresses will have received the message. Station NWFD is in direct communication with NUBJ and NUYO; NUBJ can communicate with NTFJ.

Prosign XMT (exempt) is not used in conjunction with prosign T. Relay instructions may be modified by the operating signal ZWL, meaning "No forwarding action to the designation(s) immediately following is required." Signal ZWL is used whenever it shortens the number of call signs in transmission instructions. In the following message, for example, NTSY tells NUYO to relay to all addressees except NTFJ. He could have said the same thing, in effect, by using T — NFFN NHDY NUBJ SQFK but, as you can see, T — ZWL

NTFJ is a much shorter way of doing it.

NUYO DE NTSY —
T — ZWL NTFJ —
R — 171315Z AUG 67 —
FM NTSY —
TO NFFN
NHDY
NTFJ
NUBJ
SQFK
GR98
$\overline{\text{BT}}$ (Etc.)

A general relay requires an operating signal such as ZOC, which means "Station(s) called relay this message to addressees for whom you are responsible." By using ZOC, the guardship for a number of ships and activities can be instructed to relay messages to all such stations without the necessity of individual call signs in transmission instructions. Operating signal ZOC is used most frequently in general messages. Here is the way it appears in transmission instructions of a typical general message:

NERK DE NSS W NR156 —
ZOC —
R — Ø61216Z/17 AUG 67 —
FM SECNAV —
TO ALNAV
GR85
$\overline{\text{BT}}$ (Etc.)

## CORRECTING AN ERROR

When an error is made in transmitting, the operator sends a series of eight or more Es, the error prosign. The phrase "eight or more Es" is intended to facilitate operations. It does not mean that an excessive number of Es should be transmitted. The error prosign is sent immediately after the error. Depending on whether the error was made in the message heading or text, the manner in which transmission is resumed varies somewhat.

In correcting errors in the message heading, the operator makes the error prosign, then goes back to the last prosign or operating signal that was transmitted correctly, repeats it, and continues with the correct version. Example: NFFN, transmitting a message, makes and corrects an error in the heading.

NHDY DE NFFN —
P — 13Ø93ØZ AUG 67 —
FM NAU —
TO NENB
NHTG EEEEEEEE
TO NENB
NHTZ —
INFO NHDY
GR15
$\overline{\text{BT}}$ (Etc.)

To correct an error in the text, the error sign is made, and transmission commences with the last word or group correctly sent. Example: YZZF, transmitting a message to NMVH, makes and corrects an error in the text.

NMVH DE YZZF —
P — 211827Z
GR21
$\overline{\text{BT}}$
UNCLAS
CONDUCT NO SUBMERGED OPS SOUTH
OF LAT 38 EEEEEEEE
LAT 373ØN (Etc.)

The preceding example can be used to illustrate another point. Sometimes a question arises regarding the proper procedure to use if the operator, in attempting to correct his original error, makes a mistake in the previous word, LAT, which he transmitted correctly once. Should he make the error sign and go back to the word OF before continuing his transmission? If this type of error continued, he conceivably could find himself back at the beginning of the message. Here is the answer: The last word transmitted correctly was LAT, hence the operator should continue his transmission with that word. Just because an error was made in retransmitting LAT, in the attempt to correct the original error, does not change the fact that LAT previously was transmitted correctly. Accordingly, there is no need to revert to the word OF in continuing the transmission.

The error prosign is used also to cancel a transmission while in progress. A series of eight or more Es, followed by the prosign AR, means "This transmission is in error: disregard it." Example: NALJ, while transmitting a message to OLRX, discovers that the message should not be sent and cancels the transmission.

OLRX DE NALF –
P – 1ØØ256Z AUG 67 –
FM NALJ –
TO STRK
EEEEEEEE $\overline{\text{AR}}$

After a transmission is receipted for, it is canceled by means of a properly released procedure message or service message. The error prosign method of canceling the transmission cannot be used for this purpose.

## REPETITIONS; CORRECTIONS; VERIFICATIONS

Occasionally, messages or parts of messages must be repeated, corrected, or verified. To accomplish any of these procedures, prosigns AA (all after), AB (all before), WA (word after), and WB (word before) are used in procedure messages in conjunction with prosigns $\overline{\text{IMI}}$, $\overline{\text{INT}}$, C, J, and certain operating signals.

When a message must be repeated, corrected, or verified, it is necessary to identify the message in question. Identification is made by using the date-time group and/or station serial number. When necessary, the message may be further identified by adding the call sign of the originating station, the group count, or both. If additional identification is needed, the complete preamble, or address, or the complete (or partial) text may be included. The identification data should always be as brief as possible, consistent with positive identification.

When necessary to use a code group of an encrypted message text as a reference point, it is referred to by number; that is, according to the numerical order in which it appears in the text. Use of numbers as reference to encrypted text groups is illustrated in the next topic (Use of $\overline{\text{IMI}}$).

For a plain language message, the reference point in the text is a plain language word and prosign WA or WB, as necessary. If a word or group used to identify a part of a message appears more than once in that message, the first occurrence of the word or group is meant. If otherwise intended, amplifying data such as adjacent words or groups must be included. The following message is transmitted:

NIQC DE NHAP –
R – Ø41227Z AUG 67 –
FM NHAP –
TO NIQC
INFO NOKB
GR9
$\overline{\text{BT}}$
UNCLAS
TWO ARCTIC SURVIVAL KITS
REQUIRED BY 6 AUG
$\overline{\text{BT}}$
B R
K

Prosign $\overline{\text{BT}}$ appears in the message twice. Therefore, a request using (1) AB $\overline{\text{BT}}$ denotes all before the text (the first $\overline{\text{BT}}$); (2) AA $\overline{\text{BT}}$ denotes all after the heading (the first $\overline{\text{BT}}$); (3) WA ARCTIC denotes the text word SURVIVAL; (4) AA AUG $\overline{\text{BT}}$ denotes the message ending (after the escond $\overline{\text{BT}}$).

It is important that Radiomen learn the correct usage of these prosigns. Make sure you understand the rules and examples that follow. Here is the encrypted message used throughout the ensuing examples.

YOBV DE NTSY –
R – 271545Z AUG 67 –
FM NTSY
TO NUYO
INFO NCFX
NTFJ
GR11
$\overline{\text{BT}}$
BPHTJ ODZNM WEBJL OPNGB DPBIR
FLMBJ RRWZA WUJQE DPJAF OHRUC
BPHTJ
$\overline{\text{BT}}$
K

### USE OF $\overline{\text{IMI}}$

Prosign $\overline{\text{IMI}}$ means REPEAT. It may be used by the receiving operator to mean "Repeat all of your last transmission." With identifying data, it also means "Repeat portion indicated." It may be used by the sending operator to mean "I will repeat the difficult plain language word I just transmitted," or "I am going to repeat this message." Prosign $\overline{\text{IMI}}$ cannot be sent to request repetition of a message for which a receipt has been given. For this purpose, either a procedure message (containing operating signals) or a service message must be used. Suppose that NUYO desires a repetition of the preceding message in its entirety. He sends: NTSY DE NUYO IMI K

In response to this request, NTSY replies with the entire message, exactly as he sent it the first time.

If NUYO desires a repetition of the heading, his request would be: NTSY DE NUYO IMI AB BT K

NTSY replies:

NUYO DE NTSY<br>
AB BT —<br>
YOBV DE NTSY —<br>
R — 271545Z AUG 67 —<br>
FM NTSY —<br>
TO NUYO —<br>
INFO NCFX<br>
NTFJ<br>
GR11<br>
BT<br>
K

The previous example shows how to request and send a repetition of the entire heading. When repetition of only a portion of a message heading is needed, request it in increments of entire elements (from prosign to prosign), as in the next two examples. Assume that NUYO needs part of the heading between prosigns FM and INFO. He requests:

NTSY DE NUYO<br>
IMI FM TO INFO K

NTSY answers:

NUYO DE NTSY<br>
FM TO INFO —<br>
FM NTSY —<br>
TO NUYO —<br>
INFO<br>
K

Suppose that NUYO needs a repetition of the date-time group, originator, and action addressee of the message. Here is the proper way for him to request it: NTSY DE NUYO IMI R TO INFO K

NTSY answers:

NUYO DE NTSY<br>
R TO INFO —<br>
R — 271545Z AUG 67 —<br>
FM NTSY —<br>
TO NUYO —<br>
INFO<br>
K

The following examples show how to obtain repetitions of parts of the message text. Note how groups are identified by number. Parts of encrypted texts are always identified this way; prosigns WA and WB are used only with plain language texts.

If NUYO desires all after the eighth group repeated, this is his request: NTSY DE NUYO IMI AA 8 K

Reply:

NUYO DE NTSY<br>
AA 8 — DPJAF OHRUC BPHTJ BT K

Suppose NUYO asks for the ninth group to be repeated. He sends: NTSY DE NUYO IMI 9 K

Reply: NUYO DE NTSY 9 — DPJAF K

If NUYO wants a portion of the message from the third to eighth groups repeated, he requests: NTSY DE NUYO IMI 3 TO 8 K

Answer:

NUYO DE NTSY<br>
3 TO 8 — WEBJ OPNGB DPBIR FLMBJ<br>
RRWZA WUJQE K

Here is a worthwhile rule to remember: If repetition of more than one portion of a message is needed, be sure to incorporate all requests in a single procedure message. For example, if NUYO missed group 3, and also missed groups 6, 7, and 8, he would send the following procedure message: NTSY DE NUYO IMI 3 - 6 TO 8 K

Here is how NTSY answers:

NUYO DE NTSY<br>
3 — WEBJL — 6 TO 8 — FLMBJ RRWZA<br>
WUJQE K

USE OF C

Prosign C, used alone, means "You are correct." It is applicable in this respect if an operator questions a portion of a message sent him, and the transmitting station finds that he is correct. When the prosign C is followed by other data, it takes on the meaning "This is a correct version of the message or portion(s) indicated." Uses of C are brought out in the following discussions of INT and J.

USE OF INT

So far it has been learned that the prosign INT means "Interrogative." Its use with operating signals was explained and illustrated in chapter 5 and, in connection with signal strength and readability reports, earlier in this chapter. Other uses of INT to question transmissions—messages or parts of messages—are presented here.

As with IMI, prosign INT is not used to question any part of a message for which a receipt has been given. Once "Roger" is given for a message, any further questions must be resolved by operating signals in service or procedure messages.

Prosign INT, followed by GR, is transmitted by the receiving operator to question the group count of a message. When the number of groups received does not correspond to the group count transmitted, the receiving station questions the transmitting operator with INT GR, followed by a numeral indicating what the receiving operator believes to be the correct group count. Example:

NTSY DE NCFX INT GR8 K

If, after rechecking the message, the transmitting operator finds that the receiving station is correct, he sends prosign C, meaning "You are correct." Example: NCFX DE NTSY C K

Having no further questions, NCFX then receipts for the message in the normal way.

When you are not in agreement with the transmitting operator, never hesitate to question the group count. Remember, he may have counted the groups incorrectly, or he may have omitted a word or an entire line. To prevent useless and unauthorized haggling between operators, there is a correct method for resolving a questioned group count. Rules and transmission examples are cited as this topic progresses.

For all plain language texts, and for encrypted text messages whose group count does not exceed 50 groups, the following procedure applies: If the receiving station questions the group count and is considered to be incorrect, the transmitting operator repeats the original group count and sends the first character of each word or group of the text in succession. For example, NTSY transmits this message to NCFX:

NCFX DE NTSY –
R – 272113Z AUG 67 –
GR1Ø
BT
UNCLAS
ANCHORED VICINITY CAMP LLOYD.
SITE ICE FREE. EFFECTED RDVU
BT
K

Station NCFX believes he has received the entire message but, perhaps because of adverse receiving conditions, he counts only 9 groups. He questions the group count thus:

NTSY DE NCFX INT GR9 K

Station NTSY checks and finds the group count correct as transmitted. He then repeats the group count and proceeds to send the first character in each group as follows:

NCFX DE NTSY GR1Ø BT U A V C L S I F E R BT K

Station NCFX now knows which group he lacks, obtains repetition by use of IMI, and receipts for the message.

For encrypted text messages of more than 50 groups, the following procedure governs: If the receiving station is considered to be incorrect, the transmitting operator repeats the original group count and sends the number of the first, eleventh, and each succeeding tenth group, followed by the first letter of that group. The number of the group is separated from the first letter of that group by the separative sign, as shown in the next example.

Station NTSY transmits to NCFX a message having 76 encrypted text groups. Station NCFX questions the group count: NTSY DE NCFX INT GR75 K

Station NTSY checks and finds the group count correct as transmitted, then sends:

NCFX DE NTSY GR76 BT 1 - D 11 - L 21 - E 31 - P 41 - Q 51 - M 61 - W 71 - F BT K

Now NCFX can find the 10 groups in which he has a miscount. He requests a repetition of those 10 groups: NTSY DE NCFX IMI 31 TO 4Ø K

After the repetition, NCFX receipts for the message.

The transmitting station always has the final say after a group count is checked by the foregoing procedure.

Besides the group count, the INT prosign is used also to question other portions of messages. Preceding a portion of a message, INT means "Is my reception of this correct?" For example, NCFX asks NTSY "Is the date-time group 272113Z?":

NTSY DE NCFX INT 272113Z K

If 272113Z is the correct DTG, NTSY transmits: NCFX DE NTSY C K

If, however, 272113Z is incorrect (assume correct DTG is 272112Z), NTSY must correct the entire element in which the DTG appears, working from prosign to prosign, as follows:

NCFX DE NTSY C R TO GR11 — R —

272112Z AUG 67 GR11 K

The preceding rule is similar to the use of IMI in requesting repetition of part of a message heading. When a part of a message heading is questioned by INT and is found to be incorrect, the response must be in the form of a correction that includes the entire element (from prosign to prosign) in which the correction occurs.

Continuing this discussion of the prosign INT, consider the next message example and the transmissions. They show how to use INT with prosign WA and WB when questioning parts of a plain language text. Here is the message:

NAMR DE NIIW —
R — 121314Z AUG 67 —
FM NIIW —
TO NAMR
NFDR
GR1Ø
BT
UNCLAS
MY 121135Z. TRF ONE RM3 TO USS
BEARSS IMMED
BT
K

Ensuing transmissions illustrate three different methods—each of them correct—of questioning a part of the text.

Station NAMR asks "Is the word after USS, BEARS?" He sends: NIIW DE NAMR INT WA USS — BEARS K

Station NIIW answers: NAMR DE NIIW C WA USS — BEARSS K

Here is another way NAMR could question the same word: NIIW DE NAMR INT BEARS K

Station NIIW sends his correction in the same form as his first reply: NAMR DE NIIW C WA USS — BEARSS K

In the third method, NAMR uses prosign WB when he asks "Is the word before IMMED, BEARS?" He transmits:

NIIW DE NAMR INT WB IMMED — BEARS K

To this query, NIIW corrects:

NAMR DE NIIW C WB IMMED — BEARSS K

In all three methods, if the word is correct as questioned (that is BEARS instead of BEARSS), the response from NIIW would be: NAMR DE NIIW C K

## USE OF J

Prosign J means "Verify with originator and repeat." This prosign is used when an addressee does not understand the meaning of a message. It is important to understand that the operator does not originate the verification request. A verification request may be initiated only by the addressee, and must be written up and released the same as any other message. In some instances, an addressee may draft a regular message to request a verification, especially codress messages. This procedure may be necessary for security reasons. In this chapter, however, we are concerned with obtaining verifications with the J prosign.

In contrast to the frequent need to use IMI, only infrequently is an addressee likely to require that a message be verified. Whereas IMI never is used to obtain a repetition of a message after it is receipted for, practically all requests for verification are sent after transmission of the receipt. A rare exception may be an abbreviated plaindress message wherein the text is such that its meaning normally is known before receipting for the message. If it is necessary to request a verification in such an instance, prosign J may be sent instead of a receipt. The following examples show how prosign J is used in typical situations.

Station NTSY desires NTFJS message 171623Z verified and repeated. This is his request: NTFJ DE NTSY J 171623Z K

After NTFJ verifies with the originator, he answers:

NTSY DE NTFJ
R – 171263Z AUG 67 –
FM NTFJ –
TO NUYO –
INFO NTSY
GR8
$\overline{BT}$
UNCLAS
PROCEED ON DUTY ASSIGNED. MAKE MOVEMENT REPORTS
$\overline{BT}$
K

In the example just given, note how NTFJ uses the prosign C after the callup in his reply. Here is a worthwhile rule to remember: The answer to a J is always a C (correction). Prosign C, followed by message identification data, as in this example, means "This is a correct version of the message or portions indicated." Prosign C must be used in reply to a J even though the message was correct as originally transmitted.

Taking the same message, for example, suppose addressee NUYO wishes NTFJ to verify and repeat the message heading. His request for verification would be: NTFJ DE NUYO J 171623Z AB $\overline{BT}$ K

After checking with the originator to ascertain that the message was addressed properly, NTFJ replies:

NUYO DE NTFJ
C 171623Z AB $\overline{BT}$ –
R – 171623Z AUG 67 –
FM NTFJ
TO NUYO –
INFO NTSY
GR8
$\overline{BT}$
K

Again, note how NTFJ uses prosign C in his reply.

Now, suppose that NUYO requests NTFJ to verify and repeat part of the text, such as all after the word DUTY. He would send: NTFJ DE NUYO J 171623Z AA DUTY K

The originator, NTFJ, now discovers he made an error in the original message and needs to correct part of the text to read MAKE OWN MOVEMENT REPORT. Adding another word in the text also changes the group count. The transmitting operator must send the corrections to all addressees. He therefore transmits:

NTSY NUYO DE NTFJ –
C 171623Z INFO TO $\overline{BT}$ –
INFO NTSY
GR9
$\overline{BT}$ –
AA DUTY –
ASSIGNED. MAKE OWN MOVEMENT REPORTS
$\overline{BT}$
K

The following example shows correct usage of prosign J before receipting for the message. As originator, NTFJ transmits to collective call YOBV, which includes NABC, NTSY, and NUYO:

YOBV DE NTFJ
$\overline{IX}$ $\overline{BT}$
TURN NINE
$\overline{BT}$
K

Before receipting, NABC asks for verification: NTFJ DE NABC J K

After verifying with the originator, NTFJ sends:

NABC DE NTFJ C –
$\overline{IX}$ $\overline{BT}$
TURN NINE
$\overline{BT}$
K

Prosign $\overline{IX}$ is encountered for the first time in the preceding example. This prosign, applicable only in executive method messages, is explained later in this chapter.

## BREAK-IN PROCEDURE

Occasionally, an operator may need to interrupt someone's transmission. This method is permissible if proper break-in procedure is observed.

When only two stations are concerned in a transmission, breaking in is permitted if necessary. A station desiring to break in makes a series of dashes. When the transmitting operator hears the dashes between his transmitted characters, he stops—at least momentarily—to discover the reason for the interruption. This pause allows the station breaking in to arrange for a shift of frequency, request repeats, or other reasons. When two stations are working directly on a circuit, the most frequent use of the break-in procedure is for on-the-spot repeats of portions missed. If receiving conditions are good, a preliminary call is not needed before transmission of the last word or group correctly received. For example, NHDY is transmitting to NFFN: AND WILL PROCEED IMMEDIATELY

Station NFFN missed the word IMMEDIATELY. The operator breaks in thus: — — — PROCEED

Station NHDY then commences transmission with the last word NFFN indicated he received correctly: PROCEED IMMEDIATELY (etc.)

If, however, the break-in is for a reason besides requesting immediate repetition of a missed word, a full or abbreviated call must be given. For example, NHDY is transmitting to NFFN: AND WILL PROCEED IMMEDIATELY

Station NFFN has trouble with the receiver and asks NHDY to wait:

> — — —NHDY DE NFFN $\overline{AS}$
> When ready to receive, NFFN transmits:
> DE NFFN $\overline{IMI}$ AA PROCEED K
> Station NHDY then resumes transmission:
> DE NHDY AA PROCEED -
> IMMEDIATELY (etc.)

Remember that break-in procedure cannot be used to obtain repetitions when more than one station is receiving the message. The series of three dashes (shown in these examples) to attract the attention of the sending station does not represent a hard-and-fast rule. The transmitting operator usually stops the instant the receiving station presses his key. If, however, three break-in attempts are unsuccessful, the receiving operator must cease further attempts until the transmission is completed.

In certain instances, a station on a circuit having a message of higher precedence than the one being handled has the privilege of breaking in and transmitting his message. A message with the precedence of FLASH or IMMEDIATE must be sent as quickly as possible, and therefore interrupts all messages of lower precedence. A PRIORITY message does not interrupt a ROUTINE message unless the ROUTINE is exceptionally long. Commonsense must be practiced regarding all such instances.

## RECEIPTS

Prosign R indicates receipt of a transmission. Example: NFFN DE NHDY R $\overline{AR}$

Both ships and shore stations receipt for transmissions in the form just shown. At times, however, identification of the transmission should be included in the receipt.

To eliminate possible confusion and misunderstanding on ship-shore circuits, where many stations usually are working at the same time, it is standard practice for the shore station to receipt for a message with prosign R, followed by the station serial number (if assigned) or the date-time group of the message. (Station serial numbers are not authorized presently for ship-ship or ship-shore use.) Thus the receipt would be: NHDY DE NPN R NR3 $\overline{AR}$

Or, the receipt may take this form: NHDY DE NPN R 131137Z $\overline{AR}$

It is advisable to include identification data in receipting for a message that required several transmissions incident to its reception. This procedure would apply if receiving conditions were poor and several repetitions were obtained before receiving the message correctly.

## ACKNOWLEDGMENTS

An acknowledgment is a communication announcing that the message to which it refers has been both received and is understood. Do not confuse an acknowledgment with a receipt or a reply. A receipt, as already learned, is sent by one operator to another to indicate only that the message has been received.

A reply is an answer to a message. A prompt reply referring to the message also meets the requirement of an acknowledgment.

Usually, acknowledgments are obtained by means of a request within the text. The acknowledgment itself consists of the message reference and the word acknowledged. Example: YOUR 1Ø2Ø3ØZ ACKNOWLEDGED.

Naval communications are sufficiently reliable, however, that an originator, filing a message for transmission, can expect delivery to all addressees. For this reason, acknowledgments ordinarily are not requested.

Whereas receipts are exchanged freely between operators, acknowledgments must always be authorized by the addressee of the message. If request for acknowledgment is not included in the message text, it may be requested after transmitting the message. Perhaps an acknowledgment was unnecessary at the time the message was sent, but was needed later. When this situation occurs, a separate message is sent requesting acknowledgment.

For security reasons, an acknowledgment to a codress message must be another codress message.

## ENDING PROSIGNS K AND $\overline{AR}$

Every radiotelegraph transmission must end with either the prosign K or $\overline{AR}$. These prosigns are never used together. Prosign K means "Go ahead" or "This is the end of my transmission to you and a response is necessary." As shown in many message examples in this chapter, prosign K denotes the end of a transmission when a transmitting station requires or expects a response from receiving station.

Prosign $\overline{AR}$ means "This is the end of my transmission to you and no response is required or expected." Although a recipient does not receipt for a transmission ending in $\overline{AR}$, he still can request repetitions or verifications on radiotelegraph circuits that employ the normal receipt method.

All messages on fleet broadcasts end in $\overline{AR}$. Ships copying fleet broadcasts do not receipt for messages or otherwise use their transmitters in connection with broadcast transmissions.

## USE OF $\overline{AA}$

Prosign $\overline{AA}$ (overscore means that the group is sent as one character) is not the same as AA without the overscore. It has an altogether different meaning and use. Use of AA (all after) was explained earlier. Prosign $\overline{AA}$ means "Unknown station." It is used instead of a call sign in establishing communication with a station whose call sign is not recognized.

Suppose you hear a station calling you by radiotelegraph. You are certain that he is calling your station but, possibly for a variety of reasons, you fail to get his call sign. Perhaps his signal was weak, or there might have been interference from static or other stations. In your prompt response, $\overline{AA}$ is used as follows: $\overline{AA}$ DE NHDY K

The "unknown station" sends his call sign again when he answers, and you are alerted sufficiently so that you are unlikely to miss it the second time.

One pitfall should be avoided in using $\overline{AA}$. Do not be tempted to respond with $\overline{AA}$ if you are doubtful that the station is yours. Unless you are sure that you heard your call sign, sit tight and wait until the distant station calls you a second time.

You may observe your ship's Signalmen using prosign $\overline{AA}$ frequently in signaling with flashing lights. They use it to call ships whose call signs are unknown, such as warships or merchantmen too far distant to identify.

## MESSAGES IN STRINGS

When communication is good, traffic handling frequently is speeded when one station sends several messages to another with interruption: Five messages normally should comprise a string (or sequence). The receiving station may, however, indicate by means of an operating signal the number of messages to be sent in a given string. To illustrate, NGTA has 10 messages for NAU, and sends this transmission: NAU DE NGTA ZBO1Ø K (ZBO1Ø means "I have 10 messages for you.")

Station NAU replies: NGTA DE NAU QSG5 K (QSG5 means "Send 5 messages at a time.")

Prosign B is placed in the ending of each message sent as part of a string. This prosign is followed by the precedence of the next message. When the last message of the sequence is transmitted, a receipt is requested before commencing the next string. Accordingly, the last message of each sequence is ended with prosigns B and K, meaning "There is more to follow; receipt for what I have sent." Example: NGTA sends the first of a string of 5 messages.

NAU DE NGTA —
T —
P — 112214Z AUG 67 —
FM NGTA —
TO EZRA
GR15
$\overline{BT}$
TEXT
$\overline{BT}$
B P

Station NGTA pauses briefly to allow any station to break in to transmit traffic of higher precedence. If no station interrupts, NGTA proceeds. He may make a full call, as before, or simply make a separative sign and begin with the next message:

\- P - 112216Z
FM NGTA - (Etc.)

On reaching the ending of the first string, NGTA sends:

$\overline{BT}$
B R K

If break-in procedure was not employed, NAU requests any needed repetitions. Otherwise, NAU receipts for the sequence in this manner:

NGTA DE NAU R K

Transmission of his second string of messages then is started by NGTA.

## EXECUTIVE METHOD

To speed tactical movements of ships, the executive method of transmitting messages is used frequently. It is employed when some action must be executed at a certain instant, such as when two or more ships must take action simultaneously. Although used principally for transmitting tactical signals by radiotelephone and visual communications, the executive method also may be used on radiotelegraph circuits.

Executive method messages are of two types. They are the normal executive and immediate executive. Only the normal executive method is authorized for use on radiotelegraph circuits, hence it is the only method discussed here.

In the normal executive method, the message to be executed is sent and the desired receipts are obtained. At the time for execution, another transmission is made that carries the signal of execution.

The procedure for normal executive method messages may seem complicated at first. Actually, the steps are simple, and a few drills will do much toward squaring RMs away on this method. Start by learning four rules for handling executive messages.

1. Only abbreviated plaindress messages may be used in the normal executive method.
2. In executive method messages, a group count and date-time group are never used. A time group may be used, however, to show time of origin. If a time group is used, it is placed either in the heading or in the ending, but never in both.
3. A message requiring a signal of execution carries the prosign $\overline{IX}$ immediately before the first $\overline{BT}$.
4. The signal of execution consists of prosign $\overline{IX}$ followed by a 5-second dash. It always is preceded by a full call. The instant of execution is the termination of the 5-second dash.

Following is an example of the normal executive method message.

NFFN NHDY DE PKWN
$\overline{IX}$ $\overline{BT}$
FOXTROT CHARLIE JULIETT
$\overline{BT}$
1248Q
K

Ships called receipt as follows:

DE NFFN R $\overline{AR}$
DE NHDY R $\overline{AR}$

Station PKWN executes: NFFN NHDY DE PKWN $\overline{IX}$ (5-second dash) $\overline{AR}$

An executive method message must be identified at the time of execution if it is one of several outstanding unexecuted messages. It also is identified if considerable time passes between transmitting the message and executing it. Example: NFFN NHDY DE PKWN 1248Q $\overline{IX}$ (5-second dash) $\overline{AR}$

Ordinarily, the signal of execution does not require a receipt. When a receipt is requested, however, the request is indicated by transmitting the prosign K instead of $\overline{AR}$ after the 5-second dash.

To execute a portion of an outstanding executive message, the part desired must be retransmitted and followed by the executive signal. For example, PKWN sent the following message to be executed and obtained receipts for it:

NFFN NHDY DE PKWN<br>
$\overline{\text{IX}}$ $\overline{\text{BT}}$<br>
FORM QUEBEC 1ØØ TACK SPEED 16<br>
$\overline{\text{BT}}$

Note the word TACK in the message text. It always is transmitted and spoken TACK. TACK (for tackline) is a length of signal halyard about 6 feet long. Its purpose is to separate parts of flaghoist signals which, if not separated, could convey a different meaning from that intended. It is used also in tactical signals transmitted by radio. In the preceding message example, TACK separates the text into two individual tactical signals.

Assume that the originator now wants to execute only that portion of the message concerning the speed change. Absence of prosigns $\overline{\text{IX}}$ $\overline{\text{BT}}$ in the heading indicates that it is part of a message transmitted previously. Example:

NFFN NHDY DE PKWN<br>
SPEED 16 $\overline{\text{IX}}$ (5-second dash) $\overline{\text{AR}}$

Once transmitted, the executive signal cannot be canceled. If the originator wishes to cancel all messages awaiting execution, he transmits the signal NEGAT. Originator PKWN, for example, sends the following message:

NFFN NHDY DE PKWN<br>
$\overline{\text{IX}}$ $\overline{\text{BT}}$<br>
FORM 18Ø<br>
$\overline{\text{BT}}$

Before executing the message, PKWN decides to cancel it. He transmits:

NFFN NHDY DE PKWN<br>
$\overline{\text{BT}}$<br>
NEGAT<br>
$\overline{\text{BT}}$<br>
K

Each ship addressed then receipts for the cancellation.

Although the signal NEGAT used alone cancels all messages awaiting execution, NEGAT followed by message identification cancels only the identified message. Here is the way PKWN, with more than one message awaiting execution, would cancel one of them:

NFFN NHDY DE PKWN<br>
$\overline{\text{BT}}$<br>
NEGAT TURN SIX<br>
$\overline{\text{BT}}$<br>
K

Each addressee then receipts in the normal manner.

With but one exception, the procedure for obtaining a repetition or a verification of an executive method message is the same as for a regular message. The exception is a message that consists of signals from a naval signal book. For this kind of message, requests for repetition or verification must be made for the entire message or for those portions separated by the word TACK. Example:

NCFX NWBJ DE HEFT<br>
$\overline{\text{IX}}$ $\overline{\text{BT}}$<br>
SIERRA HOTEL WHISKEY TACK DELTA<br>
ZULU ROMEO<br>
$\overline{\text{BT}}$<br>
K

Station NCFX receipts for the message, but NWBJ requests verification of the first part of the message with this transmission:

HEFT DE NWBJ<br>
J $\overline{\text{BT}}$ TO TACK K

After verifying the message with the originating officer and learning that the original version is correct, HEFT transmits:

NWBJ DE HEFT<br>
C $\overline{\text{BT}}$ TO TACK –<br>
$\overline{\text{BT}}$ SIERRA HOTEL WHISKEY TACK<br>
K

To obtain a repetition, the same procedure is followed, except that $\overline{\text{IMI}}$ is substituted for J, and the reply is not in the form of a correction.

If HEFT discovers that the portion of the original message was in error, he must cancel that portion to both addressees. He transmits:

NCFX BWBJ DE HEFT
BT
NEGAT SIERRA HOTEL WHISKEY
BT
K

(This transmission leaves the original message with only the signal "Delta Zulu Romeo" awaiting execution.)

To replace the canceled portion of the original message, HEFT then transmits a new message:

NCFX NWBJ DE HEFT
IX BT
SIERRA FOXTROT WHISKEY
BT
K

## COMMERCIAL FORM

Navy communicators frequently find that traffic from commercial radio circuits is channeled over Navy systems. Navy traffic, in turn, sometimes relies on commercial facilities. The procedure and message formats used by the Navy and by commercial communication companies are quite different, however. To handle commercial traffic efficiently, a thorough understanding of commercial practices is a requisite.

The subject of commercial communications itself is too extensive to give more than a general discussion in this chapter. The next few pages serve as an introduction to the commercial form message. A prime source of information on commercial traffic is Commercial Traffic Regulations (effective edition of DNC 26), which explains message traffic involving tolls.

A ship originating a message addressed to an individual at a nonmilitary address in the United States sends the message to a naval shore radio station in the usual plaindress message form. Following is an example of a message transmitted by a ship to a shore station for refile with a commercial company.

NSS DE NIQM —
T —
R — 291646A AUG 67 —
FM USS ENTERPRISE —
TO JOHN DOE 7927 GATEWAY BLVD
DISTRICT HEIGHTS MD
NAVY GR13
BT
UNCLAS
YOUR LEAVE EXPIRES ON BOARD AT
NORFOLK VA Ø745 6 AUG 6Ø
BT
K

The preceding message differs from those studied earlier in this chapter in that the addressee is an individual instead of a ship or other military activity. It still is a class A message because it is official Navy business. Do not confuse it with class E (personal) messages, which are explained later.

Note the word NAVY just ahead of the group count. It is an accounting symbol, always necessary in messages that are to be refiled with a commercial company for delivery to an addressee. The purpose of an accounting symbol is to indicate the Government agency financially responsible for the message. In addition to NAVY, each of the various Government agencies also has accounting symbols. All of them are listed in the effective edition of DNC 26.

In the message being examined, the Department of the Navy is billed by Western Union for delivery charges from Washington (the refile point) to the addressee. At Washington the message is refiled as a domestic telegram with Western Union. The transmission is not handled by CW, however. The teletype transmission from NAVCOMMSTA Washington takes the following form:

BEAØ45
CK12 WASHINGTON DC 29 JUL 6Ø 515P
GOVT NAVY
JOHN DOE
7927 GATEWAY BLVD
DISTRICT HEIGHTS MD
YOUR LEAVE EXPIRES ON BOARD AT
NORFOLK VA
Ø745 6 AUG 6Ø
COMMANDING OFFICER USS ENTERPRISE

In the transmission, note that the order of some of the message parts changed; also, some of the parts are altered. The beginning of the message is the circuit designator and channel number for Washington's circuit with Western Union. The check (CK12) is the count of the chargeable words in the text. Western Union does not charge for the words in the address and signature—only for those in the text.

The refile point, WASHINGTON DC, is shown as the place of origin, because that is where the toll charges begin.

The date and local time are given instead of GMT. The P stands for p.m.; A is for a.m. The month is also included. The indicator GOVT shows that the message concerns official Government business. NAVY is the accounting symbol. The originator, USS Enterprise, and the words COMMANDING OFFICER are placed after the text. The sender's name is called the signature.

## CLASS-E MESSAGES

Class E messages, discussed briefly in chapter 5, are personal messages to or from naval personnel, and are handled free of charge over naval communication circuits. Even though they are personal messages they must meet the requirements for acceptable subject matter and must be released by the commanding officer before transmission, as are all other messages.

Class E messages are of two kinds: those liable to toll charges, and the ones that do not carry tolls. Toll charges are collected from the sender only when the message must be refiled with Western Union for transmission or final delivery. Federal Communications Commission (FCC) regulations prohibit transmission of personal messages by the Navy within the continental United States. These regulations limit the free-of-charge transmission of class E messages between naval ships in the same ocean area; from ship to shore and shore to ship in the same ocean area outside the United States; and from shore station to shore station outside the United States in the same ocean area. A ship in the Atlantic, Mediterranean, Middle East, or Caribbean, for instance, can send a class E message free of charge to another ship in any of these same areas. Similarly, ships and stations in the Pacific, Far East, and Alaskan areas are considered to be in the same ocean area.

The form for a class E message not subject to toll charges is shown in the following example. Ships are in direct communication, hence the call serves as the address. Note the use of the class E message indicator MSG. It always appears as the first word in the text in every class E message.

NTAA DE NWKY —
R — 281417Z
GR14
BT
UNCLAS
MSG LTJG DALY REGRET CANNOT
MEET YOU PHILADELPHIA THIS WEEK
AS PLANNED LTJG JORDAN
BT

The next example is of a class E message that is subject to toll charges. The originating station (NFFN) addresses the message to NAVCOMMSTA Washington (address group HAYY) for refile to the addressee named in the text. Station NFFN is not in direct communication with NSS (radio call sign for NAVCOMMSTA Washington), so the operator relays via NHY. Such relays are permitted over naval circuits outside the United States, and the message is handled free of charge as far as Washington. The sender must pay the Western Union charges from Washington (the refile point) to Forestville, Maryland.

NHY DE NFFN —
T —
R — 251430Z —
FM NFFN —
TO HAYY
GR37
BT
UNCLAS
MSG CK24 NL COMLE MRS MARCELLA
CROWLEY 3319 79TH AVE FOREST-
VILLE MD EXPECT TO BE HOME
ABOUT TEN NOV NOW ABLE TO WALK
WILL ADVISE YOU EXACT TIME AFTER
ARRIVAL IN STATES HAROLD USS
JOSEPH K TAUSSIG
BT

As can be seen, the message requiring tolls is slightly more complicated. Following MSG is the check (count) of chargeable words. Note that the check (CK24) is not the same as the group count (GR37). The group count, of course, must include all words from BT to BT. Chargeable words counted in the check, however, include only the sender's text plus the name of the ship, which must be added to the signature. The address and the sender's name are not chargeable, thus are not included in the check.

After CK comes the domestic service indicator NL, showing that the sender desires (and paid for) night letter service—to be delivered by Western Union the next morning. (The sender could have paid a small additional amount to send it as a day letter (DL). Or, if he wanted the fastest Western Union handling and delivery, he could have sent it as a full-rate telegram, which carries no class-of-service indicator.)

After the class-of-service indicator is the commercial indicator COMLF. This indicator must be included in every class E message to be refiled with the Western Union Telegraph Company.

Class E messages addressed to ships are delivered by fleet broadcast. Persons in the continental United States wishing to send a class E message to a ship at sea must send it by mail or by Western Union to NAVCOMMSTA San Francisco, if the ship is in the Pacific, Alaska, or the Far East. If the ship is in the Atlantic, Mediterranean, or Caribbean, the message must be sent to NAVCOMMSTA Washington. It may also be dispatched to Newport or Norfolk, if the ship is in one of those broadcast areas.

If your ship is in port in the continental United States, you still can receive a class E message on the fleet broadcast. However, you cannot send a class E message addressed elsewhere in the States—the sender must use Western Union facilities ashore.

For inbound class E messages from ships at sea, the authorized refile points are at Newport, New York, Washington, Norfolk, Charleston, Key West, New Orleans, San Diego, Long Beach, San Francisco, and Oak Harbor, Wash.

As a general rule, a class E message from a ship in the Atlantic to a ship in the Pacific must be refiled with Western Union at one of the east coast refile points, and toll charges paid for the cross-country transmission to San Francisco. Commercial refile in this instance is required by FCC rules, because the Navy's communication circuits from Washington to San Francisco cannot be used for class E messages. One exception to the interarea refile, as outlined, should be noted. The Navy has radio circuits from Washington direct to Honolulu, so that a ship in the Atlantic, in a position to work Washington directly, can send a class E message to a ship in the Pacific copying the Honolulu broadcast or any other Pacific fleet broadcast except the San Francisco broadcast. The same rule applies if the addressee is at a shore base at Hawaii or beyond.

Persons stationed at overseas bases also are permitted to send class E messages to the United States over teletypewriter circuits. Class E messages sent by teletypewriter are illustrated in chapter 11.

A Radioman needs to know how to place outgoing class E messages in the proper form. He must know whether the message can be sent free of charge or if it must be refiled with Western Union. Usually, he must assist the sender in filling out the message form, explaining the different classes of service and their different minimum charges and charges for additional words. He must know the rules for counting chargeable words, and also must be able to compute toll charges from rate tables in the effective edition of DNC 26.

A Radioman designated by the commanding officer as commercial traffic clerk handles money, keeps records, and makes required reports on commercial message traffic. Duties and responsibilities of a commercial traffic clerk are explained fully in DNC 26.

## OPERATOR ENDORSEMENTS

Several minor details in connection with transmission and reception of a message are both significant and necessary. An operator's endorsement, placed on the original of each message he handles, is a written record of exactly how, when, and where he disposed of that message. If a question ever arises concerning the handling of a particular message, the operator's endorsement is there to supply the answer. Placing the endorsement on a message is called "servicing the message."

Operator endorsements are of two types: servicing for outgoing messages and for incoming messages.

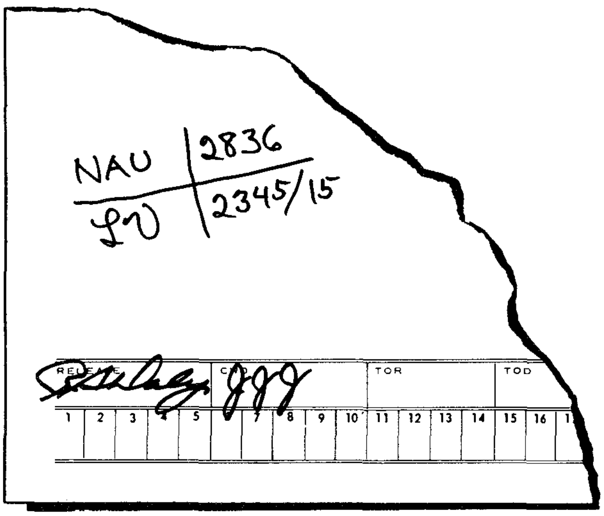
Before discussing the contents of an operator's endorsement, here are some terms every RM should know.

- Time of delivery: The TOD is the time the transmitting station completes delivery of a message. (Do not confuse this term with the time of file (TOF), which is the time an outgoing message is delivered to the communication center for processing and onward transmission.)

- Time of receipt: The TOR is the time the receiving station completes receipt of a message.
- Personal sign: A personal prosign is composed of two or more letters, frequently initials. No two signs should be alike within a station. Personal signs must not conflict with channel designations or prosigns. They are used in message endorsements to indicate individual responsibility. Personal prosigns are never transmitted.

## OUTGOING ENDORSEMENT

Servicing for an outgoing message is penciled on the face of the message blank as shown in figure 6-1. The supervisor makes the crossed lines and fills in the two upper spaces with the following information:




31.47(76)
Figure 6-1.—Servicing an outgoing message.

1. Call sign of ship or station to be called.
2. Circuit frequency in kilocycles or megacycles.

After transmitting a message, the circuit operator adds the following data in the two lower spaces:

3. Operator's personal sign.
4. The TOD expressed in Greenwich mean time, and the date delivery is completed.

A complete endorsement must appear on the station file copy of each outgoing message.

## INCOMING ENDORSEMENT

For incoming messages, the receiving operator enters the following servicing data below the text on the message blank:

1. TOR in Greenwich mean time.
2. Operator's personal sign.
3. Frequency in kilocycles or megacycles.

Whereas servicing data for an outgoing message is penciled on the message blank, that for an incoming message is typed on the message blank. All information is typed because the receiving operator keeps the message blank in his typewriter until after he receipts for the message. Slant signs separate portions of the endorsement. Example: 14Ø2/JN/8578KC.

## DISTRESS COMMUNICATIONS

To increase safety at sea and in the air, methods of communication have been developed for use in times of emergency and distress. A list of emergency and distress frequencies adopted for use at such times follows.

| | | |
|---|---|---|
| 500 kc | — | International calling and distress. |
| 2182 kc | — | International calling and distress for maritime mobile radiotelephone. |
| 8364 kc | — | International lifeboat, liferaft, and survival craft frequency. |
| 121.5 mc | — | International aeronautical emergency frequency for VHF band. |
| 243.0 mc | — | Aeronautical emergency frequency for UHF band. |

Note that 500 kc is used in times of distress, and it also is the international calling frequency. In routine radiotelegraph communications, merchant ships contact each other in 500 kc, then shift to a "working" frequency. To make sure that other uses of 500 kc will not interfere with distress traffic, two silent periods are designated. These periods are for 3 minutes each, and begin at X:15 and X:45 o'clock. That is, a silent period begins 15 minutes before each hour and 15 minutes after each hour. Ship clocks in radio spaces usually have these 3-minute segments of the clock face painted red to remind operators of silent periods. Except for actual distress messages, all traffic ceases at these times on frequencies between 480 and 520 kc.

Guarding distress frequencies is an important function of Coast Guard shore radio stations. Some naval shore stations stand continuous distress watches. Others maintain only a "loudspeaker" watch.

When a Navy ship is operating singly at sea, a continuous watch is stood on 500 kc and 8364 kc if operators and equipment are available. In all instances a receiver watch is always stood and a log is kept covering at least the silent periods. When ships are operating in a group, the officer in tactical command (OTC) arranges for the distress guard. Usually, one ship guards for the group. Under certain conditions, the OTC may request a shore radio station to handle the guard for his ships when in the area of the shore station.

Information concerning international regulations for distress, emergency, and safety traffic can be found in Distress and Rescue Procedure (ACP 135), and in Radio Navigational Aids (H.O. 117A and 117B).

## DISTRESS SIGNAL

In radiotelegraph, the distress signal $\overline{\text{SOS}}$ is transmitted as a single character. When sent on 500 kc, the dashes must be emphasized in order to operate an automatic alarm apparatus with which most merchant ships are equipped. The International Telecommunications Union also adopted an alarm signal for use on 500 kc. The ITU system consists of twelve 4-second dashes with a 1-second interval between dashes. Thus, there are two possible methods of actuating the alarm. For this reason the distress call should be preceded by the 12-dash alarm signal, followed immediately by $\overline{\text{SOS}}$ sent 3 times.

The answer to a distress message takes this international form: Call sign of the distress ship (3 times), prosign DE, call sign of own ship (3 times), followed by RRR $\overline{\text{SOS}}$. Assume that SS Blank, whose call sign is WUBN, is in distress. The call sign of own ship is NTAA, whose answer to the distress message would be:

WUBN WUBN WUBN DE NTAA NTAA NTAA RRR $\overline{\text{SOS}}$ $\overline{\text{AR}}$

Usually, the answer to a distress message is followed by the name of own ship, position, and maximum speed at which she is proceeding toward the vessel in distress. This answer, of course, must be originated by the commanding officer.

If own ship is not in position to give assistance to SS Blank, own ship may help by relaying the distress message. In the relay, the distress message is repeated word for word on the distress frequency, with full transmitter power, followed by DE and own ship's call sign repeated 3 times. Authority to relay the message must come from own ship's commanding officer. He may include the distress message in the text of a naval message to be transmitted to a shore station for possible action or broadcast to the fleet.

To handle rescue operations successfully, distress traffic must be controlled. The vessel making the distress call is the control station for distress traffic. Control may be exercised by another ship at the scene, however. Any ship can impose silence on any radio stations in the zone, or on a particular station interfering with the distress traffic. To impose silence, the signal QRT is sent, followed by the word DISTRESS. This message may be addressed to all stations (CQ) or to a specific station.

When distress traffic is ended, or radio silence no longer is necessary, a message is sent to inform all ships. This message is originated by the control vessel. Assume own ship (NTAA) was control vessel for WUBN. At the end of the distress traffic, your commanding officer would originate the following message:

$\overline{\text{SOS}}$ CQ CQ CQ DE NTAA SS BLANK WUBN QUM $\overline{\text{AR}}$

Note that DE is followed by the call sign of the ship transmitting. This call sign, in turn, is followed by the name and call of the ship that originated the distress call. The signal QUM means "Normal working may be resumed."

A naval vessel in distress ordinarily does not use the international distress signal $\overline{\text{SOS}}$. Instead, Navy communication channels and cryptoaids are utilized.

Although $\overline{\text{SOS}}$ is the international distress signal sent by radiotelegraph, the signal in radiotelephone is the spoken word MAYDAY. Pronunciation of this distress signal is the same as the French word m'aider ("Help me"), from which it derives. MAYDAY also is used by aircraft in distress.

## URGENCY SIGNAL

In addition to the distress signal $\overline{SOS}$, there is an urgency signal for use on distress frequencies. It consists of the group XXX sent 3 times before the call. The urgency signal indicates that the calling ship has an urgent message to transmit concerning the safety of the ship or of a person on board or within sight. It has priority over all other communications except distress signals.

## SAFETY SIGNAL

The safety signal, transmitted on any of the distress frequencies, consists of the group TTT sent 3 times before the call. It indicates that the ship is about to transmit a message concerning the safety of navigation or giving important meteorological (weather) warnings.

## DISTRESS DUE TO ENEMY ACTION

Merchant ships use $\overline{SOS}$ in distress messages to summon assistance only in instances of distress due to normal marine causes such as fire, collision, storm, and the like, not the result of enemy action.

In wartime, five signals are used by merchant ships to indicate distress due to enemy action. These distress signals are given in the accompanying list.

| Class of distress | Distress signal | When used |
|---|---|---|
| Warship raider | WWWW | On sighting or when attacked by enemy warship. |
| Armed merchant ship raids | QQQQ | On sighting or when attacked by armed merchant ship raider. |
| Submarine | SSSS | On sighting or when attacked by enemy submarine. |
| Aircraft | AAAA | On sighting or when attacked by enemy aircraft. |
| Mine | MMMM | On striking a mine. |

## FACSIMILE BROADCAST

Facsimile (FAX), studied in chapter 2, is a system for sending pictorial matter by radio or landline. It is discussed in this chapter because radiotelegraph procedure is used to establish and maintain communications on facsimile circuits.

Many ships not equipped to transmit FAX have equipment aboard for receiving only. It is used for copying the facsimile component of fleet broadcasts. The FAX broadcasts are sent by the following stations:

| | Call sign | Broadcast designator |
|---|---|---|
| NAVCOMMSTA Washington -- | NSS | WP |
| NAVCOMMSTA Balboa ------ | NBA | BP |
| NAVCOMMSTA San Francisco -------------------- | NPG | FP |
| NAVCOMMSTA Honolulu ---- | NPM | HP |
| NAVCOMMSTA Guam ------- | NPN | GP |
| NAVCOMMSTA Port Lyautey ------------------ | NHY | KP |
| NAVCOMMSTA Philippines --------------- | NPO | PP |

Areas covered by FAX broadcasts are the same as those covered by the RATT and CW broadcast schedules. Content of the broadcasts is almost exclusively weather charts. An example of a weather chart transmitted on the facsimile broadcast is shown in figure 6-2. Note the identification block in the lower left corner of the example. This block contains the standard message heading format and other lines as may be necessary for proper identification of the chart.

Facsimile schedules are not continuous, and transmission times vary among stations. A station normally broadcasts for 8 or 9 hours of the 24. All stations transmit simultaneously on either three or four frequencies. At least one schedule is intercepted by one or more stations to satisfy requirements of local weather activities or for purposes of training personnel in operating and maintaining facsimile equipment.

Before commencing a schedule, a station makes a 5-minute series of test calls. These test calls consist of a series of Vs, followed

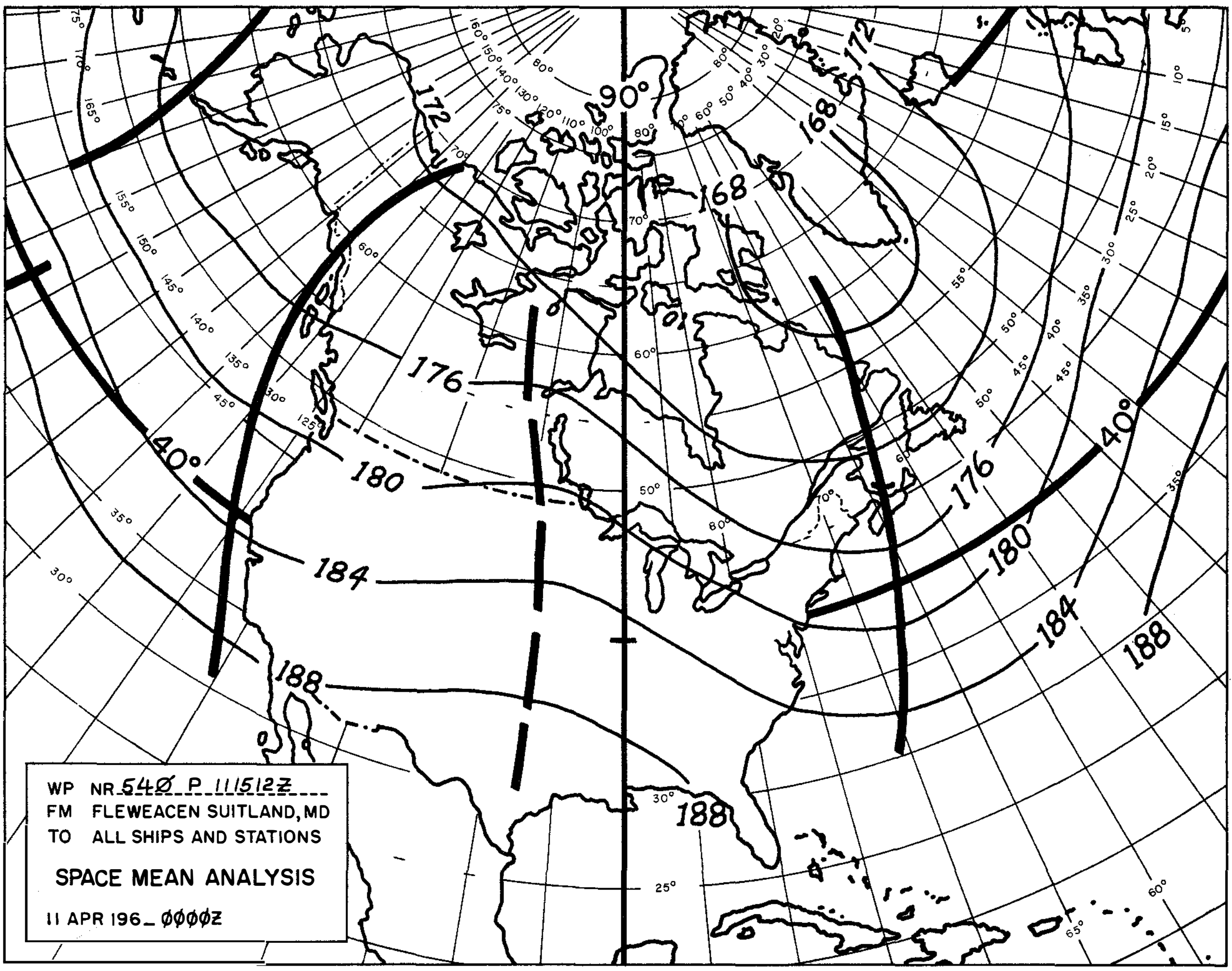



Figure 6-2.—Weather chart transmitted on Washington FAX broadcast. 76.11

by DE and its call, and the letter designator of the broadcast made 3 times. Example:

VVV VVV VVV DE NSS NSS NSS WP WP WP

After test calls are transmitted, and at least 2 minutes before scheduled broadcast time, a synchronous signal is transmitted. This signal permits receiving stations to synchronize their equipment with the transmitting station.

The last item of each day's transmission is the station log of messages sent. The log consists of station serial numbers, a short description of the contents of each item of traffic, and the TOD. By means of the log, receiving stations are enabled to request repetitions of messages missed that still would be of value to them. Because weather information is timely for only a few hours, charts whose valid times have expired are not usually requested.

Normally, requests for repetitions received by a transmitting station are answered on the first schedule after receipt of the request.

A vessel wishing to transmit facsimile traffic to a shore station or to another ship makes advance arrangements, advising the accepting station of the time of the intended transmission and the frequency to be used.

## DRILL CIRCUITS

Radio drill circuits provide a valuable opportunity for live, "on-the-air" operator training.

Each ship participating in such a drill transmits both plain language and simulated encrypted drill messages to other ships in the net.

Drill circuits are established at most ports having a concentration of naval ships. Drills are conducted in strict compliance with correct operating procedures. Prompt, on-the-spot corrections of procedural errors by the control station are a big help to the CW operator in maintaining his proficiency.

For participating in the drill, CW operators are classified into two groups, according to skill. Class 2 is for less experienced operators capable of 10 to 15 wpm. In class 1 are those operating at more than 15 wpm. Radiomen should qualify for the class of drill being conducted. Class 2 operators should not participate in a class 1 drill, nor should class 1 operators be assigned to a class 2 circuit.

Most CW drill circuits operate daily except weekends and holidays. The usual schedule provides for 2 hours for class 2 operators in the mornings, and 1-1/2 hours for class 1 operators in the afternoons. The shore station conducting the drill monitors the drill or may designate another station to monitor. Monitoring consists of keeping an accurate intercept log of every transmission heard on the circuit. Upon completion of a drill, the monitor log is examined and each ship is sent a copy of the log or a summary indicating errors noted, with corrections referencing appropriate publications.

As a result of own ship's operations, RMs often obtain little or no CW transmitting experience. Never fail, therefore, to take advantage of every opportunity to participate in a CW drill.

Besides training in radiotelegraph, drill periods are scheduled also for radiotelephone or radioteletypewriter operators.

# CHAPTER 7

# RADIOTELEPHONE

Most aspects of radiotelegraph nets have counterparts in radiotelephone. As in radiotelegraph, a radiotelephone net is an organization of two or more stations in direct communication on a common channel. One station in the net (the net control station) is in charge. Radiotelephone nets are either free or directed.

Lessons learned about radiotelegraph operating and circuit discipline also apply to radiotelephone. Abide by the instructions of the net control station, keep a good log, and stand a taut watch.

## MICROPHONE TECHNIQUE

The following guide should be used in developing good microphone technique. Practice the do's but avoid the don'ts. Remember, though, that nothing can take the place of good commonsense.

### DO's

1. Listen before transmitting. Unauthorized break-in causes confusion and often blocks a transmission in progress to the extent that neither transmission gets through.
2. Speak clearly and distinctly. Both slurred syllables and clipped speech are hard to understand. A widespread error among untrained operators is failure to emphasize vowels sufficiently.
3. Speak slowly. Unless the action officer is listening, he must rely on the copy being typed or written. Give the recorder a chance to get it all down. That way you save time and avoid repetitions.
4. Avoid extremes of pitch. A high voice cuts through interference best, but is shrill and unpleasant if too high. A lower pitch is easier on the ear, but is difficult to understand through background noises if too low.
5. Be natural. Maintain a normal speaking rhythm. Group words in a natural manner. Send your message phrase by phrase instead of word by word.
6. Use standard pronunciation. Speech with sectional peculiarities is difficult for persons from other parts of the country to understand. Talkers who use as a model the almost standard pronunciation of a broadcast network announcer are easiest to understand.
7. Speak in a moderately strong voice in order to override unavoidable background noises and prevent dropouts.
8. Keep correct distance between lips and microphone. A distance of about 2 inches is correct for most microphones. If the distance is too great, speech is inaudible and background noises creep in; if too small, blaring and blasting result.
9. Shield your microphone. Keep your head and body between noise-generating sources and the microphone while transmitting.
10. Keep the volume of a handset earphone low.
11. Keep speaker volumes to a moderate level.
12. Give an accurate evaluation in response to a request for a radio check. A transmission with feedback or a high level of background noise is not "loud and clear," even though the message can be understood.
13. Pause momentarily, after each normal phrase, and interrupt your carrier. This method allows any other station with higher precedence traffic to break in.
14. Adhere strictly to prescribed procedures. Up-to-date radiotelephone procedure is found in the effective edition of ACP 125.
15. Transact your business and get off the air. Preliminary calls waste time when

communications are good and the message is short. It is not necessary to blow into a microphone to test it, nor to repeat portions of messages when no repetition is requested.

DON'Ts

1. Transmit while surrounded by other persons loudly discussing the next maneuver or event. It confuses receiving stations, and a serious security violation can result.
2. Hold the microphone button in the push-to-talk position until absolutely ready to transmit. Your carrier will block communications on the net.
3. Hold a handset in such a position while speaking that there is a possibility of having feedback from the earphone added to other background noises.
4. Hold a handset loosely. A firm pressure on the microphone button prevents unintentional release and consequent signal dropout.
5. Tie up a circuit with test signals. Usually 10 seconds is sufficient for testing.

## PRONOUNCING NUMERALS

Care must be taken to distinguish numerals from similarly pronounced words. Pronounce numerals as indicated in the accompanying lists.

| Numeral | Pronounced |
|---|---|
| Ø | Zero |
| 1 | Wun |
| 2 | Too |
| 3 | Thuh-ree |
| 4 | Fo-wer |
| 5 | Fi-yiv |
| 6 | Six |
| 7 | Seven |
| 8 | Ate |
| 9 | Niner |

The numeral Ø is always spoken as "zero" - never as "oh." Decimal points are spoken as "day-see-mal."

In general, numbers are transmitted digit by digit, except that exact multiples of hundreds and thousands are spoken as such. However, there are special cases when the normal pronounciation is prescribed and this rule does not apply (17 would then be "seventeen"). Examples:

| Number | Pronounced |
|---|---|
| 12 | Twelve |
| 44 | Fo-wer fo-wer |
| 90 | Niner zero |
| 136 | Wun thuh-ree six |
| 500 | Fi-yiv hun-dred |
| 1478 | Wun fo-wer seven ate |
| 7000 | Seven thow-zand |
| 16,000 | Wun six thow-zand |
| 16,400 | Wun six fo-wer hun-dred |
| 812,681 | Ate wun too six ate wun |

## PHONETIC ALPHABET

Many letters of the alphabet sound alike. For this reason, the standard phonetic equivalents of the letters of the alphabet are used in radiotelephone communications. Correct pronunciation of the phonetic alphabet is important and should be practices at every opportunity.

## PROWORDS

Prowords (procedure words) are the radiotelephone equivalents of prosigns. They are words and phrases that have predetermined meanings, and are used to expedite message handling on radiotelephone circuits. Many prowords and prosigns have exactly the same meaning. They also are used in the same manner.

A list of prowords (except for precedence prowords), together with an explanation of

| Letter | Phonetic Equivalent | Spoken |
|---|---|---|
| A | ALFA | AL fah |
| B | BRAVO | BRAH voh |
| C | CHARLIE | CHAR lee |
| D | DELTA | DELL ta |
| E | ECHO | ECK oh |
| F | FOXTROT | FOKS trot |
| G | GOLF | GOLF |
| H | HOTEL | hoh TELL |
| I | INDIA | IN dee ah |
| J | JULIETT | JEW lee ett |
| K | KILO | KEY loh |
| L | LIMA | LEE mah |
| M | MIKE | MIKE |
| N | NOVEMBER | no VEM ber |
| O | OSCAR | OSS cah |
| P | PAPA | pah PAH |
| Q | QUEBEC | keh BECK |
| R | ROMEO | ROW me oh |
| S | SIERRA | see AIR rah |
| T | TANGO | TANG go |
| U | UNIFORM | YOU nee form |
| V | VICTOR | VIK tah |
| W | WHISKEY | WISS key |
| X | XRAY | ECKS ray |
| Y | YANKEE | YANG key |
| Z | ZULU | ZOO loo |

each and the corresponding prosign (if one exists), is given in table 7-1. Learn them now, because they will be used often. Precedence of a radiotelephone message is indicated by the actual word(s) of the precedence. (Example: PRIORITY, IMMEDIATE, and so on.)

## RADIOTELEPHONE MESSAGES

Radiotelephone uses a 16-line message format that is comparable to formats in radiotelegraph and teletypewriter communications. It also has the same three military message forms: plaindress, abbreviated plaindress, and codress. By far the most common message form in radiotelephone traffic is the abbreviated plaindress. Often it is so abbreviated that its resemblance to the basic message format is barely detectable. The three major message parts are still there: heading, text, and ending. Each of these major parts — as in radiotelegraph — can be reduced to parts, components, elements, and contents.

Table 7-2 shows the correct arrangement of a radiotelephone message. All the parts, components, elements, or contents are not necessarily included in any one message. When one of them is used, it must be placed in the message in the order in which it appears in the table.

### HEADING

The heading of a radiotelephone message may include any or all of the first 10 procedural lines shown in table 7-2. More often than not, though, it includes only the call, preceding the text. One explanation for such general use of the abbreviated form is that radiotelephone communication nearly always is conducted with the station originating and the station addressed in direct communication.

### TEXT

The text of the radiotelephone message is the basic thought or idea the originator wishes to communicate. It may be in the form of plain language, code words, cipher groups, or numerals.

Difficult words or groups within the text of a plain language message are spelled out in the phonetic alphabet. Groups or words to be spelled are preceded by the proword I SPELL. If the operator can pronounce the word, he should do so before and after spelling it.

#### Abbreviations In The Text

Dates within the text should be spoken digit by digit and the month spoken in full.

Example:

"19 Sep" is spoken as "One niner September."

Abbreviated initials may be transmitted in one of two ways. If the phoneticized initials are shorter than the complete words, the initials shall be spoken phonetically, omitting any periods.

Example:

"ACP" should be spoken as "Alfa Charlie Papa."

If the spelled out initials are shorter than the phoneticized version, the complete words may be used, followed by the word abbreviated.

Table 7-1.—Radiotelephone Prowords

| Proword | Explanation | Proword Equivalent |
|---|---|---|
| ADDRESS GROUP | The group that follows is an address group. | |
| ALL AFTER | The portion of the message to which I have reference is all which follows ________________. | AA |
| ALL BEFORE | The portion of the message to which I have reference is all that precedes __________. | AB |
| AUTHENTICATE | The station called is to reply to the challenge which follows. | |
| AUTHENTICATION IS | The transmission authentication of this message is ___________. | |
| BREAK | I hereby indicate the separation of the text from other portions of the message. | BT |
| CALL SIGN | The group that follows is a call sign. | |
| CORRECT | You are correct, or what you have transmitted is correct. | C |
| CORRECTION | An error has been made in this transmission. Transmission will continue with the last word correctly transmitted. | EEEEEEEE |
| | An error has been made in this transmission (or message indicated). The correct version is ___________. | C |
| | That which follows is corrected version in answer to your request for verification. | C |
| DISREGARD THIS TRANSMISSION-OUT | This transmission is in error. Disregard it. This proword shall not be used to cancel any message that has been completely transmitted and for which receipt or acknowledgment has been received. | EEEEEEEE $\overline{\text{AR}}$ |
| DO NOT ANSWER | Stations called are not to answer this call, receipt for this message, or otherwise to transmit in connection with this transmission. When this proword is employed, the transmission shall be ended with the proword "OUT." | F |
| EXECUTE | Carry out the purport of the message or signal to which this applies. To be used only with the Executive Method. | $\overline{\text{IX}}$ (5 sec dash) |
| EXECUTE TO FOLLOW | Action on the message or signal which follows is to be carried out upon receipt of the proword "EXECUTE." To be used only with the Delayed Executive Method. | $\overline{\text{IX}}$ |
| EXEMPT | The addressees immediately following are exempted from the collective call. | XMT |
| FIGURES | Numerals or numbers follow. | |
| FLASH | Precedence FLASH. | Z |
| FROM | The originator of this message is indicated by the address designator immediately following. | FM |
| GROUPS | This message contains the number of groups indicated by the numeral following. | GR |
| GROUP NO COUNT | The groups in this message have not been counted. | GRNC |
| I AUTHENTICATE | The group that follows is the reply to your challenge to authenticate. | |
| IMMEDIATE | Precedence IMMEDIATE. | O |
| IMMEDIATE EXECUTE | Action on the message or signal following is to be carried out on receipt of the word EXECUTE. To be used only with the Immediate Executive Method. | $\overline{\text{IX}}$ |
| INFO | The addressees immediately following are addressed for information. | INFO |
| I READ BACK | The following is my response to your instruction to read back. | |
| I SAY AGAIN | I am repeating transmission or portion indicated. | $\overline{\text{IMI}}$ |
| I SPELL | I shall spell the next word phonetically. | |
| I VERIFY | That which follows has been verified at your request and is repeated. To be used only as a reply to VERIFY. | |
| MESSAGE | A message which requires recording is about to follow. Transmitted immediately after the call. (This proword is not used on nets primarily employed for conveying messages. It is intended for use when messages are passed on tactical or reporting nets.) | |

76.45.1

Table 7-1.—Radiotelephone Prowords - Continued

| Proword | Explanation | Proword Equivalent |
|---|---|---|
| NET NOW | All stations are to net their radios on the unmodulated carrier wave which I am about to transmit. | |
| NUMBER | Station Serial Number. | NR |
| OUT | This is the end of my transmission to you and no answer is required or expected. | |
| OVER | This is the end of my transmission to you and a response is necessary. Go ahead; transmit. | K |
| PRIORITY | Precedence PRIORITY. | P |
| READ BACK | Repeat this entire transmission back to me exactly as received. | G |
| REBROADCAST YOUR NET | Link the two nets under your control for automatic rebroadcast. | |
| RELAY (TO) | Transmit this message to all addressees immediately following. | T |
| ROGER | I have received your last transmission satisfactorily. | R |
| ROUTINE | Precedence ROUTINE. | R |
| SAY AGAIN | Repeat all of your last transmission. Followed by identification data means "Repeat ___________(portion indicated)." | |
| SERVICE | The message that follows is a service message. | SVC |
| SIGNALS | The groups which follow are taken from a signal book. (This proword is not used on nets primarily employed for conveying signals. It is intended for use when tactical signals are passed on nontactical nets.) | |
| SILENCE (Repeated three or more times) | Cease transmissions on this net immediately. Silence will be maintained until lifted. (When an authentication system is in force the transmission imposing silence is to be authenticated.) | $\overline{HM}$ $\overline{HM}$ $\overline{HM}$ |
| SILENCE LIFTED | Silence is lifted. (When an authentication system is in force the transmission lifting silence is to be authenticated.) | |
| SPEAK SLOWER | Your transmission is at too fast a speed. Reduce speed of transmission. | |
| STOP REBROADCASTING | Cut the automatic link between the two nets that are being rebroadcast and revert to normal working. | |
| THIS IS | This transmission is from the station whose designator immediately follows. | DE |
| TIME | That which immediately follows is the time or date-time group of the message. | |
| TO | The addressees immediately following are addressed for action. | TO |
| UNKNOWN STATION | The identity of the station with whom I am attempting to establish communication is unknown. | $\overline{AA}$ |
| VERIFY | Verify entire message (or portion indicated) with the originator and send correct version. To be used only at the discretion of or by the addressee to which the questioned message was directed. | J |
| WAIT | I must pause for a few seconds. | $\overline{AS}$ |
| WAIT-OUT | I must pause longer than a few seconds. | $\overline{AS}$ $\overline{AR}$ |
| WILCO | I have received your signal, understand it, and will comply. To be used only by the addressee. Since the meaning of ROGER is included in that of WILCO, the two prowords are never used together. | |
| WORD AFTER | The word of the message to which I have reference is that which follows _________. | WA |
| WORD BEFORE | The word of the message to which I have reference is that which precedes _____________________________. | WB |
| WORDS TWICE | Communication is difficult. Transmit(ting) each phrase (or each code group) twice. This proword may be used as an order, request, or as information. | |
| WRONG | Your last transmission was incorrect. The correct version is______. | |

76.45.2

Table 7-2.—Radiotelephone Message Format

| Parts | Components | Elements | Format Line | Contents |
|---|---|---|---|---|
| HEADING | Procedure | | 1 | (Not used in radiotelephone.) |
| | | a. Call | 2 and 3 | Station(s) called (proword EXEMPT, exempted calls). Proword THIS IS and station calling. |
| | | b. Message follows | | Proword MESSAGE. |
| | | c. Transmission identification | | Proword NUMBER and station serial number. |
| | | d. Transmission instructions | 4 | Prowords RELAY TO; READ BACK; DO NOT ANSWER; words twice. Operation signals; call signs; address groups; address indicating groups; plain language designator. |
| | Preamble | a. Precedence; date-time group; message instructions | 5 | Precedence designation. Proword TIME; date and time expressed in digits and zone suffix; operating signals. |
| | Address | a. Originator's sign; originator | 6 | Proword FROM; originator's address designator. |
| | | b. Action addressee sign; action addressee | 7 | Proword TO; action addressee designator. |
| | | c. Information addressee sign; information addressee | 8 | Proword INFO; information addressee designator. |
| | | d. Exempted addressee sign; exempted addressee | 9 | Proword EXEMPT; exempted addressee designator. |
| | Prefix | a. Accounting information; group count; SVC | 10 | Accounting symbol; group count; proword SERVICE. |
| SEPARATION | | | 11 | Proword BREAK. |
| TEXT | Text | a. Subject matter | 12 | Internal instructions; thought or idea as expressed by the originator. |
| SEPARATION | | | 13 | Proword BREAK. |
| ENDING | Procedure | a. Time group | 14 | Proword TIME. Hours and minutes expressed in digits and zone suffix, when appropriate. |
| | | b. Final instructions | 15 | Prowords WAIT, CORRECTION, AUTHENTICATION IS; station designators. |
| | | c. Ending sign | 16 | Prowords OVER; OUT. |

76.46

Example:

"USS FORRESTAL" may be spoken as "United States Ship ABBREVIATED–FORRESTAL."

Personal initials shall be spoken phonetically prefixed by the word "INITIALS."

Example:

"G.M. SMITH" is spoken as "INITIALS Golf Mike Smith."

ENDING

Every radiotelephone message ends with the proword OVER or OUT. With OVER, the sender tells the receiver to go ahead and transmit, or "This is the end of my transmission to you and a response is necessary." With the proword OUT, the sender tells the receiver: "This is the end of my transmission to you, and no response is required." These two ending prowords never are used together.

## CODE AND CIPHER MESSAGES

Code words (such as LIBRA in the text EXECUTE PLAN LIBRA) are sent as plain language words. Encrypted groups such as BAXTO are spelled phonetically: BRAVO ALFA XRAY TANGO OSCAR.

The phonetic alphabet is applied not only to letters of the alphabet, but also to the names of the signal flags. Flag A is ALFA, flag B is BRAVO, and so on. Signal flags are combined into code groups that have meanings of their own. ECHO KILO TWO, for example, might mean "anchor is dragging." Meanings of such code groups are given in appropriate signal publications.

It may sound strange to a Radioman that flag signals are sent by radiotelephone, but they are; this procedure happens often. A Radioman must be able to recognize whether he is hearing a flag signal or a word or group spelled phonetically. Here is how to differentiate: If the phonetic alphabet is used, the proword I SPELL precedes it, and each phonetic letter is to be recorded as a letter. If you hear I SPELL, followed by DELTA OSCAR, write it as DO. Without that proword, assume the alphabet flags are intended, and record the transmission as DELTA OSCAR.

## SIGNAL FLAGS AND PENNANTS

A Radioman need not be expert in visual signaling, but should be acquainted with the names of flags and pennants. Flag signaling makes use of the alphabet flags already mentioned, and also numeral flags, numeral pennants, and a set of additional flags and pennants with special meanings. Alphabet flags represent letters; numeral flags, numbers. Numeral pennants are used only in calls. Special flags are used to direct changes in speed, position, formation, and course in tactical maneuvers; indicate units; identify units; and for other specialized purposes. Names of the special flags or pennants and their spoken and written equivalent are given in the following list.

| Flag or Pennant | Spoken | Written |
|---|---|---|
| CODE or ANSWER | CODE or ANSWER | CODE or ANS |
| BLACK PENNANT | BLACK PENNANT | BLACK |
| CORPEN | CORPEN | CORPEN |
| DESIGNATION | DESIG | DESIG |
| DIVISION | DIV | DIV |
| EMERGENCY | EMERGENCY | EMERG |
| FLOTILLA | FLOT | FLOT |
| FORMATION | FORMATION | FORM |
| INTERROGATIVE | INTERROGATIVE | INT |
| NEGATIVE | NEGAT | NEGAT |
| PREPARATIVE | PREP | PREP |
| PORT | PORT | PORT |
| SPEED | SPEED | SPEED |
| SQUADRON | SQUADRON | SQUAD |
| STARBOARD | STARBOARD | STBD |
| STATION | STATION | STATION |
| SUBDIVISION | SUBDIV | SUBDIV |
| TURN | TURN | TURN |

Besides special flags or pennants, there are the 1st, 2nd, 3rd, and 4th substitute flags. They are used only for flag communication, however, and are of no concern to a radiotelephone operator.

Separations in flag signals are indicated by the tackline. This is spoken and written TACK.

The preparative, interrogative, and negative pennants are known as governing pennants. In flag signaling they are hoisted either above or below a signal, whereas in radiotelephone operation they are transmitted as the first or last part of a signal. In either usage their meanings are as follows:

| Before signal | Pennant | After signal |
|---|---|---|
| Prepare to -----. | PREP | My present intention is to ---------. |
| Questions or inquiries. | INT | Request permission to ------------. |
| Cease, do not -----. | NEGAT | Action is not being carried out. |

## OPERATIONAL BREVITY CODES

A radiotelephone operator's duties require that he know and use correctly the special "language" developed for tactical maneuvering, air control, anti-air warfare, naval gunfire support, electronic countermeasures, antisubmarine warfare, and other specialized uses. Words, phrases, and abbreviations employed in radiotelephone for these specialized uses are called operational brevity codes.

For a complete list of operational brevity code words, refer to the effective edition of ACP 165. That publication is divided into sections according to subject area. Major section headings, along with representative code words from each section, are presented here to acquaint RMs with the type of information contained in the publication.

Section 1—General. (Includes surveillance, warning, reporting, aircraft control, airborne early warning, search and rescue, and electronic readiness conditions and duties.)

ABORT(ING): Cancel mission. I am (or contact designated) unable to continue mission.

BOGEY: An air contact that is unidentified but assumed to be enemy.

CHICKS: Friendly fighter aircraft.

SKUNK: A surface contact that is unidentified but assumed to be enemy.

YELLOW JACKET: Survivor in the sea wearing a lifejacket.

Section 2—Anti-air warfare coordination.

GUNS/WEAPONS FREE: Fire may be opened on all aircraft not recognized as friendly.

WARNING RED: Attack by hostile aircraft is imminent.

Section 3—Carrier deck conditions and flight operations.

ASSUME DECK: Carrier prepare deck for possible emergency landing of aircraft as soon as possible.

SLINGSHOT: Launch by catapult.

Section 4—Aircraft conditions of readiness and missions.

AUTOCAT: Automatic relay plane (radio).

SHECAT: Mine-laying plane.

Section 5—Undersea warfare.

BROTHER: Attack ship of surface ASW unit.

COLD: A/S contact has been lost.

SINKER: A radar contact that later disappeared.

SPOOK: Unidentified surface contact that is possibly an enemy submarine.

WOLF: Visually identified enemy submarine.

Section 6—Small surface craft control and direction.

BULLY: Concentrate attack on my target or target designated.

Section 7—Minesweeping operations.

DAISY: Moored mine.

Section 8—Electronic warfare.

CHATTER: Communications jamming.

HOOTER: Jammer.

SCRUB: Erase the contact designated from all plots.

The final section of ACP 165 is an alphabetical decode listing of the code words.

One must understand that words and phrases of the brevity code provide no communication security. The purposes of the codes are to (1) standardize the vocabulary, (2) increase accuracy of transmission, and (3) shorten transmission time.

## RADIOTELEPHONE CALL SIGNS

Call signs employed in radiotelephone are more commonly known as voice call signs. They consist of spoken words, which can be transmitted and understood more rapidly and more effectively than actual names of ships and afloat commands, or phonetic equivalents or international radio call signs. Under certain circumstances, however, the phonetically spelled international call sign is used in radiotelephone for station identification. At other times a ship's name serves as the call sign. These usages are explained in later paragraphs. First, consider the voice call signs contained in the JANAP 119 series.

## JANAP 119 VOICE CALLS

Voice call signs in JANAP 119 are pronounceable words taken from the English language. They are tactical in nature, and are designed to facilitate speed on tactical radio nets.

A method of deriving voice call signs from military call signs listed in the ACP 113 series is described in ACP 119. At the present time both ACP 119 and JANAP 119 are used for deriving voice call signs. Both publications should be studied carefully.

## USE OF INTERNATIONAL CALL SIGNS

Administrative shore activities are not assigned call signs in JANAP 119. Consequently, a ship cannot use her voice call sign on administrative ship-shore circuits. When operating on ship-shore radiotelephone circuits, ships must use their international call signs, spoken phonetically. Example: international call sign NHDY is spoken NOVEMBER HOTEL DELTA YANKEE.

## LOCAL HARBOR VOICE CIRCUITS

As may be seen from the preceding example, the use of phoneticized four-character call signs is extremely cumbersome for voice circuit operation. It tends to overload voice circuits, particularly in busy harbors, and provides absolutely no security. For these reasons, a separate and simplified procedure is prescribed in DNC 5 (effective edition) for local harbor voice circuits when security of the message address is not a requirement.

In U.S. ports and U.S.-controlled ports overseas, names of ships and abbreviations of administrative activity titles serve as voice call signs. As a general rule, the USS prefix, hull designations and numbers, and first names or initials of ships need not be included in the voice call unless they are essential for clarity. Even when essential for clarity, it is unnecessary to use the phonetic equivalents for letters and initials.

Port authorities controlling local harbor voice circuits are identified by the word CONTROL. On local harbor circuits established for specific purposes, such as for degaussing, tug, and shipyard services, CONTROL is preceded by the appropriate word describing the service.

The following examples illustrate the simplified voice call procedure. (Words in parentheses in the examples should not be used unless essential for clarity or to avoid confusion. Portions of examples marked with an asterisk (*) are spoken without phonetics.)

(NEWPORT) CONTROL THIS IS (*USS) ROANOKE COMDESRON TWELVE THIS IS (NORFOLK) DEGAUSSING CONTROL THIS IS (*TJ) GARY (PORTSMOUTH) SHIPYARD CONTROL THIS IS (*USS) FORRESTAL (FRANKLIN *D) ROOSEVELT THIS IS (CHARLSTON) CONTROL (NEW YORK) TUG CONTROL THIS IS *LSM ONE SIX ZERO (NORFOLK) FUEL CONTROL THIS IS (*USNS) PECOS.

Remember that the simplified type of call is authorized only in U.S. ports or U.S.-controlled ports. If a ship is in a port that is not under U.S. control, she must conform to the international practice of using phoneticized international call signs on radiotelephone circuits.

## RADIOTELEPHONE PROCEDURE

A radiotelephone circuit would soon become confusing if everyone on the circuit failed to follow the same rules and procedures. The remainder of this chapter is devoted to proper operating procedures applicable to radiotelephone communication.

Examples of radiotelephone transmissions are assumed to pass over the net shown in figure 7-1. Dashes in the examples indicate natural pauses.

## CALLING AND ANSWERING

Radiotelephone communication is established by a preliminary call and the answer thereto. In discussing radiotelegraph procedure in chapter 6, it was found that a preliminary call may be made to individual station(s) or to a group of stations collectively. It was learned also that a reply to a preliminary call may be abbreviated in certain instances.

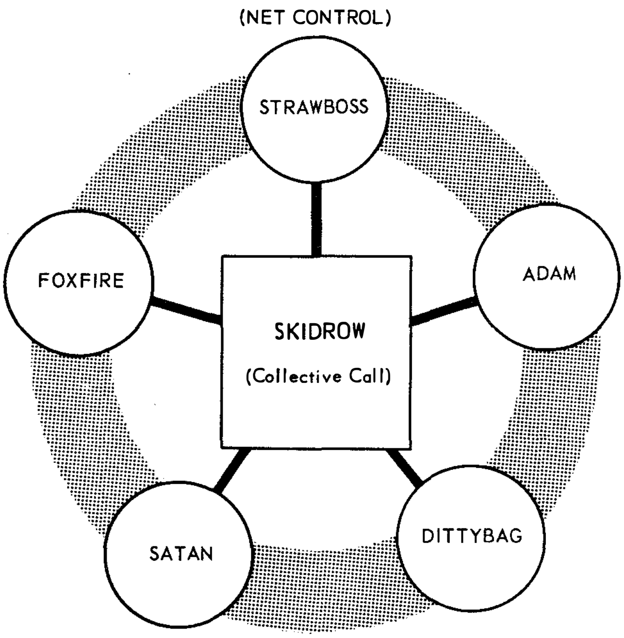



Figure 7-1.—Radiotelephone net

Single Call

A single call takes the following form:

| | |
|---|---|
| FOXFIRE — .......... | Call sign of station called. |
| THIS IS .............. | From. |
| STRAWBOSS — ........ | Call sign of station calling. |
| OVER ................ | Go ahead; transmit. |

The reply is in the same form: STRAWBOSS — THIS IS FOXFIRE — OVER. In this instance a single station was called. If two or more stations were called, they would reply in alphabetical order of call signs.

Collective Call

When stations on the net are assigned a collective call, the collective call is used if all stations are addressed. When necessary, the collective call contains the proword EXEMPT, followed by the call sign of station(s) exempted from the collective call. Example:

| | |
|---|---|
| SKIDROW — ......... | Net call. |
| EXEMPT ............ | Exempt. |
| DITTYBAG — ........ | Call sign of exempted station. |
| THIS IS ............. | From. |
| STRAWBOSS ......... | Call sign of station calling. |
| OVER ............... | Go ahead; transmit. |

ADAM, FOXFIRE, and SATAN now answer in alphabetical order of call signs.

Abbreviated Call

The call sign of the called station may be omitted when the call is part of an exchange of transmissions between stations and when no confusion is likely to result. For example, FOXFIRE and SATAN receive a preliminary call from STRAWBOSS and reply:

THIS IS FOXFIRE — OVER
THIS IS SATAN — OVER

CLEARING TRAFFIC

With communication established, STRAWBOSS commences clearing traffic. Transmissions and their meanings are given in the accompanying list.

| Transmission | Meaning |
|---|---|
| FOXFIRE — ..... <br> SATAN — ....... | Call signs of receiving stations. |
| THIS IS ......... | From. |
| STRAWBOSS — .. | Call sign of sending station. |
| MESSAGE — ..... | A message that requires recording is about to follow. |
| ROUTINE ........ | Precedence. |
| TIME ........... | Time of origin is -----. |
| ONE TWO ONE SIX FIVE NINE ZULU | |
| FEB. 67 | DTG |
| FROM — ........ | Originator of this message is -----. |
| STRAWBOSS — .. | Call sign of originator. |
| TO — .......... | Action addressee is ---. |
| SATAN — ....... | Call sign of action addressee. |

| | |
|---|---|
| INFO — ......... | Information addressee is ----. |
| FOXFIRE — ..... | Call sign of information Addressee. |
| GROUPS EIGHT.. | Group count. |
| BREAK — ....... | Separation of text from other portions of message. |
| UNCLAS GO ALONGSIDE FOXFIRE AND EFFECT PERSONNEL TRANSFER —. | Thought or idea conveyed by message. |
| BREAK — ....... | Separation of text from other portions of message. |
| OVER — ........ | Go ahead; transmit. |

On hearing the proword OVER, receiving stations check the message to see that it was received fully and correctly. When assured that it was, they receipt by sending the proword ROGER, which means "I received your last transmission satisfactorily." Example:

THIS IS FOXFIRE—ROGER—OUT
THIS IS SATAN—ROGER—OUT

REPETITIONS

When words are missing or are doubtful, repetition is requested by the receiving station. The proword SAY AGAIN (along or with ALL BEFORE, ALL AFTER, WORD BEFORE, WORD AFTER, and ____TO____) is for this purpose. In complying with such requests, the transmitting station identifies that portion to be repeated. Examples: DITTYBAG sent a message to SATAN. SATAN missed the word after "ship."
SATAN transmits:

DITTYBAG — THIS IS SATAN — SAY AGAIN — WORD AFTER SHIP — OVER

DITTYBAG replies with:

SATAN — THIS IS DITTYBAG — I SAY AGAIN—WORD AFTER SHIP—SIGHTED—OVER

After receiving the doubtful portion, DITTYBAG receipts for the entire message.

Repetitions may be given in plain language messages by natural phrases or by individual words. In encoded or encrypted messages, they are made by individual characters.

CORRECTING ERRORS

When an error is made by a transmitting operator, the proword CORRECTION is sent. The operator then repeats the last word, group, proword, or phrase correctly sent, corrects the error, and proceeds with the message. Example:

ADAM—THIS IS STRAWBOSS—TIME ONE ZERO ONE TWO ZULU—BREAK—UNCLAS—CONVOY ROMEO THREE—CORRECTION — CONVOY SIERRA ROMEO THREE—SHOULD ARRIVE—ONE SIX THREE ZERO LIMA—OVER

If the error is not discovered until the operator is some distance beyond it, he may make the correction at the end of the message. He must be careful to identify the exact position he is correcting. Example:

ADAM — THIS IS STRAWBOSS — TIME ZERO SIX THREE ZERO ZULU — BREAK—UNCLAS—ARE YOU RIGGED FOR HEAVY WEATHER — CORRECTION—TIME ZERO SIX FOUR ZERO ZULU—OVER

CANCELING MESSAGE DURING TRANSMISSION

During transmission of a message and before transmitting the ending proword OVER or OUT, the message may be canceled by sending the proword DISREGARD THIS TRANSMISSION-OUT. (A message already transmitted can be canceled only by another message.) During transmission of a message, for instance, STRAWBOSS discovers he is giving it to the wrong station:

FOXFIRE—THIS IS STRAWBOSS—ROUTINE — TIME ONE TWO ZERO SIX ZERO TWO ZULU — AUG 67 — UNCLAS — COMMENCE UNLOADING AT DAWN SIXTEENTH — PROCEED—DISREGARD THIS TRANSMISSION — OUT

DO NOT ANSWER

When it is imperative that called stations do not answer a transmission, the proword DO NOT ANSWER is transmitted immediately after the call or the proword MESSAGE (if used). The complete transmission is sent twice. Example:

SKIDROW—THIS IS STRAWBOSS—DO NOT ANSWER—IMMEDIATE—TIME ONE SIX THREE ZERO ZULU—BREAK—NOVEMBER YANKEE DELTA PAPA—I SAY AGAIN—SKIDROW—THIS IS STRAWBOSS—DO NOT ANSWER—IMMEDIATE—TIME ONE SIX THREE ZERO ZULU—BREAK—NOVEMBER YANKEE DELTA PAPA—OUT

VERIFICATIONS

When verification of a message is requested, the originating station verifies the message with the originating person, checks the cryptography (if the message is encrypted), and sends the correct version.

- Example 1:

STRAWBOSS—THIS IS ADAM—VERIFY YOUR ONE ZERO ZERO EIGHT ZERO ONE ZULU—AUGUST 67—ALL BEFORE BREAK—OVER

STRAWBOSS transmits:

THIS IS STRAWBOSS—ROGER—OUT

After checking with the originating officer, STRAWBOSS finds the heading correct as transmitted previously. He then sends:

ADAM—THIS IS STRAWBOSS—I VERIFY—MY ONE ZERO ZERO EIGHT ZERO ONE ZULU—AUGUST 67—ALL BEFORE BREAK—PRIORITY—TIME ONE ZERO ZERO EIGHT ZERO ONE ZULU—AUGUST 67—FROM—STRAWBOSS—TO—ADAM—INFO—DITTY-BAG—GROUPS ONE SEVEN-BREAK—OVER

ADAM receipts for the transmission:

THIS IS ADAM—ROGER—OUT

- Example 2:

STRAWBOSS—THIS IS SATAN—VERIFY YOUR ZERO EIGHT FOUR FIVE ZULU—WORD AFTER PROCEED—OVER

STRAWBOSS transmits:

THIS IS STRAWBOSS—ROGER—OUT

After checking with the originating officer, STRAWBOSS finds that he means HONGKONG instead of SHANGHAI as the word after PROCEED. STRAWBOSS transmits:

SATAN—THIS IS STRAWBOSS—CORRECTION—MY ZERO EIGHT FOUR FIVE ZULU—WORD AFTER PROCEED—HONGKONG—OVER

SATAN receipts:

THIS IS SATAN—ROGER—OUT

READ BACK AND WORDS TWICE

Further checks on transmission accuracy can be made by the prowords READ BACK and WORDS TWICE. READ BACK is sent when a sender wants his message (or a portion of it) repeated back to him as received. Remember to identify the message or portion to be read back. Transmit the READ BACK proword immediately after the call or the proword MESSAGE FOLLOWS, if used. Example:

ADAM—THIS IS STRAWBOSS—READ BACK TEXT—TIME ONE SIX THREE ZERO ZULU—BREAK—UNCLAS—CONVOY DELAYED ONE TWO HOURS—BREAK—OVER

ADAM replies:

THIS IS ADAM—I READ BACK TEXT—UNCLAS—CONVOY DELAYED ONE TWO HOURS—OVER

STRAWBOSS then sends:

THIS IS STRAWBOSS—THAT IS CORRECT—OUT

NOTE: When READ BACK is employed, the proword ROGER is not necessary to indicate receipt of the message.

If a message is repeated back incorrectly, it may be corrected by sending the proword WRONG, followed by the correct version. In the foregoing example, assume that ADAM made a mistake when he read back the message.

THIS IS ADAM—I READ BACK TEXT—UNCLAS—CONVOY DELAYED TWO ONE HOURS—OVER

STRAWBOSS corrects ADAM:

THIS IS STRAWBOSS—WRONG—UNCLAS—CONVOY DELAYED ONE TWO HOURS—OVER

ADAM reads back again:

THIS IS ADAM—UNCLAS—CONVOY DELAYED ONE TWO HOURS—OVER

STRAWBOSS ends the exchange with:

THIS IS STRAWBOSS—THAT IS CORRECT—OUT

WORDS TWICE is the proword used when communication is difficult. First, the call signs are transmitted twice. Then phrases, words, or groups are spoken twice. Indicate intentions by transmitting WORDS TWICE after the call or the proword MESSAGE, if used. Do not repeat the proword THIS IS. Example:

FOXFIRE—FOXFIRE—THIS IS STRAWBOSS—STRAWBOSS—OVER—OVER

FOXFIRE replies:

STRAWBOSS — STRAWBOSS — THIS IS FOXFIRE — FOXFIRE — OVER —OVER

STRAWBOSS sends his message:

FOXFIRE—FOXFIRE—THIS IS STRAWBOSS—STRAWBOSS—WORDS TWICE—WORDS TWICE — ROUTINE — ROUTINE—TIME ONE TWO ONE SIX THREE ZERO ZULU—AUGUST 67—TIME ONE TWO ONE SIX THREE ZERO ZULU—AUGUST 67—BREAK—BREAK—UNCLAS—UNCLAS—MAIL FOR YOU — MAIL FOR YOU — RECEIVE AT FIRST LIGHT—RECEIVE AT FIRST LIGHT—BREAK—BREAK—OVER—OVER

FOXFIRE receipts:

STRAWBOSS — STRAWBOSS — THIS IS FOXFIRE—FOXFIRE—ROGER—ROGER—OUT—OUT

EXECUTIVE METHOD

The executive method of transmitting radiotelephone messages is employed to execute tactical signals when two or more units are to take action at the same time. Executive method messages usually are in abbreviated form and contain the proword EXECUTE TO FOLLOW or IMMEDIATE EXECUTE, whichever is applicable, immediately after the call. The signal to carry out the meaning of the message is the proword EXECUTE. It may be sent shortly after transmission of the message (normal executive method), much later (delayed executive method), or if urgent, as a part of the final instructions of the message itself (immediate executive method). In any event, a warning STANDBY precedes the proword EXECUTE. Three examples of sending executive method messages follow.

1. In the first example the OTC sends a message to the task group by the normal executive method.

SKIDROW—THIS IS STRAWBOSS—EXECUTE TO FOLLOW—BREAK—CORPEN THREE FIVE SEVEN—OVER

All ships reply in alphabetical order:

THIS IS ADAM—ROGER—OUT
THIS IS DITTYBAG—ROGER—OUT
THIS IS FOXFIRE—ROGER—OUT
THIS IS SATAN—ROGER—OUT

When STRAWBOSS is ready to execute, he sends the executive signal. To save time, only one station (ADAM) is to receipt.

SKIDROW—THIS IS STRAWBOSS—STANDBY—EXECUTE—BREAK—ADAM—OVER

ADAM replies:

THIS IS ADAM—ROGER—OUT

2. A delayed executive method message is handled in exactly the same way as a normal executive method message except that, as a memory refresher, the text of the message is repeated just before giving STANDBY—EXECUTE. Assume that the foregoing message is sent by the delayed executive method. The message is transmitted, and all stations receipt for it as before. But this time STRAWBOSS is not ready to execute until several minutes elapse. When ready, he sends:

SKIDROW—THIS IS STRAWBOSS—
CORPEN THREE FIVE SEVEN—
STANDBY—EXECUTE—BREAK—
ADAM—OVER

ADAM replies:

THIS IS ADAM—ROGER—OUT

3. In the immediate executive method, the text of the message is transmitted twice, separated by I SAY AGAIN. The warning proword IMMEDIATE EXECUTE replaces the proword EXECUTE TO FOLLOW in the message instructions. The executive signal itself is in the final instructions of the message. Because only one transmission is made, the immediate executive method message does not allow stations to obtain verifications, repetitions, acknowledgments, and cancellations befor the message is executed. Example:

SKIDROW—THIS IS STRAWBOSS—IMMEDIATE EXECUTE—BREAK—TURN
NINE—I SAY AGAIN—TURN NINE—
STANDBY—EXECUTE—BREAK—
SATAN—OVER

SATAN receipts:

THIS IS SATAN—ROGER—OUT

ACKNOWLEDGMENT

An acknowledgment is a reply from an addressee indicating that he received a certain message, understands it, and can comply with it. Note the difference between an acknowledgment and a receipt. The receipt means only that the message was received satisfactorily. Remember that only the commanding officer or his authorized representative can authorize a Radioman to send an acknowledgment.

A request for acknowledgment is the word acknowledge (not a proword) as the final word of the text. The reply is the proword WILCO. If the commanding officer can acknowledge at once, the operator may receipt for the message with WILCO, because the meaning of ROGER is contained in WILCO. If the acknowledgment cannot be returned immediately, the operator receipts for the message with ROGER, and WILCO is sent later. The return transmission to a request for an acknowledgment is either ROGER or WILCO—never both.

In the following example, the OTC sends a tactical signal. He desires acknowledgment from two ships.

SKIDROW—THIS IS STRAWBOSS—SIGNALS FOLLOW—EXECUTE TO FOLLOW—BREAK—TANGO BRAVO—
TACK—ONE FIVE—TACK—ZERO
ZERO ZERO—TACK—ONE TWO—
FOXFIRE—DITTYBAG—ACKNOWLEDGE—OVER

The commanding officer of FOXFIRE wishes to consider the message before acknowledging. His operator transmits:

THIS IS FOXFIRE—ROGER—OUT

The commanding officer of DITTYBAG heard the message, understands it, and can comply. He directs his operator to acknowledge:

THIS IS DITTYBAG—WILCO—OUT

When the commanding officer of FOXFIRE is ready to acknowledge, he has two choices of reply.

STRAWBOSS—THIS IS FOXFIRE—
WILCO—YOUR LAST TRANSMISSION—OUT

STRAWBOSS—THIS IS FOXFIRE—WILCO—YOUR EXECUTE TO FOLLOW—BREAK—TANGO BRAVO—TACK—ONE FIVE—TACK—ZERO ZERO ZERO—TACK—ONE TWO—OUT

When ready to execute the signals, the OTC transmits:

SKIDROW—THIS IS STRAWBOSS—STANDBY—EXECUTE—ADAM—OVER

ADAM receipts as directed:

THIS IS ADAM—ROGER— OUT

RELAY

The proword RELAY indicates that the station called is to relay the message to all addressees. Example:

FOXFIRE—THIS IS STRAWBOSS—RELAY—PRIORITY—TIME ZERO NINE ONE ZERO ZULU—FROM—STRAWBOSS—TO ADAM—BREAK—UNCLAS—REPORT NUMBER ROUNDS EXPENDED LAST RUN—BREAK—OVER

After FOXFIRE receipts for the message, he relays it to the action addressee:

ADAM—THIS IS FOXFIRE—PRIORITY—TIME ZERO NINE ONE ZERO ZULU—FROM—STRAWBOSS—TO—ADAM—BREAK—UNCLAS—REPORT NUMBER ROUNDS EXPENDED LAST RUN—BREAK—OVER

The proword RELAY TO, followed by an addressee, means that the station called is to relay the message to the station indicated. When more than one station is called, the call sign of the station to relay precedes the proword RELAY TO. Example:

DITTYBAG—SATAN—THIS IS STRAWBOSS—SATAN—RELAY TO FOXFIRE—MESSAGE—ROUTINE—TIME ZERO ONE TWO TWO ZULU—FROM—STRAWBOSS—TO—FOXFIRE—INFO—DITTYBAG—SATAN—BREAK—UNCLAS—PROCEED ON MISSION ASSIGNED—BREAK—OVER

SATAN receipts and relays as instructed:

FOXFIRE—THIS IS SATAN—MESSAGE ROUTINE—TIME ZERO ONE TWO TWO ZULU—FROM—STRAWBOSS—TO—FOXFIRE—INFO—DITTYBAG—SATAN—BREAK—UNCLAS—PROCEED ON MISSION ASSIGNED—BREAK—OVER

Occasionally, it is necessary to relay by radiotelephone a message received by some other means of communication. In the final example, NOLT (FOXFIRE) receives a radiotelegraph message from NAAT (STRAWBOSS) for relay to NRTK (DITTYBAG):

NOLT DE NAAT-T-P-241632Z-AUG 67 FM NAAT-TO NRTK GR4 $\overline{BT}$ UNCLAS RETURN TO BASE $\overline{BT}$ K

FOXFIRE places the message in radiotelephone form and relays:

DITTYBAG—THIS IS FOXFIRE—MESSAGE—PRIORITY—TIME TWO FOUR ONE SIX THREE TWO ZULU—AUGUST 67—FROM—STRAWBOSS—TO—DITTYBAG-GROUPS FOUR-BREAK-UNCLAS—RETURN TO BASE—BREAK—OVER

OPENING A NET

Procedures described here are either for opening a net for the first time or for reopening a net secured temporarily. Procedures for both free and directed nets are described.

Free Net

In the following example, STRAWBOSS opens a free net by transmitting:

SKIDROW—THIS IS STRAWBOSS—OVER

SKIDROW (a collective call) answers in alphabetical order of stations:

(STRAWBOSS—THIS IS) ADAM—OVER
(STRAWBOSS—THIS IS) DITTYBAG—OVER
(STRAWBOSS-THIS IS) FOXFIRE-OVER
(STRAWBOSS—THIS IS) SATAN—OVER

STRAWBOSS then calls the net and informs all stations that their transmissions were heard:

(SKIDROW—THIS IS) STRAWBOSS—OUT
(or proceeds with message)

NOTE: Words in parentheses may be omitted if communications are good.

If a station does not reply to a collective call within 5 seconds, the next station answers. The delinquent station then answers last, if able to do so. If the station is having difficulty and is unable to answer the call, the operator reports in to the net when he can. In the preceding example, assume FOXFIRE had equipment failure and could not answer. SATAN waits 5 seconds and answers as usual. When FOXFIRE is able to transmit, he calls STRAWBOSS:

STRAWBOSS—THIS IS FOXFIRE—REPORTING IN TO NET—OVER

STRAWBOSS replies:

THIS IS STRAWBOSS—ROGER—OUT

Directed Net

In the next example, STRAWBOSS calls member stations and announces that the net is directed. He requests the precedence and addressees of traffic to be transmitted.

SKIDROW—THIS IS STRAWBOSS—THIS IS A DIRECTED NET—OF WHAT PRECEDENCE—AND FOR WHOM—ARE YOUR MESSAGES—OVER

SKIDROW replies, each station indicating the traffic on hand:

(STRAWBOSS—THIS IS) ADAM— I HAVE ONE IMMEDIATE AND ONE ROUTINE FOR YOU—OVER
(STRAWBOSS—THIS IS) DITTYBAG—NO TRAFFIC—OVER
(STRAWBOSS—THIS IS) FOXFIRE—I HAVE ONE PRIORITY FOR DITTYBAG—OVER
(STRAWBOSS—THIS IS) SATAN—NO TRAFFIC—OVER

NOTE: Words in parentheses may be ommitted if communications are good.

STRAWBOSS informs all stations that their transmissions were received, and commences to clear traffic in order of precedence:

SKIDROW—THIS IS STRAWBOSS—ROGER—ADAM—SEND YOUR IMMEDIATE—OVER

When ADAM transmits, and obtains a receipt for his message, net control gives the station with next highest precedence message permission to transmit.

FOXFIRE—THIS IS STRAWBOSS—SEND YOUR PRIORITY—OUT

DITTYBAG, hearing the authorization, tells FOXFIRE to go ahead. This procedure saves FOXFIRE the trouble of making a preliminary call.

THIS IS DITTYBAG—OVER

FOXFIRE goes ahead with his message at once:

DITTYBAG—THIS IS FOXFIRE—MESSAGE—(ETC.)

When STRAWBOSS hears the proword OUT that ends the exchange between DITTYBAG and FOXFIRE, he directs ADAM to send the ROUTINE that still is outstanding.

As operators are handed messages to be sent out, they call net control and request permission to transmit. SATAN, for example, has a ROUTINE for ADAM:

STRAWBOSS—THIS IS SATAN—I HAVE ONE ROUTINE FOR ADAM—OVER

STRAWBOSS replies (assuming no other station wishes to send a message of higher precedence):

THIS IS STRAWBOSS—SEND YOUR MESSAGE—OUT

SATAN then sends his message. If, however, higher precedence traffic awaits transmission, STRAWBOSS sends:

THIS IS STRAWBOSS—WAIT—OUT

When traffic conditions permit, STRAWBOSS then calls SATAN and gives him permission to transmit:

SATAN—THIS IS STRAWBOSS—SEND YOUR ROUTINE—OUT

ADAM answers, thereby saving a preliminary call, and SATAN clears his message.

SIGNAL STRENGTH AND READABILITY

A station is understood to have good readability unless otherwise notified. Strength of signals and readability are not exchanged unless for good reason.

When necessary to inform another station of his signal strength and readability, it is done by means of a concise report of actual reception. Examples: "Weak but readable," "Loud but distorted," "Weak with interference," and so on. Reports such as "Five by five," and "Four by four," which are derivatives of numerals used with operating signals QSA and QRK, are forbidden.

The following prowords are for the purpose of exchanging information concerning signal strength and readability. They were not included in the previous list of prowords (table 7-1), because their meanings apply only to signal strength and readability.

RADIO CHECK...... What is my signal strength and readability?
ROGER............. I have received your last transmission satisfactorily. (The omission of comment on signal strength and readability is understood to mean that reception is loud and clear.)
NOTHING HEARD.... Used when no reply is received from a called station.
LOUD.............. Your signal is strong, interference will not bother my copying.
GOOD.............. Your signal is good.
WEAK.............. I can hear you only with difficulty.
VERY WEAK....... I can hear you only with great difficulty.
FADING............ At times your signal strength fades to such an extent that continuous reception cannot be relied upon.
CLEAR............. Excellent quality (readability).
READABLE......... Quality good—no difficulty reading you.
UNREADABLE...... The quality of your transmission is so bad that I cannot read you.
DISTORTED ........ Having trouble reading you.
WITH INTERFERENCE .... Having trouble reading you because of interference.

To illustrate two stations exchanging information on signal strength and readability, a ship (FOXFIRE) and a plane (CATFISH ONE) establish communications as follows:

FOXFIRE—THIS IS CATFISH ONE—
RADIO CHECK—OVER
CATFISH ONE THIS FOXFIRE—
ROGER—OVER
THIS IS CATFISH ONE—OUT

Had FOXFIRE not received CATFISH ONE loud and clear, the transmissions could have been:

CATFISH ONE—THIS IS FOXFIRE—
WEAK BUT READABLE—OVER
THIS IS CATFISH ONE—ROGER—OUT

With communications established firmly, there is no need for further checks of the foregoing nature unless equipment difficulty or other adverse conditions develop.

AUTHENTICATION

Specific instances when a radiotelephone message must be authenticated are the same as those for a radiotelegraph message. In general, a message must be authenticated when there is any possibility that the message is of enemy origin. Be alert! Sometimes (but not always) an enemy deceptive message can be spotted by the operator's mistakes in procedure or by his mistakes in English grammar or pronunciation. Security reasons for authentication were discussed in chapter 3.

COMMERCIAL RADIOTELEPHONE SERVICES

During peacetime, fleet commanders usually authorize naval vessels to utilize commercial radiotelephone services. Such services provide two-way telephone conversations through commercial land radiotelephone stations between ships at sea and any telephone on land. Naval vessels using this service are limited to calls originating aboard ship. Incoming calls to the ship cannot be accepted.

## COASTAL HARBOR RADIOTELEPHONE SERVICE

The Coastal Harbor Radiotelephone Service meets the needs of ships operating within a few hundred miles of shore. Stations are established at most seaports on the Atlantic, Pacific, and gulf coasts, and also at Honolulu.

## HIGH SEAS RADIOTELEPHONE SERVICE

High Seas Radiotelephone Service stations are located at New York, Miami, and Oakland. They provide long-range radiotelephone service. Ordinarily, service through High Seas stations is used by ships operating beyond the normal range of the Coastal Harbor stations.

## CHARGES FOR SERVICES

The charge for commercial radiotelephone service depends on the location of a ship as well as the land telephone, and, of course, on the time length of the call. For Coastal Harbor Service, only the coastal waters are divided into rate areas. For High Seas Service, the United States is divided into three land rate areas by groups of states, and the oceans are divided into three ocean rate areas defined by latitude and longitude. Land and ocean rate areas, station call signs, and operating frequencies are listed in DNC 26 (effective edition).

## TRANSMITTING AND RECEIVING EQUIPMENT

Practically all standard Navy medium-high frequency transmitters and receivers designed for amplitude modulation are suitable for commercial radiotelephone service. The transmitter must be on the exact frequency specified; otherwise, the carrier does not actuate the automatic calling device at the telephone company marine operator's position, and the call is unanswered. To prevent the calling device from becoming actuated unintentionally, it is best to tune the transmitter before coming into range. The microphone recommended is the push-to-talk (release to listen) type. Because most users know nothing about radio equipment, a Radioman should demonstrate operation of the microphone to the user before he goes on the air.

## PLACING A CALL

Assume that own ship is an authorized radiotelephone subscriber and that equipments are tuned properly. The Radioman listens to ascertain that the circuit is not busy. If the circuit is clear, he calls the marine operator by voice:

NORFOLK MARINE OPERATOR THIS IS USS ROWE

When the marine operator responds, he is given the name of the ship, coastal rate area in which the ship is located, city and telephone number desired, and the name of the individual called (if the call is person-to-person). He then is requested to quote the rates for the call. Example:

THIS IS USS ROWE—RATE AREA 2B—CALLING WASHINGTON DC-LUDLOW 4-5400—PERSON TO PERSON LAURENCE K RICE—QUOTE TIME AND CHARGES

When the marine operator makes the necessary telephone connections, the circuit is ready for the caller. Best results are obtained by speaking plainly and naturally. Instruct the caller not to speak until the other person finishes. When the conversation is over, the Radioman notifies the marine operator:

THIS IS USS ROWE—CALL COMPLETED

The marine operator then quotes the time and charges. Actually the Coastal Harbor and High Seas channels are like party lines and are shared by a large number of ships. A single incoming passenger liner such as SS United States may have hundreds of calls to clear. Courtesy and discretion are necessary if everyone is to share the service equally.

## BE SECURITY CONSCIOUS

As pointed out in chapter 3 (Communication Security), radiotelephone is potentially the least secure method of radio communications. Radiomen must ever be alert to avoid disclosure of classified information when transmitting on radiotelephone circuits. This precaution applies to military voice circuits as well as to commercial circuits.

# CHAPTER 8

# ANTENNAS AND RADIO WAVE PROPAGATION

The transmission of radio waves through space is known as wave propagation. A study of antennas and wave propagation is essential to an understanding of radio communication.

In any radio system, energy in the form of electromagnetic (radio) waves is generated, by a transmitter and is fed to an antenna by means of a transmission line. The antenna radiates this energy out into space at the speed of light (approximately 186,000 miles per second). Receiving antennas, placed in the path of a traveling radio wave, absorb part of the radiated energy and send it through a transmission line to a receiver. Thus, components required for successful transmission of intelligence by means of radio waves are a transmitter, a transmission line, a transmitting antenna, a medium through which radio waves travel (for example, the atmosphere surrounding the earth), a receiving antenna, another transmission line, and the receiving equipment. Figure 8-1 is a block diagram showing the arrangement of these components.

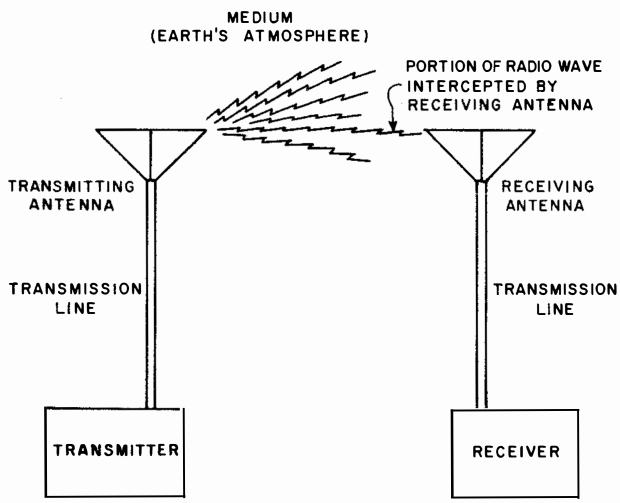



Figure 8-1.—Simple radio communication network.

Successful communication by means of radio waves depends chiefly on the power of the transmitter, frequency used, distance between transmitter and receiver, and sensitivity (ability to amplify weak signals) of the receiver. The ability of the earth's atmosphere to conduct energy to its destination, together with the nature of the terrain between sending and receiving points, may be responsible for the frequency selected. Interfering signals can make reception impossible at a desired time. Moreover, the amount of noise present and transmission line losses may combine to make unintelligible an otherwise good signal.

To understand the importance of all the foregoing factors, it first is necessary to investigate the nature of a radio wave, as well as conditions affecting its successful propagation.

## RADIO WAVE

Any wire or other conductor carrying alternating current produces electromagnetic fields that move outward into surrounding space. As the current increases and decreases, the electromagnetic field alternately grows and collapses about the wire. When the speed of these alternations is increased above a certain point, the collapsing electromagnetic field does not have time to return to the wire before the next alternation begins. Hence, some of the electromagnetic energy is disengaged from the wire and set free in space. The radiated electromagnetic energy, known as the radio wave, moves in free space at the speed of light. (The speed of light is 300,000,000 meters, or about 186,000 miles, a second.) It travels almost—but not quite—that fast in air. Regardless of the frequency of alternation, the velocity of the radio wave is constant.

It is believed that radio waves travel in a series of crests and troughs, similar to ocean waves or round, outward-moving waves created by dropping a stone on the smooth surface of a pond. Although this analogy is not exact, it serves a useful purpose because it compares the movement of the radio waves with a well-known physical action. The movement of radio waves is somewhat like the movement of water waves away from a point of disturbance.

Figure 8-2 shows how a falling stone imparts wave motion to a water surface. The action illustrated compares with electromagnetic radiation except that a continuous wave motion is not imparted to the surface of the water by a dropped stone. A study of figure 8-2 should aid in understanding four important aspects of the radio wave: amplitude, cycle, frequency and wavelength.

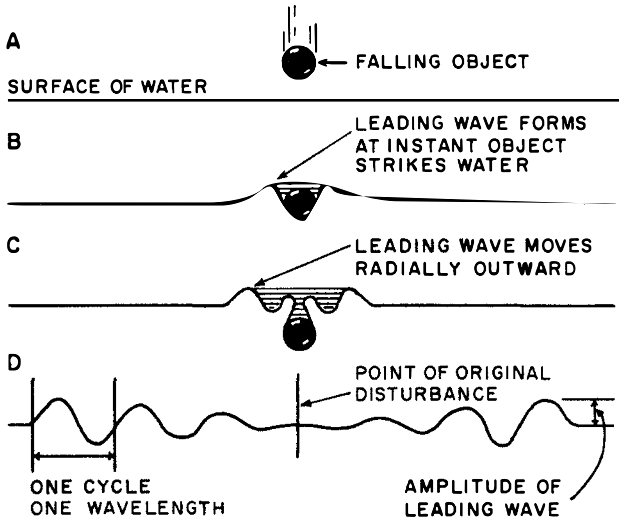



Figure 8-2. — How a falling stone imparts wave motion to a water surface.

Amplitude of the wave in part D of figure 8-2 is the distance from the average water level to the peak (or trough) of the wave. In other words, amplitude is the measure of the wave's energy level. This is the concept in which amplitude is applied to a radio wave—as the measure of energy level.

A cycle is a complete sequence of variation of movement of the wave. Usually a cycle is represented graphically from a point at the average level through a crest and a trough and back again to the corresponding average level. Thus, with the average level as the reference point, each cycle is made up of two reversals. In a complete cycle the wave moves first in one direction, then in the other, and returns to the first direction to begin its next cycle (fig. 8-2, part D).

Frequency of a wave is the number of cycles that occur in 1 second. Unlike the wave illustrated, which would have a very low frequency, radio waves may have frequencies of a few thousand cycles per second or many million cycles per second. They become so large, numerically, that it is more convenient to use a unit larger than the cycle. For this reason radiofrequencies are counted in thousands, millions, billions, and trillions of cycles, using four prefixes from the metric system: kilo, mega, giga, and tera. The latter two, giga and tera, as yet have limited application in naval communications.

A kilocycle is 1 thousand cycles and is abbreviated kc: a megacycle is 1 million cycles (or 1000 kc), abbreviated mc: a gigacycle is 1 billion cycles (or 1000 mc), abbreviated gc; and the teracycle is 1 trillion cycles (or 1000 gc) and is abbreviated tc. A frequency of 15,000 cycles per second, for example is expressed as 15 kc; 500,000 cycles is expressed as 500 kc. When the number of kilocycles becomes too large, megacycles are substituted to simplify the figure. Thus, 82,000 kc is expressed as 82 mc, and so on.

Characteristics of low-frequency propagation are different from those of high-frequency propagation. For ease of identification, the various frequencies usually are classed in bands, as in table 8-1. Choice of a given frequency as the point of division between bands, as between very high frequencies and ultrahigh frequencies, is more or less arbitrary and is agreed upon for convenience.

Table 8-1. —Frequency Bands

| Description | Abbreviation | Frequency |
|---|---|---|
| Very low | VLF | Below 30 kc |
| Low | LF | 30 to 300 kc |
| Medium | MF | 300 to 3000 kc |
| High | HF | 3 to 30 mc |
| Very high | VHF | 30 to 300 mc |
| Ultrahigh | UHF | 300 to 3000 mc |
| Superhigh | SHF | 3 to 30 gc |
| Extremely high | EHF | 30 to 300 gc |

A wavelength is the space occupied by a cycle, and may be measured from crest to crest, trough to trough, or from any point to the next corresponding point. The wavelength of a radiofrequency may vary from several miles to a fraction of an inch. In actual practice, though, radio wavelength usually is measured in meters instead of feet or inches. (A meter is 39.37 inches, or 3.28 feet.)

Finding the wavelength of any frequency is a relatively simple process. It is known that a radio wave travels at a constant speed of 300,000,000 meters (or 186,000 miles) per second. From this constant speed the length of 1 cycle (wavelength) can be found simply by dividing velocity of a wave by its frequency. The foregoing statement is expressed in the following formulas.

1. Wavelength (in meters) =

$$\frac{300,000,000}{\text{Frequency (in cycles)}}$$

Because there are 3.28 feet in 1 meter and a radio wave travels at 300,000,000 meters per second, 3.28 times 300,000,000 gives 984,000,000 feet; therefore:

2. Wavelength (in feet) =

$$\frac{984,000,000}{\text{Frequency (in cycles)}}$$

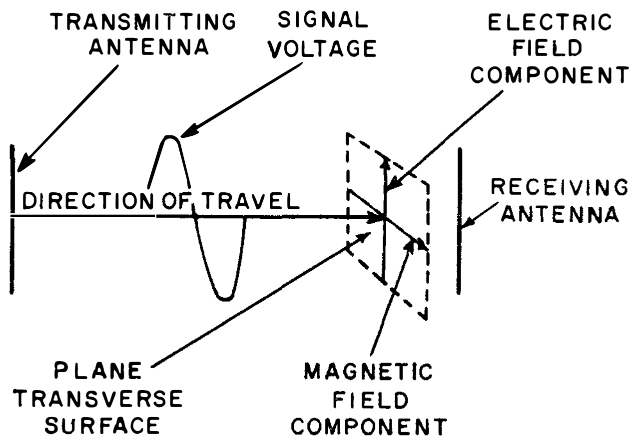
It should be noted that these specific formula are only applicable where frequency in cycles is used. When the frequency is expressed in values other than cycles (kc, or mc) the constant must be converted to the corresponding value (300,000 or 984,000 for kc and 300 or 984 for mc).

## RADIATION

When radiofrequency current flows through a transmitting antenna, radio waves are radiated from the antenna in all directions in much the same way that waves travel on the surface of a pond into which a rock is thrown. As the waves travel outward from the point of origin, they increase in circumference until the field of radiation is so large that a portion of any wave appears to be a straight line or a plane surface.

In considering the radio signal path from a transmitting antenna to a receiving antenna, the concept of a moving wave becomes important. A moving wave actually consists of moving electric and magnetic fields. A moving electric field always creates a magnetic field; a moving magnetic field creates an electric field. Lines of force of both fields are always at right angles to each other and perpendicular to the direction of travel through space.

Figure 8-3 diagrams components of a radio wave. From the point of view of an observer. the wave marches past, varying in direction and magnitude as in the picture. Imagine that the entire wave is moving at a constant speed in the direction indicated. Intensities of both electric and magnetic fields are maximum at the exact instant the crest of the wave passes the antenna. Conversely, intensities of both fields are minimum at the same instant the zero point is reached. At all times, however, the fields are perpendicular to each other.



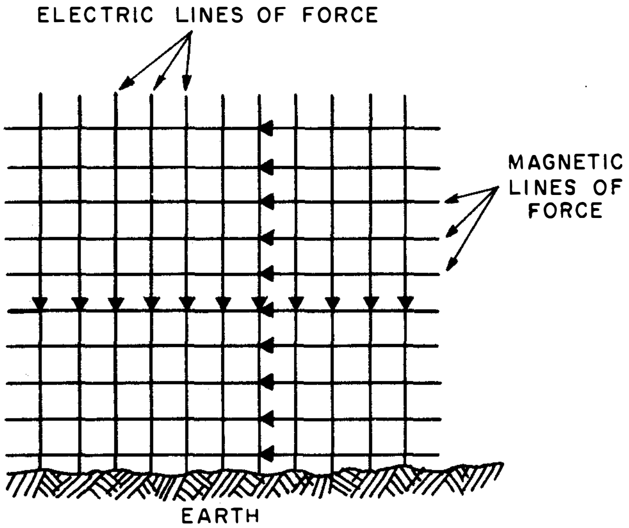

31.8

Figure 8-3. —Components of a radio wave.

Figure 8-4 illustrates the instantaneous cross section of a radio wave moving in a direction away from an observer. Electric lines of force are perpendicular to the earth, whereas magnetic lines are horizontal. A change in direction of either the electric or magnetic lines would result in a change in direction of wave travel.

## POLARIZATION

Lines of force of the electric field are propagated perpendicular to the earth when a transmitting antenna is oriented perpendicular to the earth. In this instance, a radio wave is said




20.241
Figure 8-4. –Instantaneous cross section of a radio wave.

to be polarized vertically. If the transmitting antenna is horizontal, electric lines of force are horizontal, and the wave is then said to be polarized horizontally. Actually, polarization of the wave may be altered somewhat during travel. Regardless of polarization, electric and magnetic lines of force are always perpendicular to each other and to the direction of travel.

Polarization of a radio wave is a major consideration in efficient transmission and reception of radio signals. Thus, if a single-wire antenna is used to extract energy from a passing radio wave, maximum pickup results when the antenna is so placed physically that it lies in the same direction as the electric field component. For this reason, a vertical antenna (one perpendicular to the ground) should be used for efficient reception of vertically polarized waves (those transmitted from a vertical antenna). A horizontal antenna should be used for reception of horizontally polarized waves (those transmitted from a horizontal antenna). In both instances, it is assumed that the wave is traveling parallel to the earth's surface from a transmitting to a receiving antenna. Such a condition does not always prevail, however, as will be seen when considering effects of atmosphere on behavior of radio waves.

## RADIO WAVE PROPAGATION

The study of radio wave propagation is concerned chiefly with properties and effects of the medium through which radio waves must travel in their journey between transmitting and receiving antennas. Because atmosphere is the common medium for propagation of radio waves, it is discussed here in some detail.

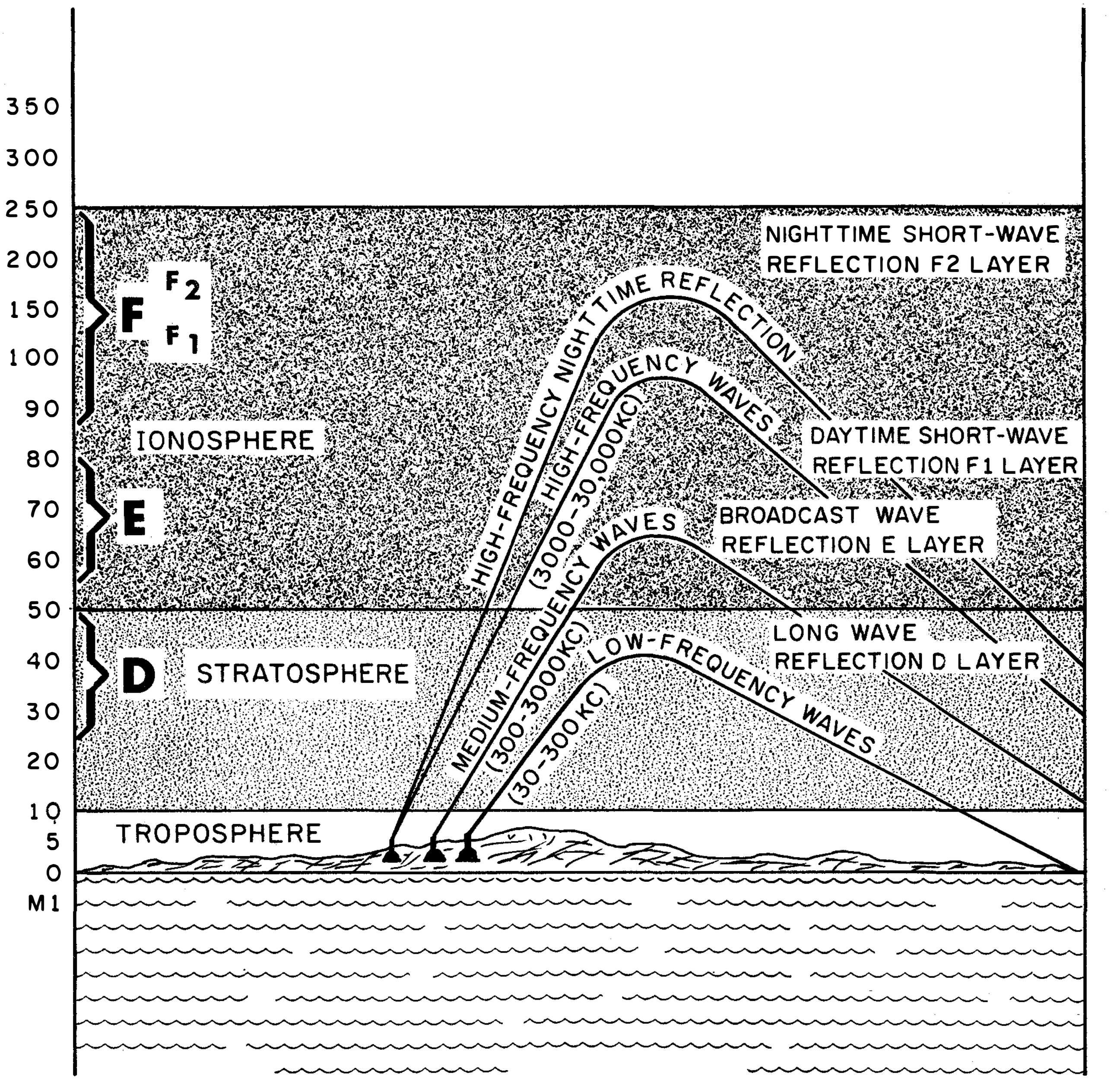
### ATMOSPHERE

The atmosphere about the earth is not uniform. Changes in moisture content, temperature and density occur at different heights or geographical locations, or even with changes in time (day, night, season, year). To assist in understanding the effects of these changes on radio waves, various atmospheric regions have been distinguished. These regions are the troposphere, stratosphere and ionosphere. Their relative positions are seen in figure 8-5.

The troposphere is the portion of the earth's atmosphere extending from the surface of the earth to heights of about 10 miles. Temperature in this region varies appreciably with altitude.

The stratosphere lies between the troposphere and the ionosphere. It extends from about 10 miles to approximately 50 miles above the earth's surface. Temperature in this region varies from -65°F at the bottom, decreases to -140°F and then increases to 104°F at 50 miles.

Besides the usual variations in moisture content and temperature, and variations in density associated with a change in elevation, atmosphere is distinguished mainly by variation in amount of ionization present. Ionization, believed to result from ultraviolet radiation from the sun, is explained later in greater detail. For the present, it is enough to know that the ionosphere is that portion of the earth's atmosphere above the lowest level at which ionization affects the transmission of radio waves. Ionization of this region is large compared with that near the surface of the earth. The inosphere extends from about 50 miles to 250 miles above the earth. Different densities of ionization make the ionosphere appear to have separate layers (fig. 8-5).




31.9(76)

Figure 8-5.–Layers of the earth's atmosphere.

PROPAGATION IN ATMOSPHERE

Radio waves travel in two principal ways from a transmitter to a receiver: by means of groundwaves, which pass directly from transmitter to receiver; or by skywaves, which travel up to electrically conducting regions of the atmosphere and are refracted by them back to earth. Long-distance radio transmission takes place chiefly by skywaves. Short-distance transmission however, and all ultrahigh-frequency transmission occur by means of groundwaves. Some forms of transmission consist of combinations of both skywaves and groundwaves.

Like other forms of electromagnetic radiation (such as light), radio waves can be reflected, refracted, and diffracted. Propagation of groundwaves are affected partially by electrical characteristics of the earth (soil or sea) and by diffraction (bending) of the waves in conformance with the curvature of the earth. These characteristics vary in different localities, but under most conditions they are practically constant with time. Skywave propagation, on the other hand, is variable, because the state of the ionosphere is always changing, and consequently affects reflection or refraction of waves.

Reflection

When a beam of light falls on the surface of a mirror, nearly all of it is turned back or reflected. (See fig. 8-6, view A.) The angle of incidence is equal to the angle of reflection and lies in the same plane. When the incident ray is along the normal, the reflected ray is also along the normal. For reflection to occur, the object doing the reflecting must have the right type of surface and it must be larger than the wavelength of the incident wave. Dust particles, for example, reflect light because they are large compared to wavelengths of light. Actually, light is scattered out of the beam because of reflections from the particles. As with light waves, the efficiency of reflection depends on the reflecting material. Large, smooth metal surfaces of good electrical conductivity (such as copper) are efficient reflectors of radio waves. The surface of the earth itself is a fairly good reflector.

As has been mentioned, reflection takes place only when the reflecting surface is large compared to the wavelength of the incident wave, and smooth for an appreciable portion of a wavelength. Under these circumstances, the angle of incidence is equal to the angle of reflection. When these conditions are not met, scattering occurs. Scattering is a common occurrence. As a matter of fact, forward scatter (discussed later) of radio waves in the troposphere and ionosphere (because of irregularities in density) is an important new method of radio wave propagation.

Refraction

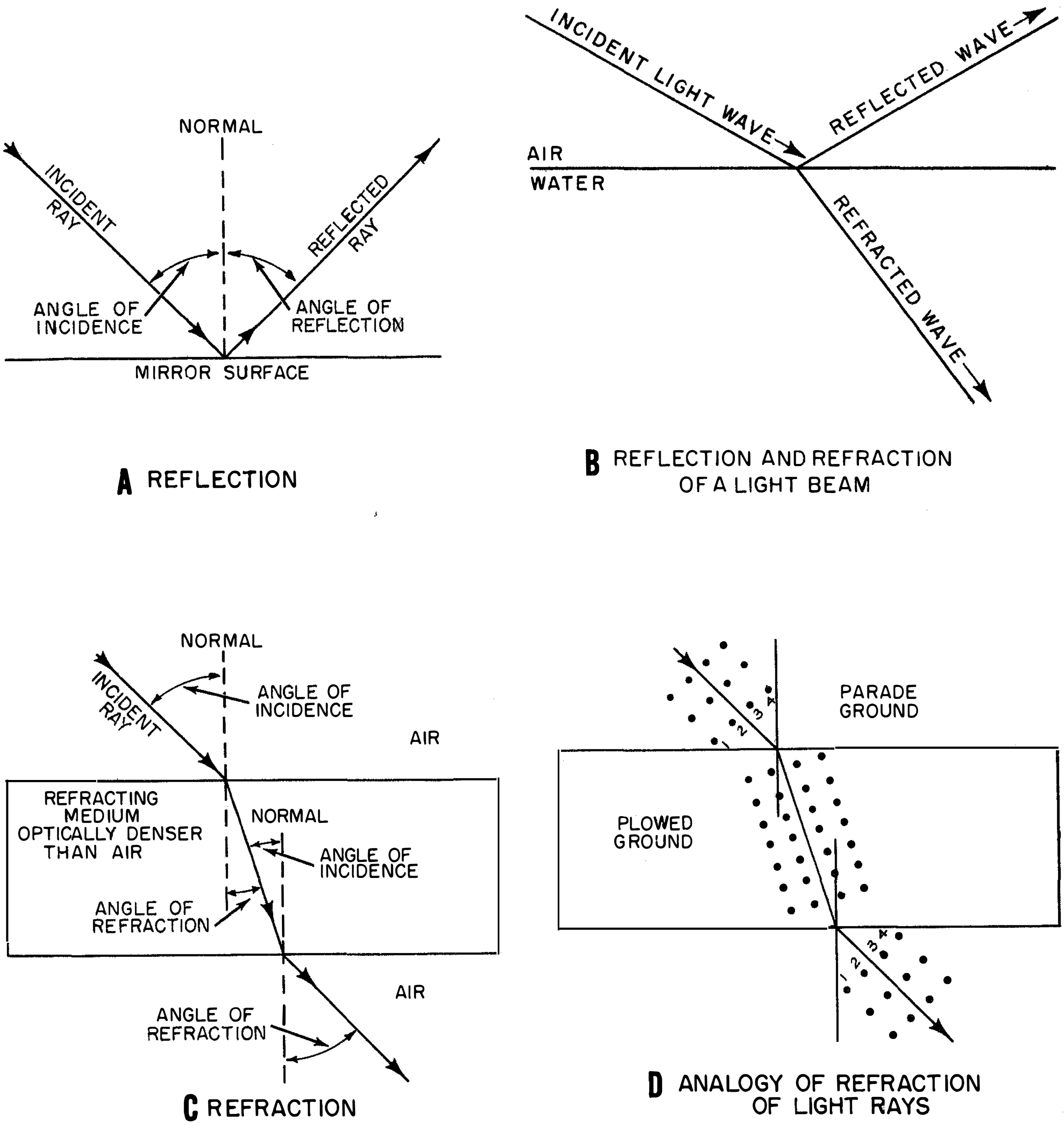
If a beam of light shines on a smooth surface of water, some light is reflected and the remainder penetrates the water, as diagramed in sketch B of figure 8-6. The phenomenon by which light waves penetrate the water in the manner shown is called refraction. It can be observed readily by examining a glass of water into which a spoon is immersed. If viewed from an angle, the spoon appears broken or bent at the point where it enters the surface of the water. The reason for this appearance is that light waves travel at a slower speed through water than through air. Thus, the direction of travel of refracted light is different from that of the light beam striking the surface of the water. Radio waves are refracted similarly when passing from one medium to another.

When a light ray passes at an angle from a less dense to a denser medium, it is bent toward the normal; in other words, the angle of refraction is less than the angle of incidence. Likewise, when a light ray passes from a denser to a less dense medium, it is bent away from the normal; in other words, the angle of refraction is greater than the angle of incidence. Both of these conditions are shown in figure 8-6(C).

Refraction may be understood more easily if the incident ray is thought of as being a company of men marching, for example, four abreast (fig. 8-6 D) from a parade ground to a plowed field. The refracting medium is thought of as being the plowed field. In marching obliquely from the parade ground to the plowed field, each soldier in the front line is slowed up as he crosses the boundary. Because the soldiers arrive at the boundary at different times, they will begin to slow up at different times (No. 1 slowing up first and No. 4 last in each row). The net effect is a bending action, as indicated in the illustration. Upon leaving the plowed ground, the reverse action takes place.

Index of refraction is a term that describes how much bending takes place in a given substance. The higher the index of refraction, the more the bending. Actually, the index of refraction is the ratio of the velocity of light waves in a vacuum to the velocity of light in the substance considered.

In figure 8-6, bending is considered to take place at the surfaces of the refractive medium.




7.9:31.10

Figure 8-6. –Reflection and refraction.

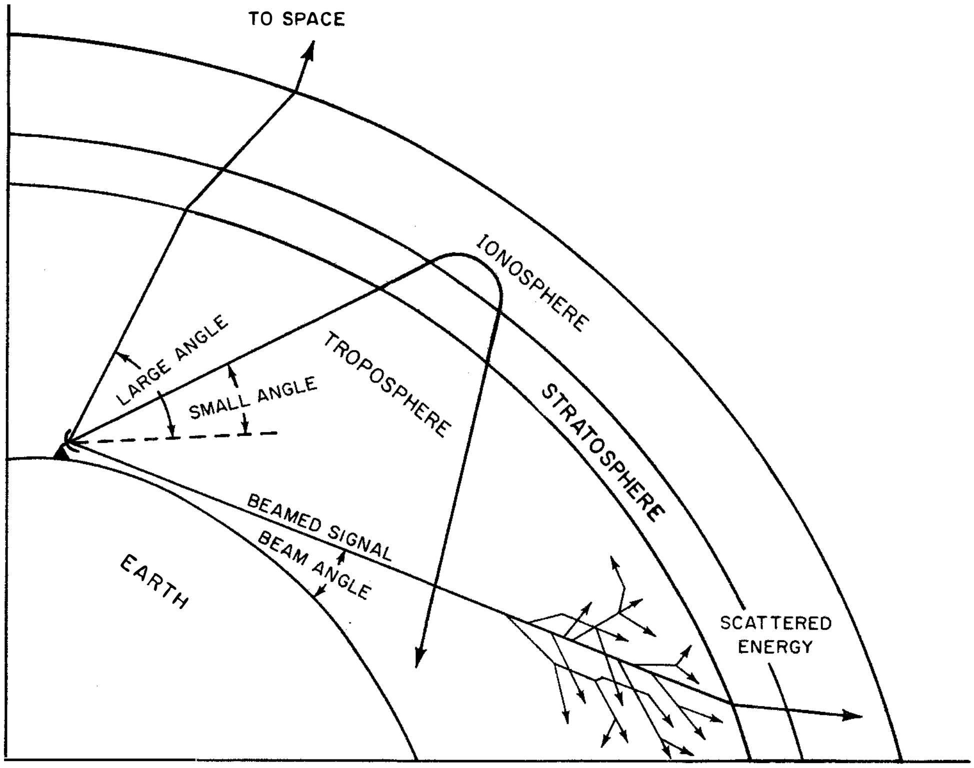
For radio waves refracted in the ionosphere, the path is curved gradually because there is no sharp point of transition between layers of different densities. Rays that make a large angle with respect to the horizontal along the earth may be refracted a small amount and pass on through the ionosphere to outer space. Rays that make a smaller angle travel a greater distance in the ionosphere and may be bent to such an extent that they will return to earth. The net result is as though the wave had been reflected back to the earth. A simplified illustration of ionospheric refraction is given in figure 8-7. A certain amount of refraction also takes place in the tropospheric (below the ionosphere) because of the proximity of warm and cold air masses.

Diffraction

If a beam of light in an otherwise blacked-out room shines on the edge of an opaque screen, it can be observed that the screen does not cast a perfectly outlined shadow, The edges of the shadow are not outlined sharply because the light rays are bent around the edge of the object and decrease the area of total shadow. This diffraction or bending of a light wave around the edge of a solid object is slight. The lower the frequency of the wave, or the longer the wavelength, the greater the bending of the wave. Thus, radio waves are diffracted more readily than light waves, and sound waves more so than radio waves. Figure 8-8 illustrates this phenomenon and helps to explain why radio waves of proper frequency can be received on the far side of a hill, and why sound waves can be heard readily from around the corner of a large building. In the propagation of radio waves at a distance, diffraction is a significant consideration because the largest object to be contended with is the bulge of the earth itself, which prevents a direct passage of the wave from transmitter to receiver.

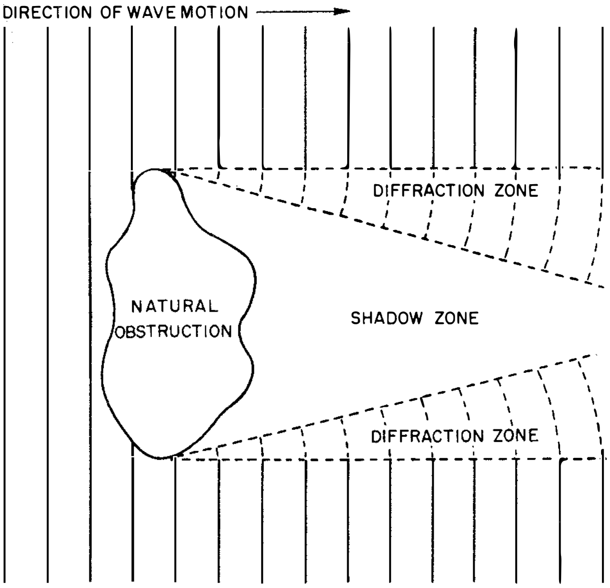
GROUNDWAVE

Because groundwave radio transmission does not make use of reflections from the ionosphere, the field intensity of groundwaves depends on other factors. They include the following: (1) transmitter power, (2) frequency of waves, (3) diffraction of waves around the

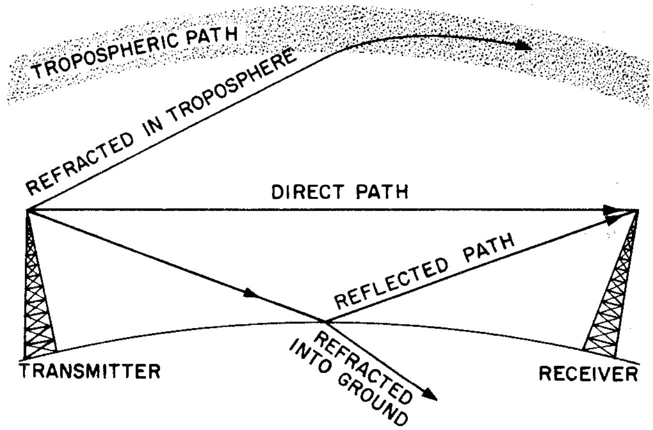



25.93

Figure 8-7. —Refraction of radio waves in the atmosphere.




31.11
Figure 8-8. —Diffraction of waves around solid object.




31.12
Figure 8-9. —Possible routes for groundwaves.

curvature of the earth, (4) electrical conductivity of local terrain, (5) nature of transmission path, and (6) weather conditions, such as distribution of water vapor content of the atmosphere. Moreover, the earth itself is a semiconductor and, upon contact with its surface, some of the energy of the radiated wave is absorbed and rapidly wasted in the form of heat. Sometimes losses suffered by groundwave transmission are excessive. For this reason, its use ordinarily is limited to moderate-distance communication (up to several hundred miles).

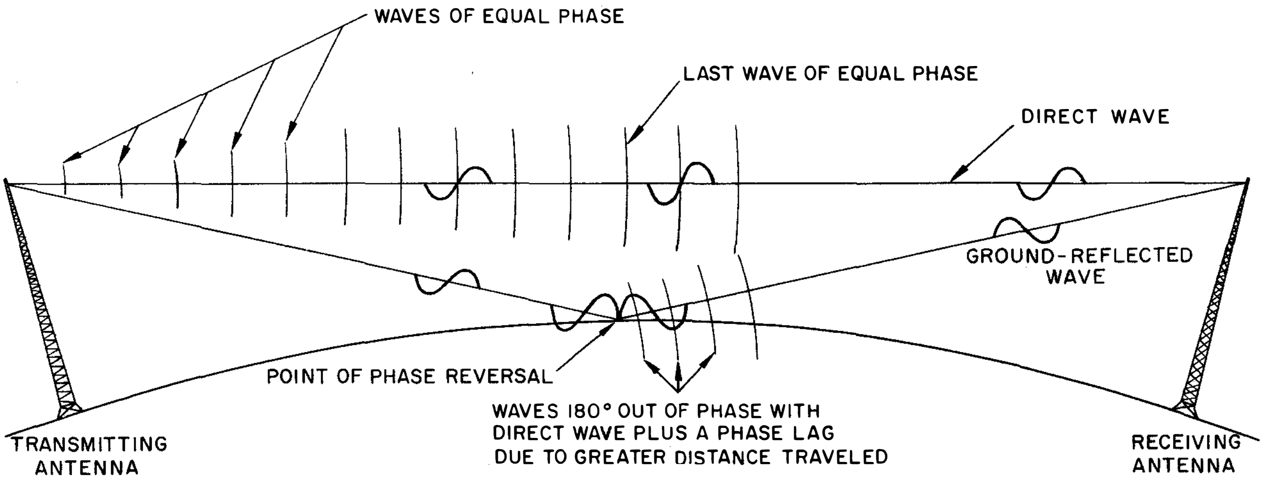
Figure 8-9 shows how groundwaves take a direct or reflected course from transmitter to receiver. They also may be conducted by the surface of the earth, or may be refracted in the troposphere. Accordingly, the groundwave can be considered as composed of one or more of the following components: direct wave, ground-reflected wave, surface wave, and tropospheric wave.

## Direct Wave

A direct wave is that part of the ground wave that travels directly from a transmitting antenna to a receiving antenna. This component of the groundwave thus is limited only by the distance to the horizon (or line of sight) from the transmitter, plus the small distance added by the atmospheric diffraction of the wave around the curvature of the earth. This distance can be extended by increasing the height of either the transmitting or receiving antenna, effectively extending the horizon. The direct wave is not affected by the ground nor by the earth's surface, but is subject to refraction in the tropospheric air between transmitter and receiver. Refraction becomes particularly important at very high frequencies.

## Ground-Reflected Wave

A ground-reflected wave, as its name indicates, is the part of the radiated wave that reaches the receiving antenna after it is reflected from ground or sea. Upon reflection from the earth's surface, the reflected wave undergoes a phase reversal of 180° (fig. 8-10). This phase reversal is important in determining the effect of its combining with the direct wave upon arrival at the point of reception. Because the reflected wave travels a longer time in reaching its destination, a phase displacement (over and above the 180° shift caused by reflection) results. In figure 8-10 it may be seen that waves start out with fronts of equal phase, continuing in phase up to the point of reflection of the ground component. Beyond this point, corresponding waves are 180° out of phase, plus whatever small phase displacement results from the relatively longer path




31.13

Figure 8-10. —Comparison of direct and ground-reflected waves.

of the reflected wave. Thus, the reflected wave arrives at the receiving antenna nearly 180° out of phase with the direct wave. An undesirable cancellation of signal energy results.

Surface Wave

A surface wave is that part of the groundwave that is affected chiefly by the conductivity of the earth and is able to follow the curvature of the earth's surface. The surface wave is not confined to the earth's surface, however. It extends to considerable heights. diminishing in strength with increased height. Because part of its energy is absorbed by the ground, intensity of the surface wave is attenuated (weakened) in its travel. The amount of attenuation depends on the relative conductivity of the earth's surface. Table 8-2 gives the relative conductivity for various types of surface.

Table 8-2. —Surface Conductivity

| Type of surface | Relative conductivity |
|---|---|
| Sea Water | Good |
| Large bodies of fresh water | Fair |
| Wet soil | Fair |
| Flat, loamy soil | Fair |
| Dry, rocky terrain | Poor |
| Desert | Poor |
| Jungle | Unusable |

Sea water is the best type of surface for surface-wave transmission. Sea water accounts for the long-distance coverage attainable by fleet broadcasts when using surface-wave transmission of very low frequencies. The most reliable frequency band for one-way broadcasts is VLF.

In general, the surface wave is transmitted as a vertically polarized wave, and it remains vertically polarized at appreciable distances from the antenna. Vertical polarization is chosen because the earth has a short-circuiting effect on the intensity of a horizontally polarized wave. When conductivity of the earth is high and frequency of the wave is below 30 mc, the surface wave is the principal component, except in aircraft-to-aircraft or aircraft-to-ground transmission, in which the direct wave and ground-reflected waves are the chief means of communication. At frequencies higher than 30 mc, losses suffered by the surface wave become so excessive that transmission usually is possible only by means of the direct wave. At frequencies where the surface wave predominates, vertical polarization is superior to horizontally polarized radiation, except in heavily wooded or jungle areas. In such areas, horizontal polarization provides better reception, even at distances and frequencies where the surface wave normally would predominate, because most foliage grows vertically and absorbs vertically polarized energy. Above 30 mc, where the direct wave is the main component, there is little difference between vertical and horizontal polarization,

### Tropospheric Wave

A tropospheric wave is that component of the groundwave that is refracted in the lower atmosphere by rapid changes in humidity, atmospheric pressure, and temperature. At heights of a few thousand feet to 1 mile or so, huge masses of warm and cold air exist near each other, causing abrupt differences in temperature and pressure. The resulting tropospheric refraction and reflection make communication possible over distances far greater than can be covered by the ordinary groundwave. Because the amount of refraction increases as frequency increases, tropospheric refraction is more effective at higher frequencies, particularly above 50 mc. Temperature inversion is a common cause of tropospheric refraction, especially when warm layers of air are located above cooler layers. Temperature inversion results from several causes. They include a warm air mass overrunning a colder mass, sinking of an air mass heated by compression, rapid cooling of surface air after sunset, and heating of air above a cloud layer by reflection of sunlight from the upper surface of clouds. Tropospheric wave propagation depends on weather conditions. Because weather conditions do vary from minute to minute, they can cause fading of the radio signal.

### Forward Propagation Tropospheric Scatter

The troposphere is used for multichannel telephone, teletype, and data transmission out to a range of 400 miles or more. Directional parabolic transmitting and receiving antennas utilize the troposphere in a system called forward propagation tropospheric scatter (FPTS), commonly called tropo scatter.

Tropo scatter takes advantage of reflective and refractive properties within the troposphere. Almost all weather phenomena occur in the troposphere, causing varying layers of hot and cold air. These layers have different densities, hence a large amount of reflection and refraction takes place. When a radio signal is beamed to an area in the troposphere, part of it goes through a complex series of partial refraction and reflection, causing energy to be scattered in all directions and become partially diffused. If the beamed angle with respect to the horizon is kept low, most of the energy is scattered in a forward direction. A simplified idea of how scattering might take place is shown in figure 8-7. Because hot and cold masses of air are shifting constantly, the amount of energy in a given area of the troposphere also changes constantly.

A receiving antenna, beamed at the same point in the troposphere as the transmitting antenna, will pick up enough transmitted energy to make it useful. For a particular transmitter power and a given antenna size, an average received signal depends on beam (scatter) angle, distance between stations, frequency used, and weather conditions at the midpoint of the radio path (fig. 8-11).

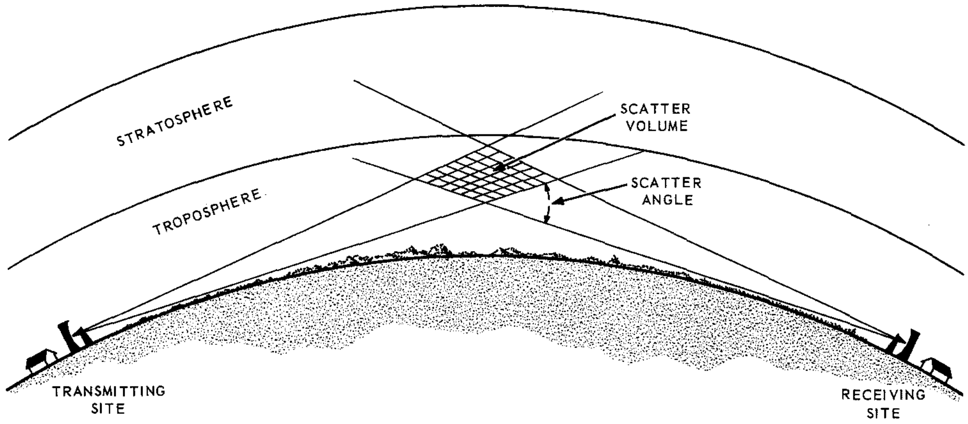
Scatter angle influences the amount of received signal. Better reception is obtained when scatter angle is kept to a minimum. The takeoff angle of transmitter and receiver antennas is made as low as permissible by local terrain and general geographical location.

The received signal of scattered energy varies extensively, causing conditions of fast and slow fading. Fast fading, caused by multipath transmission, exists for short intervals. Slow fading usually extends over several hours and is brought about by changes in refractive properties of the troposphere. Seasonal variation in signal strength also is experienced. Received signal level is higher during the best month of the summer season. Another factor is that communication paths in tropical or temperate zones are somewhat better in yearly average signal level than are paths in higher latitudes.

Tropo scatter is discussed further under the topic heading Parabolic Antennas.

## LAYERS OF IONIZATION

When considering the ionosphere in detail, one can see how different levels of ionization affect propagation of radio waves. Although the earth's atmosphere extends to a distance of about 250 miles, air particles beyond this height are so rare that they are practically nonexistent. The atmosphere is under constant bomdardment by radiation and particle showers from the sun and by cosmic rays whose source is unknown. Radiation from the sun includes not only light rays that can be seen, but also the entire spectrum (series




50.148

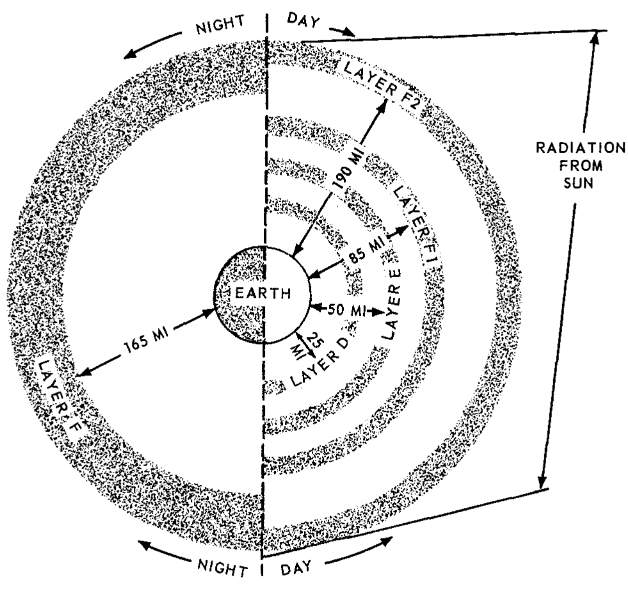
Figure 8-11.—Scatter propagation.

of wavelengths), ranging from infrared rays to ultraviolet rays. As these forms of radiation approach earth's atmosphere, they reach certain critical levels where gases are of such density that they are particularly susceptible to ionization by their action. Stated another way, radiation from the sun is capable of dislodging some loosely bound electrons from gas atoms, and the gas is then ionized. The reason it is ionized is that it has positively charged atoms (called ions) lacking their normal amount of electrons, and free electrons unassociated with any atom. Ultraviolet radiation from the sun is the predominant source of ionization.

There are four distinct layers of ionization. In order of increasing heights and intensities, they are called the D, E, F1, and F2 layers. Relative distribution of these layers about the earth is indicated in figure 8-12. As may be seen in this illustration, the four layers are present only during the daytime, when the sun is directed toward that portion of the atmosphere. At night, the F1 and F2 layers merge into a single F layer, and the D and E layers fade out. It is well to remember that the actual number of layers, their heights above the earth, and the relative intensity of ionization present in the layers vary from hour to hour, from day to day, from month to month, from season to season, and from year to year.

D Layer

Between heights of 25 to 50 miles above the surface of the earth is the first layer of pronounced ionization, known as the D layer. The amount of ionization in the D layer is not extensive and has little effect in bending the paths of high-frequency radio waves, although it does weaken or attenuate such waves crossing




31.15

Figure 8-12.—Ionosphere layers.

through this layer. At times it may absorb low- and medium-frequency waves completely. The D layer exists only during the daytime. Its density follows the variation of the sun, becoming densest at noon, and fading out shortly after sunset. It is chiefly responsible for the intensity of high-frequency waves being lower when the transmission is in sunlit hours than during darkness.

### E Layer

The second layer in order of height, called the E layer, lies at heights between 50 and 80 miles. Its height varies somewhat with seasons. Lower heights occur when the sun is in that latitude, probably because the ultraviolet radiation penetrates farther into the atmosphere when the sun is more directly overhead. Ionization of the E layer follows the sun's altitude variations closely. It attains its maximum density at about noon, fading to such a weak level during the night that it is practically useless as an aid to high-frequency radio communication. Ionization in this layer usually is sufficient to bend back to earth radio waves at frequencies as high as 20 mc. Thus, the E layer is of great importance to radio transmission for distances under approximately 1500 miles. For longer distances, transmission by this means is rather poor. At distances greater than 1500 miles, better transmission can be obtained by means of the F, F1, and F2 layers.

### F Layer

At heights between 85 and 250 miles above the earth's surface is another layer of ionization, known as the F layer. Ionization exists at all hours, usually with two well-defined layers during the daytime (F1 and F2) and one during the night. At night, the single F layer lies at a height of about 170 miles. The atmosphere is so rare at that height that sufficient ions remain throughout the night to refract high-frequency waves back to earth.

### F1 and F2 Layers

During daylight hours, especially when the sun is high (as in the tropics), and during summer months, the F layer splits into two distinct layers—the F1 and F2. Depending on the seasons and the time of day, maximum ionization occurs in the F1 layer between 135 and 145 miles. The F2 layer maximum ionization occurs between 190 and 230 miles. The F2 layer is the most highly ionized of all layers and is most useful for long-distance radio communication. Intensity of ionization reaches a maximum in the afternoon, gradually decreases throughout the night, with a rapid rise in ion density in the morning.

### Other Layers

In addition to the layers of ionization that appear regularly and undergo variations in height and intensity daily, seasonally, and from year to year, other layers appear occasionally. They appear particularly at heights near that of the E layer, much as clouds appear in the sky. Frequently their appearance is of sufficient intensity to enable good radio transmission to take place by means of reflection from them. At other times, especially during disturbances in polar regions (such as those that cause the northern lights), ionization may occur over such a large range of heights that it is detrimental to radio transmission because of excessive absorption of the radio wave.

## VARIATIONS OF IONIZATION

Because existence of ionization depends on radiations from the sun, it is obvious that variations in ionization result from the movement of the earth about the sun or from changes in the sun's activity that might cause an increase or decrease in the amount of its radiation. These variations include (1) changes that are more or less regular in their nature, thus predictable in advance, and (2) irregular variations resulting from abnormal behavior of the sun. Regular variations are divided into four classes: daily, seasonal, 11-year, and 27-day variations.

Table 8-3 lists regular variations, together with effects on the ionized layers and on radio communications. It also gives suggestions that may be followed in compensating for various effects.

### Daily Variations

In table 8-3 note that higher frequencies are suggested for daytime use, and lower frequencies at night, to compensate for daily variations. The reason for this difference is that ionization of the F2 layer is greater during the daytime. Also, the F2 layer reflects waves of higher frequency than the F layer during the night. Higher frequency waves suffer less absorption in passing through the D layer,

Table 8-3.—Regular Variations of Ionization

| Type of variation | Effect on ionized layers | Effect on communications | Method of compensation |
|---|---|---|---|
| Daily | F layer: Height and density decrease at night, increase after dawn. During day, layer splits into (1) F1 layer: Density follows vertical angle of sun; (2) F2 layer: Height increases until midday, density increases until later in day.<br>E layer: Height approximately constant, density follows vertical angle of sun. Practically nonexistent at night.<br>D layer: Appears after dawn, density follows vertical angle of sun, disappears at night. | Skip distance varies in 1-mc to 30-mc range. Absorption increases during day. | Use higher frequencies during day, lower frequencies at night. |
| Seasonal | F2 layer: Heights increase greatly in summer, decrease in winter. Ionization density peaks earlier and reaches higher value in winter. Minimum predawn density reaches lower value in winter.<br>F1, E, and D layers: Reach lower maximum densities in winter months. | Maximum usable frequencies generally reach higher midday values in winter but maintain high values later in afternoon in summer. Predawn dip in maximum usable frequencies reaches lower value in winter. Less absorption in winter. | Provide greater spread between nighttime and daytime operating frequencies in winter than in summer. |
| 11-year sunspot cycle. | Layer density increases and decreases in accord with sunspot activity (maximum 1958-1959 and 1969-1970; minimum 1955, 1966). | Higher critical frequencies during years of maximum sunspot activity. Maximum usable frequency variation: Sunspot max: 8-42 mc; sunspot min: 4-22 mc. | Provide for higher operating frequencies to be used during periods of sunspot maximum and lower frequencies for use during minimum. |
| 27-day sunspot cycle. | Recurrence of increased ionization at 27-day intervals. Disturbed conditions frequently may be identified with particularly active sunspots whose radiations are directed toward the earth every 27 days as the sun rotates. | Normally usable frequencies above 1 mc are rendered useless because of high absorption in the abnormally ionized D layer. Frequencies higher than normal will survive this absorption for short hops. Low frequencies may not penetrate the D layer and thus may be transmitted for long distances. | Raise working frequency above normal for short-hop transmission. Lower frequency below normal for long-hop transmission. |

whereas disappearance of the D layer at night permits lower frequencies.

Seasonal Variations

While the apparent position of the sun moves from one hemisphere to the other as seasons change, the maximum ionization in the D, E, and F1 layers shifts accordingly. Ionization of each layer is greater during the summer. The F2 layer does not follow this seasonal shift pattern. In most localities, the F2 ionization is greatest in winter and least in summer, the reverse of what might be expected. In winter ionization of the F2 layer rises sharply at about noon, maintaining a much higher density than in summer. Separation of the F1 and F2 layers is not so well defined in summer because the height of the F2 layer is higher during that season.

11-Year Sunspot Cycle

Sunspot activity varies in conformity with an 11-year cycle. Sunspots affect the amount of ultraviolet radiation and likewise the ionization of the atmosphere. During periods of high sunspot activity, ionization of various layers is greater than usual, resulting in higher critical frequencies for the E, F1, and F2 layers, and higher absorption in the D layer. Consequently, higher frequencies can be used for communication over long distances at times of greatest sunspot activity. Increased absorption in the D layer, which has the greatest effect on the lower frequencies, requires higher frequencies. The overall effect is an improvement in propagation conditions during years of maximum sunspot activity.

27-Day Sunspot Cycle

Another cycle due to sunspot activity is the 27-day variation, caused by rotation of the sun on its axis. As the number of sunspots changes from day to day with rotation of the sun, formation of new spots, or disappearance of old ones, absorption by the D layer also changes. Similar changes are observed in the E layer, and cover a wide geographic range. Fluctuations in the F2 layer are greater than for any other layer, but usually are not of a worldwide character.

Irregular Variations

In addition to the regular variations of the ionized layers, a number of transient and unpredictable events have an important bearing on propagation of the skywave. Some of the more prevalent of these events are sporadic E, effects, sudden ionospheric disturbance, ionospheric storms, and scattered reflections.

Sporadic E is an ionized cloud that appears at indefinite times and at a greater height than the normal E layer. Sometimes it is capable of reflecting so much of the radiated wave that reflections from other layers of the ionosphere are blanked out completely. Sporadic E may be so thin at other times that reflections from upper layers can be received through it easily. Although the sporadic E layer is more prevalent in the tropics than in higher latitudes, its occurrence is frequent. It may occur during the night or day.

The most startling of all irregularities of radio wave transmission is a phenomenon generally known as sudden ionospheric disturbance (SID) which causes radio fadeout. (SID is a misnomer in some respects since the disturbance associated with it occurs in the D layer which is actually a part of the stratosphere. See fig. 8-5.) This disturbance, caused by a solar eruption of ultraviolet radiation, comes without warning and may last for a few minutes or for several hours. All stations on the sunlit side of the earth are affected. At the onset of the disturbance, receiving operators are inclined to believe that their radio sets are defective. The solar eruption causes a sudden increase in ionization of the D layer, frequently accomplished also by disturbances in the earth's magnetic field. Increased ionization of the D layer usually causes total absorption of the skywave at all frequencies above 1000 kc.

An ionospheric storm is caused mainly by particle bombardment and usually follows an SID by approximately 18 hours. The storm may last from several hours to several days; it usually extends over the entire earth. High-frequency skywave transmission is subject to severe fading, and wave propagation is erratic. Often, it is necessary to lower the frequency to maintain communications during one of these storms.

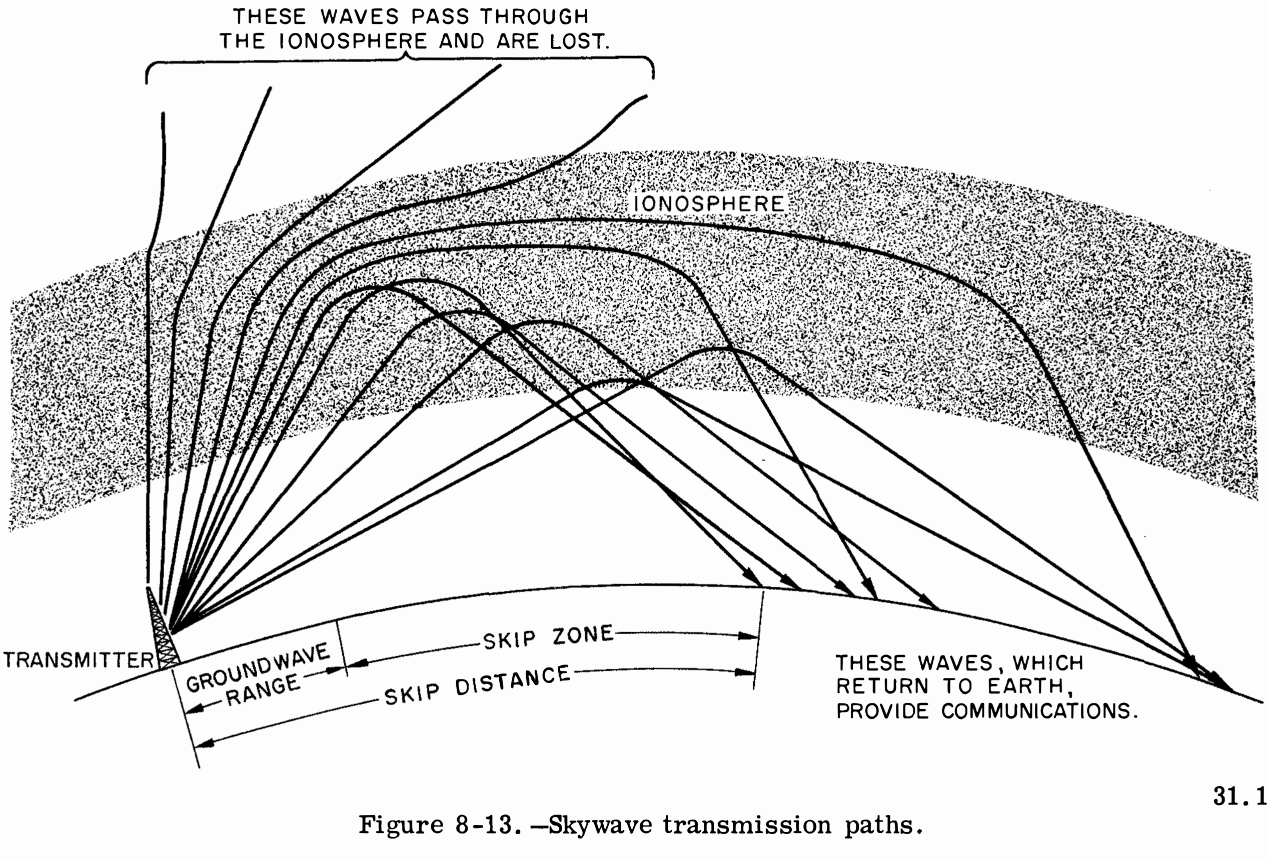
Scattered reflections (called spread F effect) frequently occur from irregular layers in the ionosphere, and may happen at all seasons, both day and night. A radio wave can reflect from either the top or bottom of one of these scattering ionospheric clouds, causing signal distortion and so-called flutter fading. In general, fading is of short duration. Usually no compensation by the radio operator is required.

## SKYWAVE PROPAGATION

Skywave propagation makes use of ionospheric reflections and refractions to provide signal paths between transmitters and receivers. Skywave transmission is by far the most important method for long-distance radio communications. This method presents many problems that can be solved adequately only through an understanding of the principles of skywave composition.

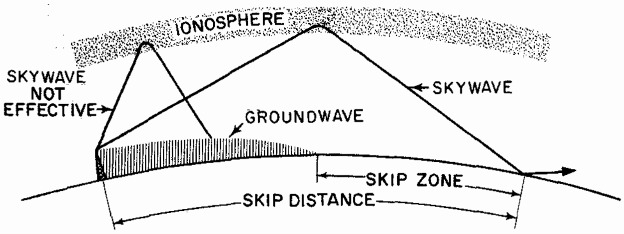
Figure 8-13 illustrates many possible paths radio waves travel from a transmitter to a receiver by reflection from the ionosphere. Note that some of the waves are assumed to be too high in frequency for reflection by the ionized layer, and pass on through and are lost in outside space unless they are reflected from a higher layer that has a greater degree of ion density. Other components of the wave, which are of the correct frequency for reflection from the ionospheric layer, are returned to earth. These latter components of the wave provide for communications. Figure 8-13 also shows that the skip distance extends from the transmitting antenna to the nearest point at which reflected waves return to earth. Relation of the skip zone and the groundwave is shown in figure 8-14. If the skywave returns to earth at a point where the groundwave and skywave are of nearly equal intensity, the skywave alternately reinforces and cancels the groundwave, resulting in severe fading of the signal. Fading is caused by phase difference between groundwave and skywaves resulting from the longer path traveled by skywaves.

Note the distinction between the terms "skip distance" and "skip zone." For each frequency at which reflection from an ionospheric layer takes place, there is a skip distance that depends on the frequency and the degree of ion-




31.16

Figure 8-13. —Skywave transmission paths.




31.17

Figure 8-14. —Relation of skip zone and groundwaves.

ization present. The skip zone, on the other hand, depends on the extent of the groundwave range and disappears entirely if the groundwave range equals or exceeds the skip distance.

The distance at which the wave returns to earth depends on the height of the ionized layer and the amount of bending of the wave. Upon return to earth, part of the energy enters the earth and is dissipated rapidly. Another part is reflected back into the ionosphere, where it may be reflected downward again at a still greater distance from the transmitter. This means of travel in hops—by alternate reflections from the ionosphere and from the surface of the earth—may continue, enabling transmissions to be received at great distance from the transmitter. Figure 8-15 illustrates the hop means of travel for paths involving one and two reflections from the ionosphere (called single-hop and double-hop).

As mentioned earlier, in the discussion of the ionosphere, the higher the frequency of a wave, the less it is refracted by a given degree of ionization. Figure 8-16 shows three separate waves of different frequencies entering an ionospheric layer at the same angle. Here, the 100-mc wave is not refracted sufficiently by the ionosphere, and is not returned to earth; the 5-mc and the 20-mc waves are returned. But the 20-mc wave, refracted less than the 5-mc wave, returns at a greater distance from the transmitter.

## MAXIMUM USABLE FREQUENCY (MUF)

Early experimenters in high-frequency radio transmission learned that, for a fixed distance of transmission, an upper limit of frequency would return to earth at that distance. The upper-limit frequency is greater for greater distances, greater in daytime that at night, and greater on a winter day than a summer day. Existence of this upper-limit frequency depends on ionization in the ionosphere reflecting only waves of frequencies less than a certain critical value. This value is called maximum usable frequency, abbreviated MUF. At frequencies above MUF for a given distance, the wave is said to skip, because it then returns to earth at a greater distance from the transmitter.

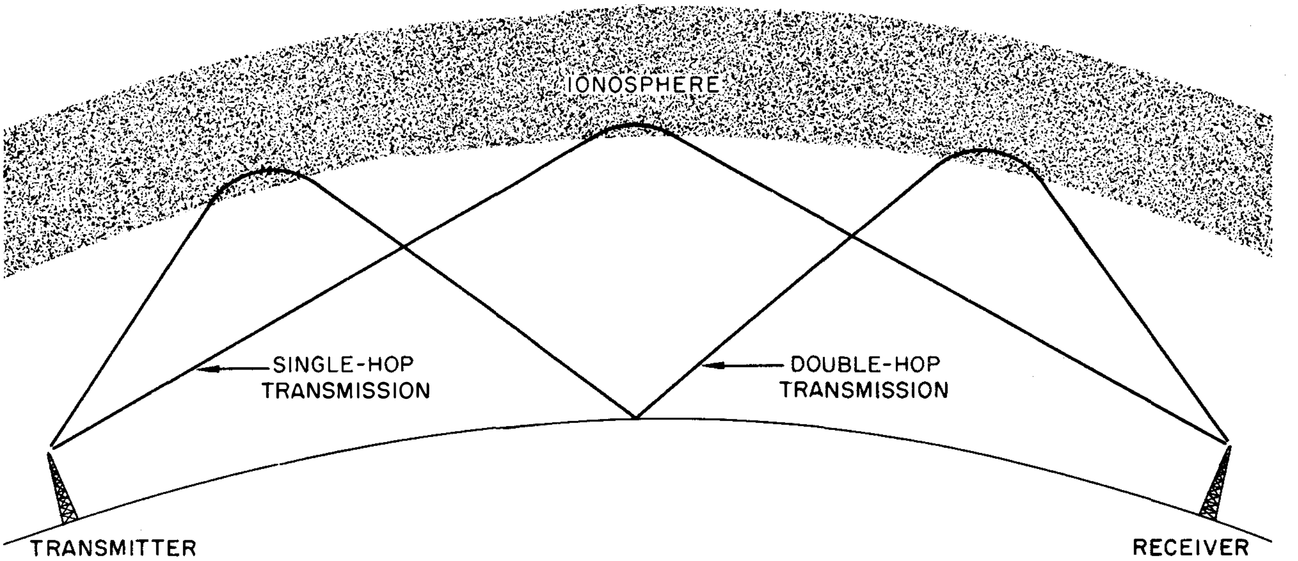
It is essential to know the MUF for any transmission path at any particular time. If operating frequency is above MUF, the wave skips, because it is not reflected from the ionosphere at the desired distance. If operating frequency is decreased below the MUF in the daytime, it is weakened or attenuated. In the high-frequency range, attenuation occurs because the lower the frequency, the greater its absorption in the ionosphere. Usually it is desirable to transmit on a frequency as near the MUF as possible. Inasmuch as a direct relationship exists between MUF, condition of ionosphere, and time, it is possible months in advance to predict MUF for any transmission path.

## FREQUENCY GUIDE

The Central Radio Propagation Laboratory of the National Bureau of Standards receives and analyzes ionospheric data from many stations throughout the world. These ionospheric data, in the form of MUF predictions, are utilized by the Armed Forces as well as by many other users. To assist the Navy communicator, the DNC 14 series, entitled Recommended Frequency Bands and Frequency Guide, is published quarterly, 3 months in advance of its effective data. The publication contains tables of frequency bands recommended for use under normal conditions for communications from one area to another. In most instances, the exact frequency recommended in DNC 14 is not available. Selection of an available frequency is made as near as possible, but not exceeding, the MUF. If a frequency higher than MUF is used, it is probable that reliable communications will result.

## ANTENNAS

An antenna is a conductor or a system of conductors for radiating (transmitting) or intercepting (receiving) radio waves.




31.18

Figure 8-15.—Single-hop and double-hop transmissions.

The subject of antennas and antenna theory covers a broad field. Most antenna theory is based on the performance of an antenna located in free space—away from all modifying influences such as the earth. In actual practice, however, this "ideal" condition is almost impossible to attain. There are many reasons why the antenna performs differently from the ideal free space theory, particularly on shipboard where space limitations cause adverse effects.

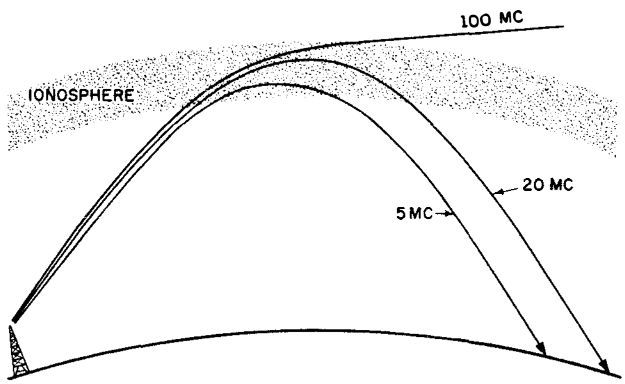
Any wire carrying alternating current radiates some energy because of the changing electromagnetic field. Consider the interference to an automobile radio when near powerlines. A powerline, of course, is a poor antenna because it was designed for carrying energy instead of radiating energy.

Usually, discussions of antenna theory concern antennas used for transmitting, although an efficient transmitting antenna for any particular frequency is also an efficient receiving antenna for that same frequency. It must be remembered, however, that there may be other limitations affecting the use of an antenna for both transmitting and receiving.

## ANTENNA LENGTH

The strength of a radio wave radiated by an antenna depends on the length of the antenna and the amount of current flowing in it. Because the antenna is a circuit element having inductance, capacitance, and resistance, the largest current is obtained when the inductive and capacitive reactances (opposition to the flow of alternating current) are tuned out; that is, when the antenna circuit is made resonant at the frequency being transmitted.

The shortest length of wire that will be resonant at any particular frequency is one just long enough to permit an electric charge to travel from one end of the wire to the other end and back again in the time of 1 cycle. The distance traveled by the charge is 1 wavelength. Because the charge must travel the




31.19

Figure 8-16.—Frequency versus distance for returned waves.

length of the wire twice, the length of wire needed to have the charge travel 1 wavelength in 1 cycle is half a wavelength. Thus, the half-wave antenna is the shortest resonant length and is used as the basis for all antenna theory.

An antenna can be made resonant by two methods: (1) by adjusting frequency to suit a given antenna length; or, as usually is more practical, (2) by adjusting the length of the antenna wire to suit a given frequency. It is, of course, impracticable to lengthen or shorten an antenna physically every time the transmitter is changed to a new frequency. The antenna length may, however, be changed electrically. This change is accomplished by a process known as tuning, or loading, the antenna.

The electrical length of an antenna is not necessarily the same as its actual physical length. Earlier it was learned that radio waves travel 186,000 miles per second in free space. Radiofrequency energy on an antenna, however, moves at a speed considerably less than that of radiated energy in free space. Because of the difference in velocity between the wave in free space and the wave on the antenna, the physical length of an antenna no longer corresponds to its electrical length. Thus, a half-wave antenna (called a dipole) is half a wavelength electrically, but it is physically somewhat shorter.

Assume that a station wishes to transmit on a frequency of 3 mc. Applying the formula for finding wavelength in meters.

$$\frac{300}{3} = 100 \text{ meters (wavelength).}$$

Or, if preferred, express the wavelength in feet:

$$\frac{984}{3} = 328 \text{ feet (wavelength).}$$

The wavelength, 328 feet, found by the preceding formulas, would also be the correct length of a full-wave antenna for 3-mc transmission except for differences between actual and electrical antenna lengths. A dipole for that frequency would be half the length, that is, 164 feet (or 50 meters).

Although the formulas are correct for finding wavelength, they do not hold true for finding antenna length except for an ideal antenna, completely free of the influence of the earth. If the antenna were made of very thin wire and isolated perfectly in space, its electrical length would correspond closely to its physical length, Actually, though, the antenna is never isolated completely from surrounding objects. Circumference of the wire itself and capacitance introduced by insulators and nearby objects combine to change velocity of the wave in the antenna. This change is called end effect, because ends of the antenna are made farther apart electrically than they are physically. Consequently, the physical length of a half-wave antenna should be about 5 percent shorter than the corresponding wavelength in space.

As previously shown, wavelength in feet is found by dividing speed of radio waves (984,000,000 ft/sec) by the frequency used. Thus, at a frequency of 1 mc wavelength or electrical length is 984 feet for a full-wave antenna. Because an antenna's physical length is 5% less than its electrical length, physical length is 936 feet. Electrical length of a half-wave antenna, of course, is 468 feet, and thus we can derive the formula: Half-wave antenna length (in feet) = 468/Frequency (in mc).

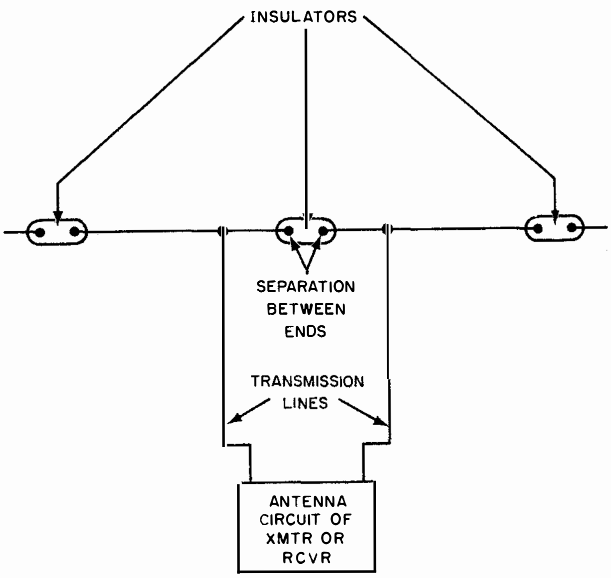
Substituting, the correct physical length for 3 mc is 468/3 = 156 feet.

For all practical purposes the formula is accurate for calculating the actual or physical length of a half-wave antenna for frequencies up to 30 mc.

## HALF-WAVE DIPOLE

A dipole antenna consists of two radiating elements in line with each other, with their ends slightly separated as shown in figure 8-17. A half-wave dipole (sometimes called a Hertz or doublet) is an antenna with a length approximately equal to half a wavelength at the frequency being transmitted. A transmitter, remember, is merely a high-frequency generator of alternating current. If a feeder line from a transmitter is connected to the center of a dipole, the antenna will act as though an a-c generator were set between two quarter-wave antennas, as in figure 8-18. During one-half the generator's alternation, electrons in the antenna flow from right to left (fig. 8-18, view B). During the next half alternation, electrons flow in the opposite direction (fig. 8-18, part C).

The dipole is the basis for many complex antennas. When used for transmitting medium



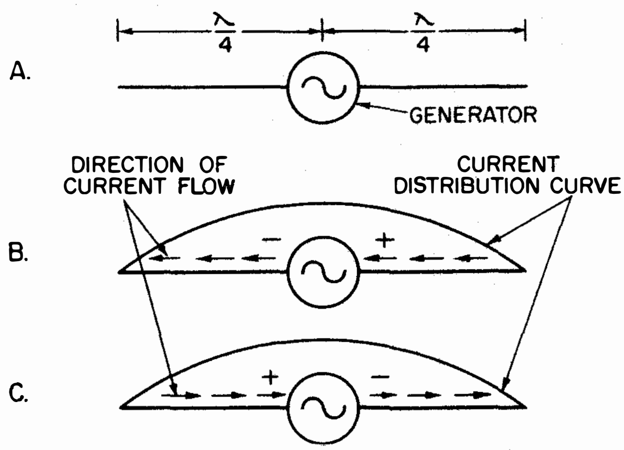

25.205(76)
Figure 8-17.—Dipole antenna.

and high frequencies, it usually is constructed of wire. At very high and ultrahigh frequencies, the shorter wavelength permits construction using metal rods or tubing. Depending upon the wave polarization desired, the dipole may be mounted either horizontally or vertically. Because the dipole is an ungrounded antenna, it may be installed far above the ground or other absorbing structures.

A vertical dipole, suspended in space away from the influence of the earth, would be surrounded by an electromagnetic field (called radiation pattern) the shape of a doughnut, as in figure 8-19, parts A and B. No radiation takes place at the ends of the dipole (line OA). Radiation increases progressively through lines OB and OC, until maximum radiation is obtained on a horizontal plane.

The field radiated by a horizontal dipole is in the shape of a doughnut standing on edge. Figure 8-19, part C, shows half of the doughnut pattern for a horizontal dipole. Again, maximum radiation takes place in a plane perpendicular to the axis of the antenna.

At low and medium frequencies, half-wave antennas are rather long and have little use in the Navy except at shore stations where there is room for them. A dipole for 500 kc, for example, would have to be about 936 feet long. At lower frequencies another basic



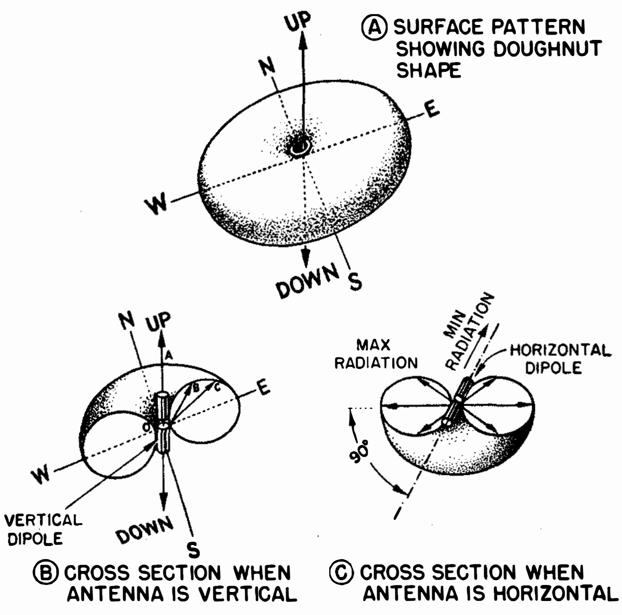

20.242
Figure 8-18.—Instantaneous direction and distribution of current in a dipole.

type of antenna affords a solution to the problem of undue length. It is the quarter-wave antenna.

## QUARTER-WAVE ANTENNA

A quarter-wave antenna is known also as the Marconi antenna. The latter term is being replaced by more descriptive terms relating to specific types of quarter-wave antennas.

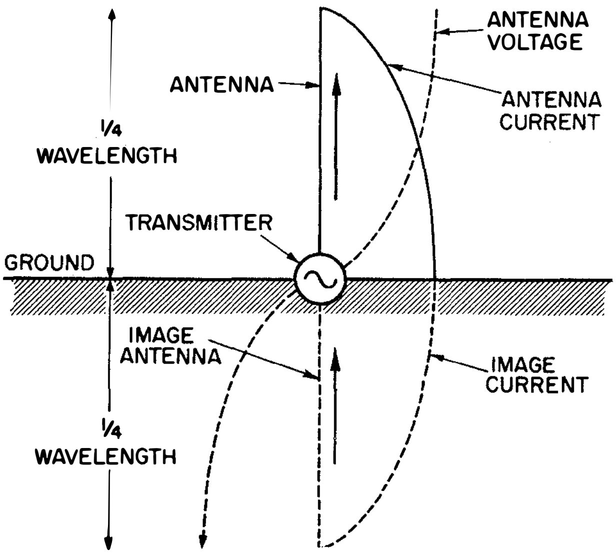
For medium and low frequencies, the earth is a fairly good conductor and acts as a large




1.255
Figure 8-19.—Electromagnetic field surrounding a dipole.

mirror for radiated energy. The ground reflects a large amount of energy that is radiated downward from an antenna mounted over it. It is as though a mirror image of the antenna is produced, the image being located the same distance below the surface of the ground as the actual antenna is located above it. Even in the high-frequency range (and higher), many ground reflections occur, especially if the antenna is erected over highly conducting earth or salt water.

Utilizing this characteristic of the ground, an antenna only a quarter-wavelength long can be made into the equivalent of a half-wave antenna. If such an antenna is erected vertically and its lower end is connected electrically to the ground (fig. 8-20), the quarter-wave antenna behaves like a half-wave antenna. Here, the ground takes the place of the missing quarter-wavelength, and the reflections supply that part of the radiated energy that normally would be supplied by the power half of an ungrounded half-wave antenna.

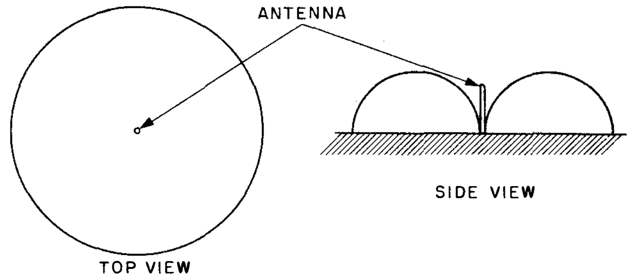



13.35(76)

Figure 8-20.—Grounded quarter-wave antenna, showing image current.

The relationship of current and voltage in a quarter-wave antenna is similar to their relationship in a dipole. Voltage is greatest at the top of the antenna and least at the bottom. Current is greatest at the bottom and least at the top.

Figure 8-21 shows the radiation pattern produced by a grounded quarter-wave antenna,




76.12

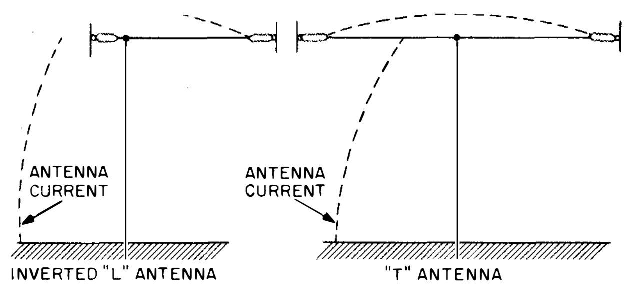
Figure 8-21.—Radiation pattern of a grounded quarter-wave antenna.

One bad feature of these shorter antennas is that radiation is less than that of a half-wave antenna. Radiation decreases with the length of antenna wire used, because less wire is carrying the high current that produces radiation.

Space limitations aboard ship usually prohibit installation of vertical antennas that are long enough to be resonant at low and medium frequencies. Two principal methods have been found for improving shipboard antennas that are electrically short at lower frequencies.

One method of increasing effective height of a short vertical antenna is by means of a flattop. A length of wire equal to the missing length of the antenna is added to it to form a horizontal flattop (fig. 8-22). In this way, current in the vertical section is made more nearly constant, thus increasing the antenna's effective height. Actually, the flattop contributes very little to the radiation, most of which comes from the vertical portion of the antenna.

Another method for making the antenna resonant, when short antennas must be used at low frequencies, is to add an inductance (called




76.13

Figure 8-22.—Flattop antennas and their current distribution.

a loading coil) at the base of the antenna. Inductance has the effect of increasing antenna length. If the antenna must be used over a wide frequency range, a large variable capacitor is placed in series with the loading coil. A capacitor has the effect of shortening the antenna. The combination of loading coil and capacitor permits the antenna to be tuned to resonance over a wider frequency range.

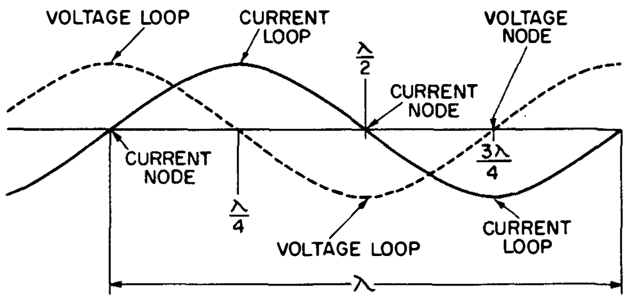
A different method of operating a vertical quarter-wave antenna is to use a ground plane (frequently called a counterpoise) with the antenna. Usually the ground plane is made of wires or rods extending radially from the base of the antenna. The ground plane actually substitutes for the ground connection, thereby establishing the ground level at the base of the antenna. Thus the antenna can be installed high above ground on masts or towers.

Ground plane antennas of this sort are used mostly for VHF and UHF communications.

## STANDING WAVES

If an antenna is energized by an alternating current of a frequency equal to the antenna's resonant frequency, current and voltage values vary along the length of the wire, and always are 90° out of phase. Figure 8-23 shows the relationship of current and voltage in a full-wave antenna. Points where voltages or current are maximum are called voltage or current loops. Points of minimum voltage or current are known as voltage or current nodes. Current and voltage nodes appear every half wavelength, but are separated from each other by one-fourth wavelength.

The wave of energy sent out by the transmitter travels to the ends of the antenna, and from there it is reflected back along the length of the wire. The wave moving from the transmitter toward the end of the antenna is called the incident wave; its reflection is called the reflected wave. The time required for this process depends on antenna length and hence on frequency. If the antenna is resonant to the frequency generated by the transmitter, the returning wave arrives at the driving point exactly in phase with the outgoing wave, and the two waves tend to reinforce each other. This condition continues as long as the antenna is energized. The effect is the same as though there were standing waves along the length of the wire instead of two sets of moving waves, as really happens. Only




76.14

Figure 8-23. —Standing waves along full-wave antenna.

in the presence of standing waves does the antenna radiate at maximum.

## TYPICAL SHORE STATION ANTENNAS

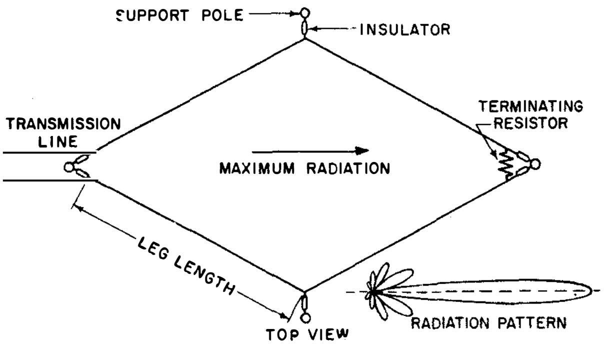
It is difficult to classify a particular type of antenna as strictly a shore station type or a shipboard type unless, of course, its physical dimensions are the fundamental consideration. For this reason, several antennas described in the remainder of this chapter are used both ashore and afloat, even though they may be indicated as either typical shore station or typical shipboard types. The types described are merely a sampling of the many and varied antennas Radiomen will encounter.

### Rhombic Antenna

A type of antenna used widely for long-distance transmission and reception is the rhombic antenna. It is so named because of its diamond shape. Figure 8-24 shows a typical rhombic antenna.

A rhombic antenna requires so much space that its use is confined to shore stations. Because of its directive radiation pattern (fig. 8-24), it is useful in point-to-point communications. The basic rhombic antenna has four straight wires joined to form the diamond, and it is suspended horizontally from four poles. Each leg of the antenna is at least 1 or 2 wavelengths at the operating frequency. Length may be as many as 12 or more wavelengths, so that rhombic antennas, even for high-frequency work, have leg lengths of several hundred feet.

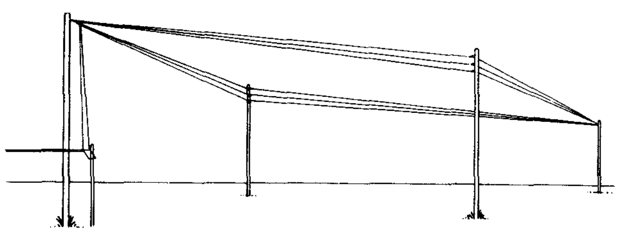
Some advantages of a rhombic antenna are simplicity of construction, ease of maintenance, high gain, and its usefulness over a wide range of frequencies. It will perform even better if




13.37(76)A

Figure 8-24.—Typical rhombic antenna.

more than a single wire is used to form each leg. The most common multiwire rhombic antenna is the three-wire type (fig. 8-25). Spacing between the three wires is greatest at the side poles and least at the ends. The three-wire rhombic provides a better match to the transmission line. When used for receiving, it reduces noise caused by precipitation static. For the foregoing reasons it is the only type of rhombic presently installed at both transmitting and receiving stations.



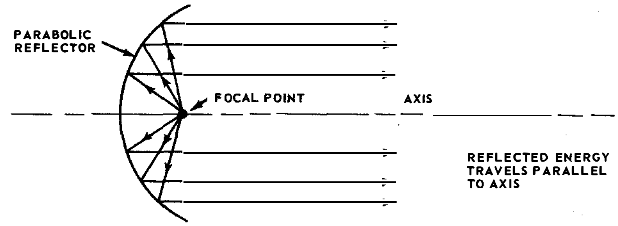
13.37(76)B

Figure 8-25.—Three-wire rhombic.

## Parabolic Antenna

Communication systems such as microwave line-of-sight radio and tropospheric scatter use parabolic antennas. These systems operate at frequencies that have radiation properties approaching those of light waves and therefore can be reflected in much the same manner that a searchlight reflector controls a light beam.

Parabolic reflectors are designed to fit the needs of the particular system with which they will be used, but they all work on the same basic theories. Figure 8-26 illustrates that energy from a radiating element placed at the focal point of a parabolic reflecting surface will be reflected into a narrow beam. Antennas or radiating elements used with parabolic reflectors are either dipole or horn type.

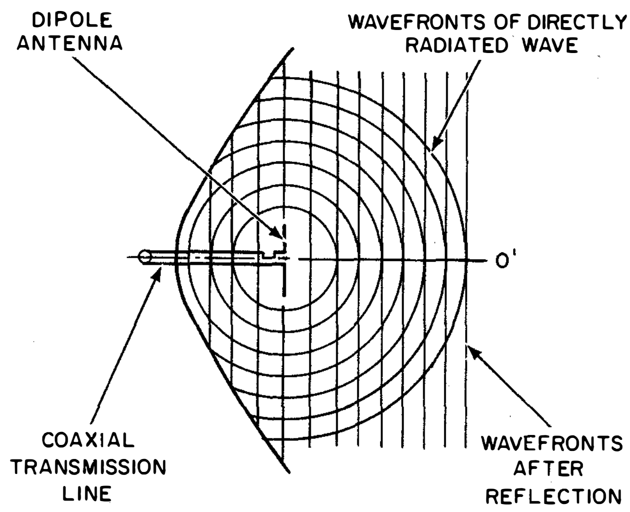



1.49

Figure 8-26.—Principle of parabolic reflection.

Dipole antennas at microwave frequencies are physically small. Figure 8-27 shows the wavefronts of a parabolic reflector and dipole antenna. Some of the radiated field leaves the antenna directly. Because it is not reflected, it does not become part of the main beam and therefore serves no useful purpose.

Horn radiators, like parabolic reflectors, may be used to obtain directive radiation at microwavelengths. They are practicable in this frequency region because their dimensions, which must be large compared with operating wavelengths, do not involve unduly large physical sizes. Because there are no resonant elements, they have the advantage of being usable over a wide frequency band. Operation of a horn as an electromagnetic directing device is analogous to that of acoustic horns. Usually, however, the throat of an acoustic



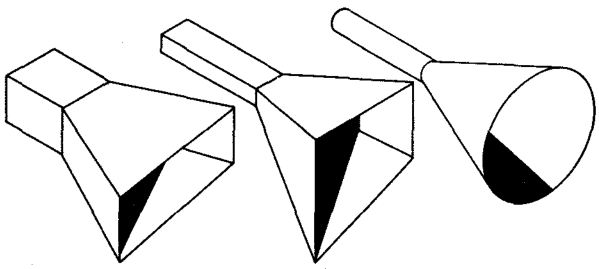

25.226

Figure 8-27.—Dipole antenna and parabolic reflector wavefronts.

horn has dimensions much smaller than the sound wavelengths for which it is used.

On the other hand, the throat of the electromagnetic horn has dimensions that are comparable to the wavelength being used. Horn radiators may be fed by coaxial or other types of lines.

Horns are constructed in a variety of shapes (fig. 8-28). Shape of a horn, along with dimensions of its mouth, largely determines the field pattern shape. In general, the larger the horn's opening, the more directive is the resulting field pattern. An aperture of approximately 5 wavelengths in the long dimension produces a radiated lobe of approximately 30°.



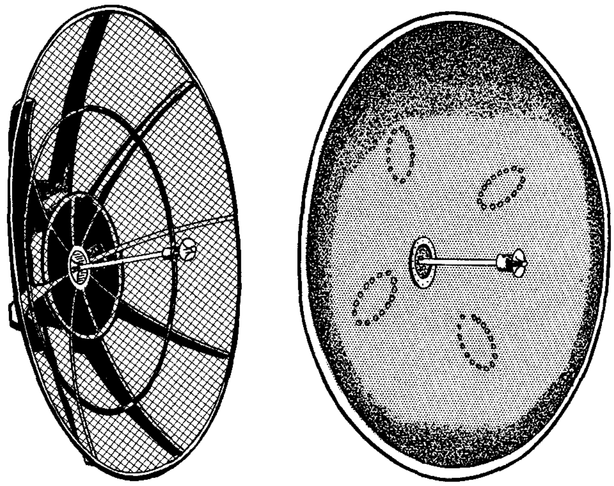

13.41

Figure 8-28.—Horn radiators.

Two types of microwave antennas are shown in figure 8-29. The top one is a 6-foot solid parabolic with dipole-antenna. The bottom one is a 6-foot mesh parabolic with dipole antenna. Both types are used with the Navy's model UQ radio relay equipment. Figure 8-30 shows both types of antennas mounted on a tower at Bataan peninsula in the Philippines.

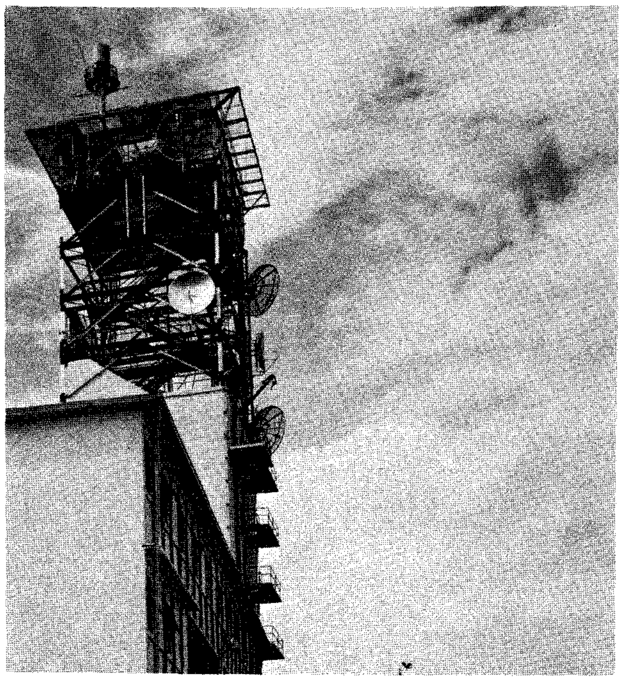
Usually, the distance between transmitting and receiving antennas for microwave systems is determined by local terrain. In actual practice, transmit and receive antennas can be separated by a slightly greater distance than is possible in the actual horizon-to-horizon line-of-sight distance, because of refraction of the microwave beam by the atmosphere.

Figures 8-31 and 8-32 show two types of tropospheric scatter antennas. Because of the wave propagation in the troposphere, the signal strength fluctuates considerably, consequently much of the signal is lost. A steady signal can be maintained by using diversity reception. Energy from each of a number of fluctuating signals may be combined. All tropo scatter systems use diversity reception. To obtain signals over different paths that fade and vary independently, some or all of the following methods may be used. Signals obtained over two or more independent paths by the methods are combined in the receiver in such a way as to utilize the best signal at all times.



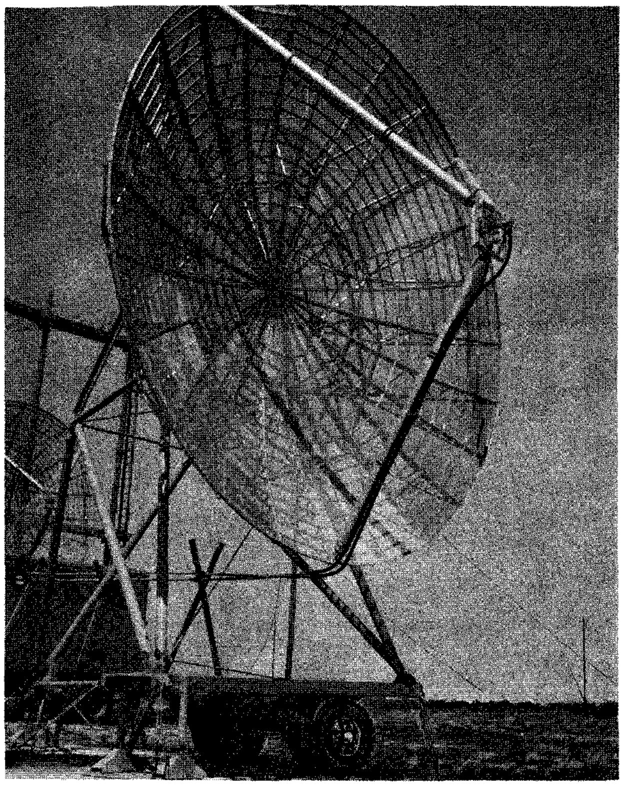
76.56

Figure 8-29. —Two types of microwave antennas.



76.57

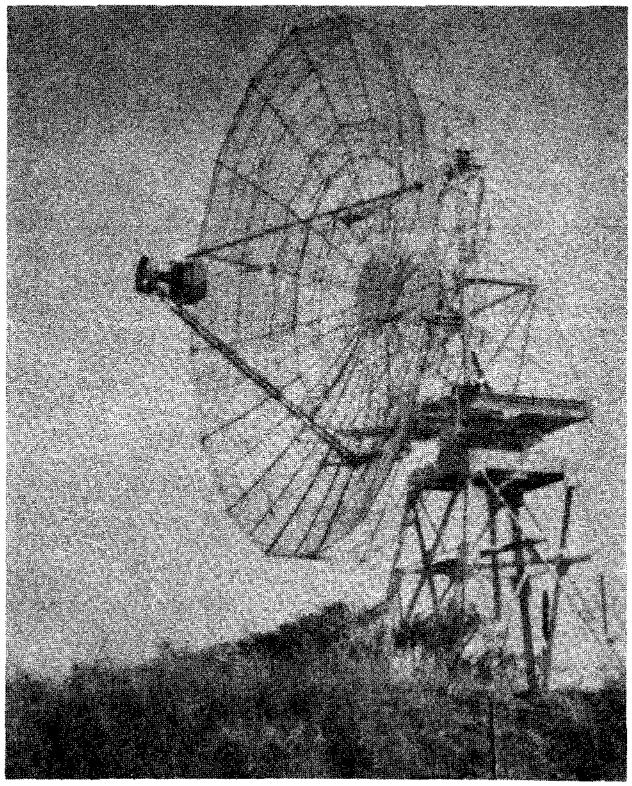
Figure 8-30. —Microwave antennas.



76.58
Figure 8-31.—Mobile tropospheric 30-foot scatter antenna.

- Space diversity: Receiving antennas separated by 50 wavelengths or more at the signal frequency (usually 10 to 200 feet is sufficient).
- Frequency diversity: Transmission on different frequencies fades independently, even when transmitted and received through the same antenna.
- Angle diversity: Two feedhorns produce two beams from the same reflector at slightly different angles. This method results in two paths based on illuminating different scatter volumes in the troposphere.

Figure 8-33 shows a possible arrangement of a tropospheric scatter site. Antennas on the left are called billboard antennas; those on the right are dish antennas. Antennas vary in size from 60 feet in diameter to 120 feet in diameter or more. Dish antennas are similar to those shown in figures 8-30 and 8-31.



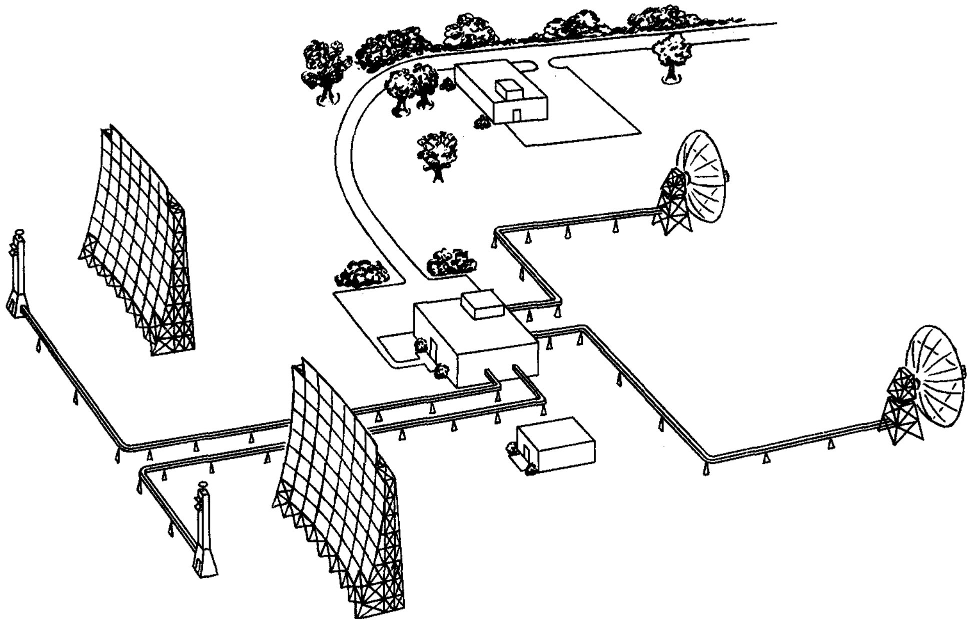
76.59
Figure 8-32.—Tropospheric scatter antenna.

Sleeve Antenna

A sleeve antenna is a high-frequency antenna. It is capable of operating over a wide range of frequencies, and is known as a broadband antenna. Originally it was developed to fill the need for a versatile, long-distance antenna at shore stations, but it has been modified for shipboard use also. Figure 8-34 is a shore station version of a sleeve antenna. A shipboard sleeve antenna is shown in figure 8-35. Sleeve antennas are especially helpful in reducing the total number of conventional narrowband antennas that otherwise would be required to meet requirements of shore stations. By using multicouplers (discussed in chapter 9), one sleeve antenna can serve several transmitters operating over a wide range of frequencies. This feature also makes the sleeve antenna ideal for small antenna sites.

Conical Monopole Antenna

Another broadband antenna that is used extensively is the conical monopole shown in fig-



76.60

Figure 8-33.—Possible arrangement of a tropospheric scatter communication site.

ure 8-36. Like the sleeve antenna, it is used both ashore and aboard ship.

When operating at frequencies near the lower limit of the high-frequency band, the conical antenna radiates in much the same manner as a regular vertical antenna. At higher frequencies the lower cone section radiates, and the effect of the top section is to push the signal out at a low angle. The low angle of radiation causes the skywave to return to the earth at great distances from the antenna. Hence, the conical monopole antenna is well suited for long-distance communication in the high-frequency range.

## TYPICAL SHIPBOARD ANTENNAS

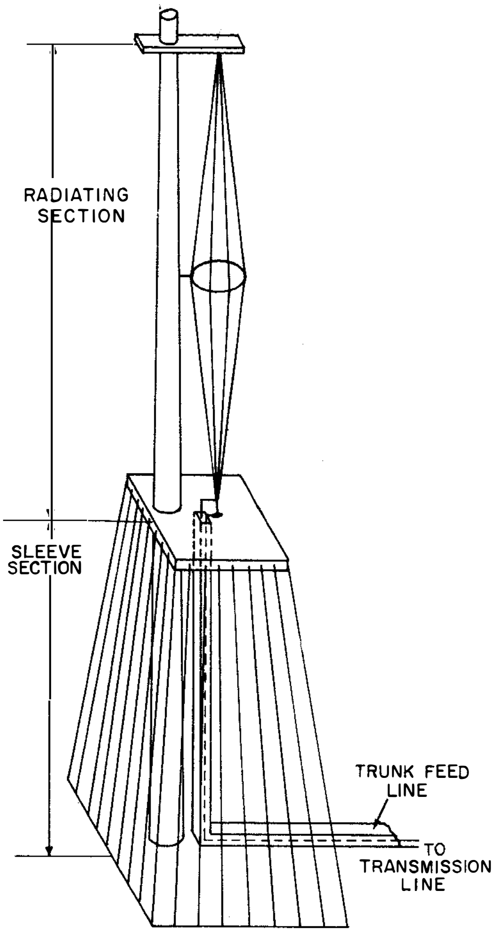
Problems not usually present in land installations arise when antennas are installed aboard ship. Most of the masts, stacks, and other structures above decks are connected electrically (grounded) to the ship's hull and, through the hull, to the water. To obtain adequate coverage from the antenna, it must be installed so that minimum distortion of the radiation pattern results from grounded structures.

### Wire Antennas

Wire antennas (fig. 8-37) are installed aboard ship for medium- and high-frequency coverage. Normally, they are not cut for a given frequency. Instead, a wire rope is strung either vertically or horizontally from a yardarm (or the mast itself) to outriggers, another mast, or to the superstructure. If used for transmitting, the wire antenna is tuned electrically to the desired frequency.

Much larger wire is used for shipboard antennas than for land installations. The larger wire is less likely to break under the strain of shipboard vibrations. Additionally, it can be stretched tighter to avoid sagging in hot weather. The wire is twisted and stranded for additional strength. Usually it is made of phosphor-bronze, a material that is nonmagnetic and resists corrosion. Wire of receiving antennas ordinarily is covered with a plastic insulation, but wire of transmitting antennas is uninsulated.

Receiving wire antennas normally are installed forward on the ship, rising nearly vertically from the pilothouse top to brackets on the mast or yardarm. They are located as far as possible from transmitting antennas so that a



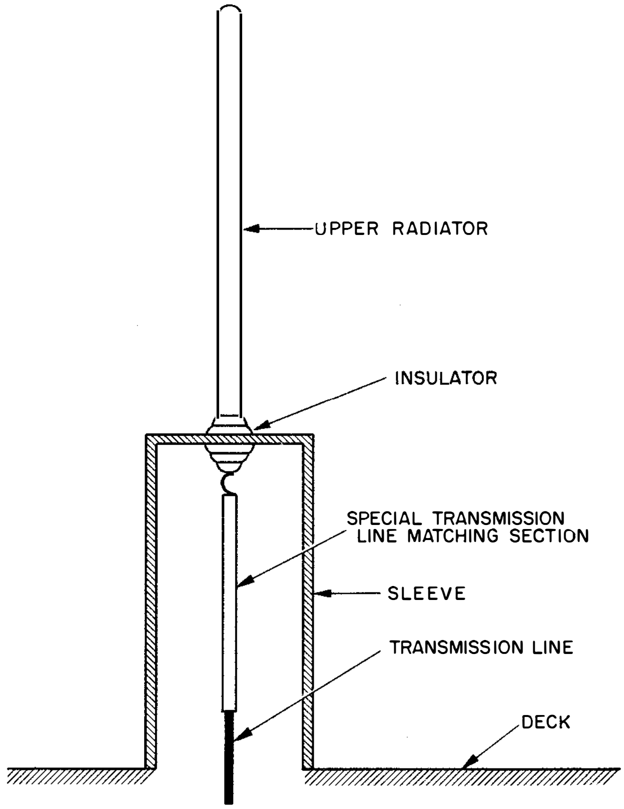

13.40
Figure 8-34.—Sleeve antenna (shore station).

minimum of energy is picked up from local transmitters. The transmission line (lead-in) for each receiving antenna terminates in antenna transfer panels in radio spaces.

Transmission lines of the transmitting antenna may be of coaxial cable or copper tubing. They are supported on standoff insulators and are enclosed in rectangular metal ducts called antenna trunks. Each transmission line connects with an individual transmitter or with an antenna multicoupler.

Whip Antennas

Whip-type antennas have replaced many wire antennas aboard ship. Because they are essentially self-supporting, whip antennas may be installed in many locations aboard ship. They

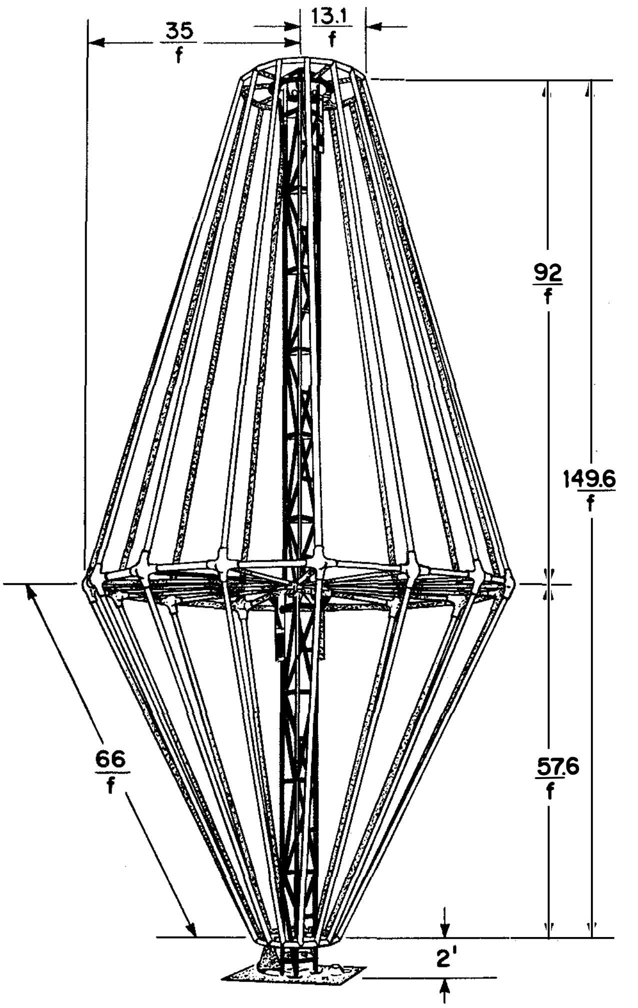



25.217
Figure 8-35.—Sleeve antenna (shipboard).

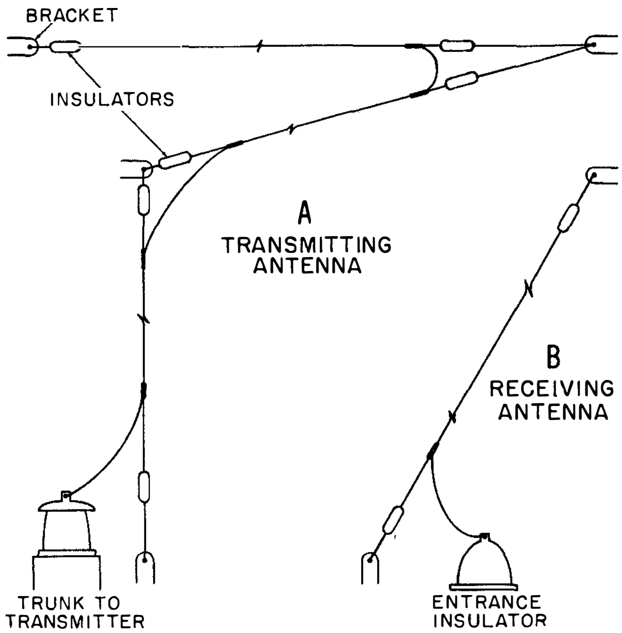
may be deck-mounted, or they may be mounted on brackets on the stacks or superstructure (fig. 8-38). Whip antennas commonly used aboard ship are 25, 28, or 35 feet in length and are made up of several sections.

On aircraft carriers, whip antennas located along the edges of the flight deck can be tilted. The tilting whip is pivoted on a trunnion, and is equipped with a handle for raising and lowering the antenna. A counterweight at the base of the antenna is heavy enough to nearly balance the antenna in any position. The antenna may be locked in either a vertical or horizontal position.

Several special types of tilting mounts for whip antennas, called erecting mechanisms, are used aboard submarines. They may be operated from within a submarine. In some installations, as a submarine dives, the force of the water causes the whip to be folded back from a vertical to a horizontal position; a catch holds the antenna in this position. When the submarine surfaces, the catch is released, and a spring




25.214
Figure 8-36.—Conical monopole antenna.




1.46
Figure 8-37.—Shipboard wire antennas.

mechanism causes the antenna to snap back to its vertical position. In newer submarines, whip antennas are mounted on retractable masts, enabling the antenna to be raised or lowered from within the submarine in much the same manner as the periscope.

VHF-UHF Antennas

At VHF and UHF frequencies, the shorter wavelength makes the physical size of the antenna relatively small. Aboard ship these antennas are installed as high and as much in the clear as possible. The reason for the high installation is that vertical conductors, such as masts, rigging, and cables in the vicinity, cause unwanted directivity in the radiation pattern.

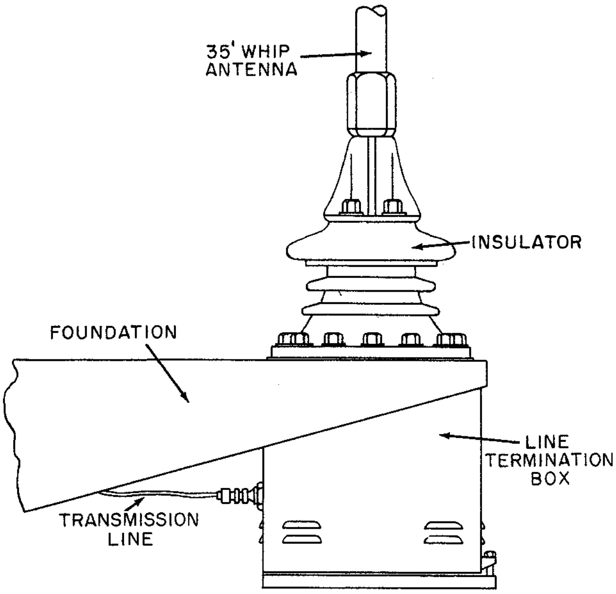
For best results in the VHF and UHF ranges, both transmitting and receiving antennas must have the same polarization. Vertically polarized antennas are used for all ship-to-ship, ship-to-shore, and air-ground VHF-UHF communications. Usually, either a vertical half-wave dipole or a vertical quarter-wave antenna with ground plane is used.

An ultrahigh frequency antenna of the half-wave (dipole) type is the AT-150/SRC (fig. 8-39). The horizontal (longer) portion of the antenna does not radiate, but acts as a mounting arm for the antenna and as an enclosure for the antenna feed line. This type of antenna is normally mounted horizontally.

The AS-390/SRC (fig. 8-40) is a quarter-wave UHF antenna with a ground plane. The ground plane consists of a round plate (called a counterpoise) and eight equally spaced drooping radials (rods). This antenna is mounted vertically.

EMERGENCY ANTENNAS

Loss or damage to an antenna from heavy seas, violent winds, or enemy action may cause




1.47

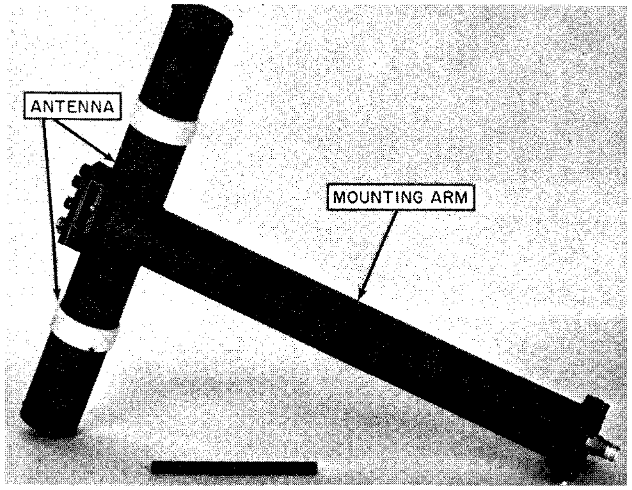
Figure 8-38.—Whip antenna.

serious disruption of communications. Sections of a whip antenna may be carried away, insulators may be damaged, or a shellburst may cause a wire antenna to snap in half. If loss or damage should happen when all available equipment is needed, Radiomen must rig an emergency antenna (or at least assist ETs) to restore communications on a temporary basis until the regular antenna can be repaired.

Emergency antennas vary considerably in design. Among influences affecting their design are type of ship, location of transmitting or receiving equipment, availability of space, and suitability of nearby structures for rigging the antenna quickly.

The simplest emergency antenna consists of a length of wire rope to one end of which a high-voltage insulator is attached; a heavy alligator clip or lug is soldered to the other end. The end with the insulator is hoisted to the nearest mast, yardarm, or other high structure and secured. The end with the alligator clip (or lug) is attached to the equipment transmission line. To radiate effectively, the antenna must be sufficiently clear of all grounded objects.

Well in advance of any possible emergency situation, emergency antennas should be cut to proper length; insulators and other necessary hardware should be installed. They are then stowed in radio spaces so that they are readily accessible.



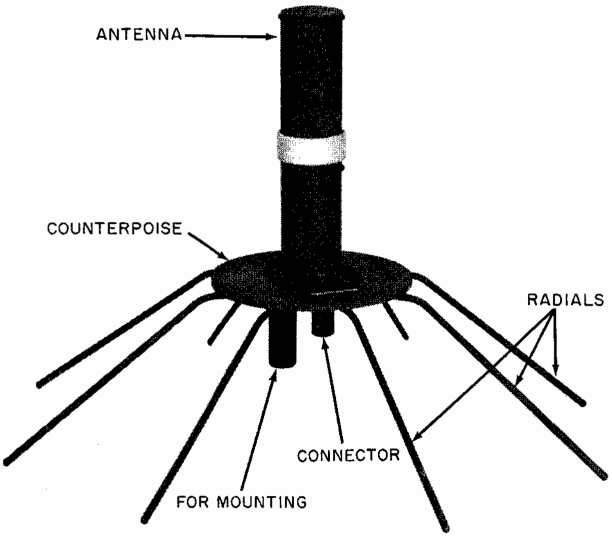

1.48

Figure 8-39.—UHF antenna AT-150/SRC.

## ANTENNA TUNING

As pointed out earlier, shipboard antennas used for communications at medium and high frequencies usually are not of the proper length to give optimum performance at the operating frequency. This condition exists because (1) all antennas are of standard size and shape, or (2) they are installed in whatever space may be available for them, or (3) because each antenna is operated at more than one frequency. All transmitting equipment must be able to operate at any frequency within its tuning range. It is necessary, therefore, to employ some means at the transmitter for adjusting the antenna for reasonable efficiency at any frequency, regardless of the physical size or arrangement of the antenna.

Because each transmitter usually is associated with only one antenna, which is of fixed length, adjustment of the antenna's effective length must be made electrically. This process, called antenna tuning, is accomplished by increasing or decreasing inductance and/or capacitance in the antenna system at the point where the antenna is fed from the transmitter or transmission line. Added inductance has the effect of increasing the electrical length of the antenna, whereas capacitance decreases it. In this manner the antenna can be made to respond




25.220

Figure 8-40. —UHF antenna AS-390/SRC.

as though it has a number of quarter waves along its length. By tuning the antenna properly, standing waves are increased and radiated energy is increased.

In studying transmitters in chapter 9, more information will be learned about the antenna tuning procedure for a typical model of Navy shipboard transmitting equipment.

# CHAPTER 9

# RADIO COMMUNICATION EQUIPMENT

This chapter presents the elementary principles of operation for radio equipment. It is meant to be studied in conjunction with the effective additions of Navy Training Courses Basic Electricity, NavPers 10086 and Basic Electronics, NavPers 10087. Chapters applicable to Radiomen appear in the Reading List at the front of this manual.

In descriptions of representative communication equipment, only fundamental features are given. Circuits are represented largely by block diagram. Emphasis is on the types and purposes of the stages on which performance capabilities and limitations of equipment are based.

Because detailed schematic drawings and exact descriptions of all the various elements cannot be given here, the reader is referred to the equipment technical manuals for information pertaining to the circuit details.

Before going into the study of transmitters and receivers, it is essential first to review the subject of electrical units, as well as schematic symbols used in electronic circuit drawings.

## REVIEW OF ELECTRICAL UNITS

A thorough knowledge of electrical units presented in Ohm's law is a necessity for every Radioman. Coverage given these units in the following topics is intended as a review only.

- Current: An electrical current often is compared to the flow of water through a main. To gage the rate of flow it is necessary to have a measure of quantity (pints, quarts, gallons, barrels, etc.) and a measure of time (seconds, minutes, hours, etc.).

In an electrical circuit, current that flows is composed of electrons, which are tiny charged particles that form one of the constituent parts of atoms. The electron is far too small to serve as a measure of quantity. Instead, a larger unit, the coulomb, is used. One coulomb is equivalent to 6.3 billion electrons. The measure of time is the second. A flow of 1 coulomb per second is equal to 1 ampere, a term that is at the same time a measure of quantity and time, just as the term knot is a measure of both distance and time.

- Voltage and resistance: Assume that a water main is fed from a standpipe some miles away. Water flows because the water level in the standpipe is higher than the outlet of the main, and the difference in their levels causes a pressure to be exerted on water in the main.

The movement of electricity is comparable. If there is a difference in the relative electrical level (charge) between two terminals of the conductor, electrons move from the point of relative surplus (negative terminal) to the point of relative shortage (positive terminal), and a current flows. This difference in electrical level is termed difference in potential, and may also be thought of as pressure. It is measured in volts. An electrical conductor offers resistance to the flow of current just as the inside surface of the main offers resistance to the flow of water. Electrical resistance is measured in ohms. To force 1 ampere through a resistance of 1 ohm requires a pressure of 1 volt.

- Power: Power, the time rate of doing work, is the product of voltage and amperage. The electrical unit of power, the watt, is the product of 1 volt and 1 ampere.

## SCHEMATIC SYMBOLS

Radiomen should become familiar with the various schematic symbols encountered both in studying and working with electrical and electronic circuits. These graphic symbols represent a shorthand method used by designers and engineers on electronic circuit drawings.

In recent years many changes have resulted from efforts by Government activities and the electronic industry to standardize these circuit symbols. Some older textbooks and equipment technical manuals, prepared before adoption of the standard, contain some symbols that are not quite identical with those shown in this manual. In most instances, however, familiarity with the modern standard enables Radiomen to recognize easily the intent of the older symbols.

The list of symbols shown in figure 9-1 is not all-inclusive, but illustrates most of the basic symbols of interest to Radiomen. It also includes many typical combinations, called buildup symbols. A complete listing of all possible buildup examples has never been compiled. A reasonably comprehensive knowledge of the basic symbols, however, will enable an understanding of the more complex buildups. Radiomen should know particularly, in studying electronic circuits, that schematic symbols may be drawn to any proportional size that suits a particular drawing. Additionally, they may be oriented in any direction without altering the meaning of the symbols. Explanatory details often are added, when necessary, adjacent to the symbols.

The work of a Radioman requires a knowledge of the meanings of schematic symbols. He must be able to identify, in schematic diagrams, certain basic radio circuits, such as amplifiers, oscillators, mixers, and rectifiers. These circuits are schematically illustrated and discussed in detail in Basic Electronics.

Upon advancing in rating beyond RM2, needs increase for knowledge of schematic symbols. in reading and interpreting circuit diagrams and in understanding special circuits of increased complexity used in Navy communication equipment.

## EQUIPMENT DESIGNATING SYSTEMS

A nameplate on the front of each item of electronic equipment carries a group of letters and numbers to identify the equipment. This group is assigned in accordance with either the Joint Electronics Type Designation System (commonly called AN nomenclature system) or the Navy Model System, depending on the relative age of the equipment. Most new electronic equipment procured for the Navy, Army, Air Force, Marine Corps, and Coast Guard is assigned model letters under the AN system.

### Joint Nomenclature System

The first two letters of the Joint Nomenclature System are AN, designating a major equipment.

The AN designator is followed by a slant sign and three identifying letters. Letters to the right of the slant sign give a brief description of the equipment: First Letter—where installed, and whether designed for use in aircraft, submarine, surface craft, shore station, etc.; second letter—type of equipment (radio, radar, sonar, visual, etc.); third letter—purpose of equipment; (communications, direction-finding, receiving, transmitting, etc.).

The three equipment indicator letters are followed by the model number. The model number may be succeeded by additional letters to indicate a modification of the original equipment. Consider, for example, equipment designation AN/SRT-15. The AN denotes the system indicator. A glance at table 9-1 gives the meaning of these equipment indicator letters: S—Water surface craft, R—radio, T—transmitting; figure 15 indicates the fifteenth equipment in this category to which an AN designator has been assigned.

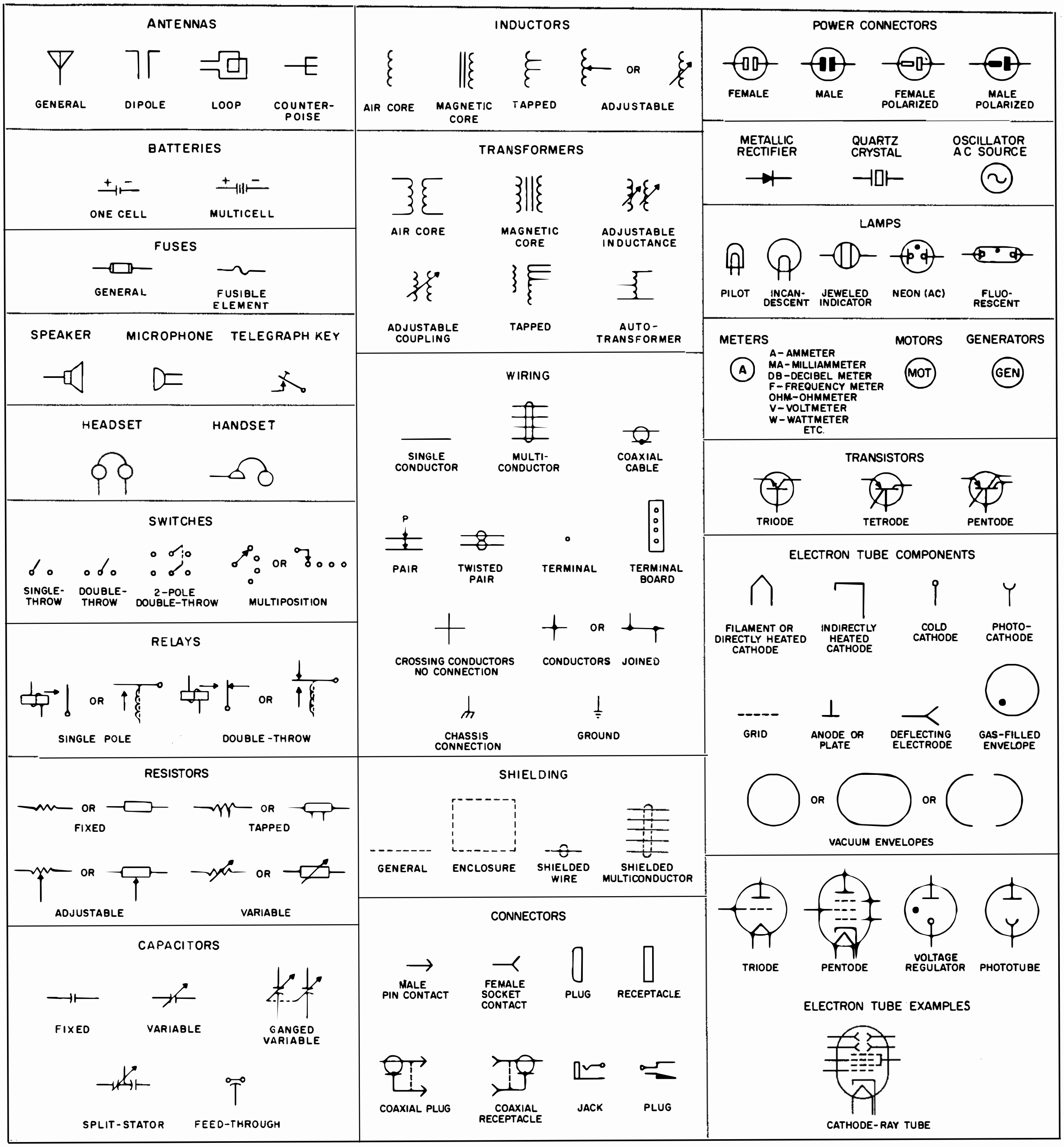
### Navy Model System

The AN nomenclature system was adopted by the Navy in 1946, but a considerable quantity of equipment, marked and identified by the older Navy model system, still is in use.

Assignment of Navy model letters to electronic equipment depends on the primary function of the equipment, such as receiving, transmitting, direction-finding, etc. In this system only the first letter (in a few instances, the first two letters) indicates the basic purpose of the equipment. Remaining letters were assigned in alphabetical sequence as newer equipments were designed. Some first letters on equipment nameplates are: D—radio direction-finding, FS—frequency shift keying, L—precision calibrating (such as frequency meters), R—radio receiving, T—radio transmitting (includes combination transmitting and receiving). It can be seen in the list that letter R means radio receiving. The first receiver designated under the system was RA, RB the second, and so on. When the alphabet was exhausted, 3-letter designators were used. For example, RAA followed RZ, then RAB came after RAA; RAZ was succeeded by RBA, and so on.

Numbers after model letters indicate a modification of equipment or the award of a new manufacturer's contract.

Although the Navy model letter system of equipment identification no longer is in primary




13.5A

Figure 9-1. —Schematic symbols.

use, some equipments under this system are of comparatively recent design and manufacture—for example, the model TED transmitter.

## CLASSIFICATION OF EMISSIONS

Radio wave emissions (transmissions) are classified by international agreement, depending

Table 9-1. —Equipment Indicator Letters, AN Nomenclature System

| 1st letter (designed installation classes) | 2d letter (type of equipment) | 3d letter (purpose) |
|---|---|---|
| Installation | Type of Equipment | Purpose |
| A—Airborne (installed and operated in aircraft). | A—Invisible light, heat radiation. | A—Auxiliary assemblies (not complete operating sets). |
| B—Underwater mobile, submarine. | B—Pigeon. | B—Bombing. |
| C—Air transportable (inactivated). | C—Carrier. | C—Communications (receiving and transmitting). |
| D—Pilotless carrier. | D—Radiac. | D—Direction finder and/or reconnaissance. |
| F—Fixed. | E—Nupac (nuclear protection and control). | E—Ejection and/or release. |
| G—Ground, general ground use. | F—Photographic. | G—Fire control or searchlight directing. |
| K—Amphibious. | G—Telegraph or teletype. | H—Recording and/or reproducing (graphic, meteorological, and sound). |
| M—Ground, mobile (installed as operating unit in a vehicle which has no function besides transporting the equipment). | I—Interphone and public address. | L—Searchlight control (inactivated; use G). |
| P—Pack or portable (animal or man). | J—Electromechanical (not otherwise covered). | M—Maintenance and test assemblies (including tools). |
| S—Water surface craft. | K—Telemetering. | N—Navigational aids (including altimeters, beacons, compasses, racons, depth sounding, approach, and landing). |
| T—Ground, transportable. | L—Countermeasures. | P—Reproducing (inactivated). |
| U—General utility (includes two or more general installation classes, airborne, shipboard, and ground). | M—Meteorological. | Q—Special, or combination of purposes. |
| V—Ground, vehicular (installed in vehicle designed for other functions than carrying electronic equipment, etc., such as tanks). | N—Sound in air. | R—Receiving, passive detecting. |
| W—Water surface and underwater. | P—Radar. | S—Detecting and/or range and bearing. |
| | Q—Sonar and underwater sound. | T—Transmitting. |
| | R—Radio. | W—Control. |
| | S—Special types magnetic, etc., or combinations of types. | X—Identification and recognition. |
| | T—Telephone (wire). | |
| | V—Visual and visible light. | |
| | W—Armament (peculiar to armament, not otherwise covered). | |
| | X—Facsimile or television. | |
| | Y—Data processing | |

on the type of modulation used. Classifications devised by the International Telecommunication and Radio Conference in 1938 included: A1—CW telegraphy, A2—modulated telegraphy (MCW), A3—telephony, A4—facsimile, and, A5—television. The foregoing classification of emissions still is widely used, but is inadequate because no provision is made for such systems as frequency modulation, pulse-time modulation, frequency shift keying, and multiplexing. The Ordinary Administrative Radio Conference at Geneva in 1959 adopted a system that is more comprehensive than the earlier one. This system classifies emissions according to type of modulation, type of transmission, bandwidth, and supplementary characteristics. Following are typical examples of designators that are of interest to Radiomen. A complete list can be found in JANAP 195.

| | |
|---|---|
| 0. 1A1 | CW manual morse telegraphy. |
| 2. 04A2 | CW telegraph, tone-modulated, 1020 cycle tone. |
| 6A3 | AM telephony. |
| 36F3 | FM telephony. |
| 1. 5A7 | 60 wpm single channel audio frequency tone shift RATT. |
| 1. 08F1 | 60 wpm single channel radio frequency carrier shift RATT. |
| 1. 24F1 | 100 wpm single channel radio frequency carrier shift RATT. |
| 12A9B | Two independent sidebands. Four 3-kc channels. |
| 2. 85F1 | 100 wpm 4 channel time division radio frequency carrier shift RATT. |
| 4F4 | Facsimile. |

## TRANSMITTERS

The largest and most powerful transmitter used by the Navy (it is the largest in the world) is the VLF installation on the Atlantic coast near the town of Cutler, Maine. Its 2 million-watt signal makes this transmitter the granddaddy of them all. Together with a similar station in the Pacific area and the VLF station at Jim Creek, Washington, the Navy is assured of reliable worldwide VLF coverage.

The smallest Navy transmitter is the handie-talkie, with an output of 0. 027 watt that can be heard through a radius of a few miles. Most ships are equipped with transmitters rated at between 100 and 500 watts. It is difficult to generalize on the maximum range of shipboard equipment. As learned in studying wave propagation, effective distance varies both daily and seasonally, and is affected by atmospheric disturbances and geographical location. It may be said, however, that a ship rarely is out of radio communication because of equipment limitations.

In the VLF range there are no standard shipboard radio transmitters. All shore transmitters for this band are of special design and are of tremendous size. Power ranges are from 300 kw to 2 million watts.

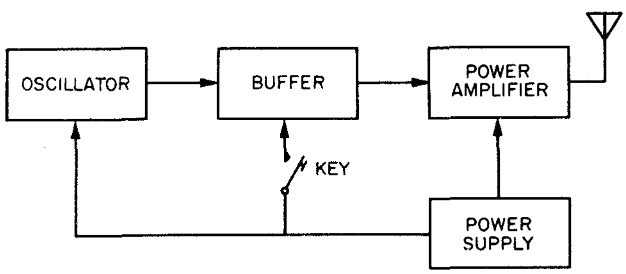
The types of shipboard transmitters used in the LF through UHF bands are many and varied. Specified equipment models are treated later in this chapter, preceded by a discussion of the theory of operation of radio transmitters.

### PURPOSE OF TRANSMITTER

The purpose of a radio transmitter is to produce radiofrequency energy, and, with its amplifiers and antenna, to radiate a useful signal. The general plan for all transmitters is seen in figure 9-2.

Every transmitter has an oscillator that generates a steady flow of radiofrequency energy. An oscillator may be the self-excited type, which orginates a signal in electron tubes or transistors and associated circuits. Or it may be of the crystal type, which uses, in conjunction with an electron tube or transistor, a quartz crystal cut to vibrate at a certain frequency when electrically energized. In either type, voltage and current delivered by the oscillator are weak. Thus, the outputs of both types of oscillators must be amplified many times to be radiated any distance.

The buffer stage or first intermediate power amplifier stage is a voltage amplifier that increases the amplitude of the oscillator signal to a level that will drive the power amplifier. Power delivered by the buffer varies with the type of transmitter, but it may be hundreds or thousands of volts.




20. 201

Figure 9-2. —Stages of a typical transmitter.

The buffer serves two other purposes, one of which is to isolate the oscillator from the amplifier stages. Without the buffer, changes in the amplifier (due to keying or variations in source voltage) would vary the load on the oscillator and cause it to change frequency. A buffer also may be a frequency multiplier, (discussed later).

The final stage of a transmitter is the power amplifier. Power is the product of current times voltage. In the power amplifier a large amount of r-f current is made available for radiation by the antenna. The power amplifier of a high-power transmitter may require far more driving power than can be supplied by an oscillator and its buffer stage. This additional driving power is provided by one or more low power intermediate amplifiers. The main difference between many low-power and high-power transmitters is in the number of intermediate power-amplifying stages used.

In the block diagram of figure 9-3, the input and output powers are given for each stage of a typical medium-frequency transmitter. It is shown that the power output of a transmitter can be increased by adding amplifier stages capable of delivering the power required.

## HARMONICS AND FREQUENCY MULTIPLICATION

The term harmonics sometimes is loosely used to designate unwanted radiations caused by imperfections in the transmitting equipment, but this interpretation is not entirely accurate. True harmonics are always exact multiples of the basic or fundamental frequency generated by an oscillator, and are created in vacuum tubes and their associated circuits. Even harmonics are 2, 4, 6, 8 (and so on) times the fundamental; odd harmonics are 3, 5, 7, 9 (etc.) times the fundamental. If an oscillator has a fundamental frequency of 2500 kc, harmonically related frequencies are—

| | |
|---|---|
| 5000 | 2d harmonic |
| 7500 | 3d harmonic |
| 10, 000 | 4th harmonic |
| 12, 500 | 5th harmonic |

The series ascends indefinitely until the intensity is too weak to be detected. In general, the energy in frequencies above the third harmonic is too weak to be significant.

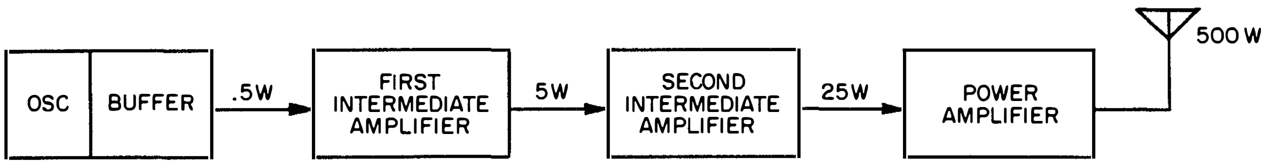
It is difficult to design and build a stable oscillator for high frequencies. Moreover, if a crystal is used to control a high-frequency oscillator, it must be ground so thin that it might crack while vibrating. These transmitters therefore have oscillators operating at comparatively low frequencies, sometimes as low as one-hundredth of the output frequency. Oscillator frequency is raised to the required output frequency by passing it through one or more frequency multipliers. Frequency multipliers are special power amplifiers that multiply the input frequency. Stages that multiply the frequency by 2 are called doublers; those that multiply by 3 are triplers; and those multiplying by 4 are quadruplers.

The main difference between many low-frequency and high-frequency transmitters is in the number of frequency-multiplying stages used. Figure 9-4 shows the block diagram of a typical Navy VHF-/UHF transmitter. The oscillator in this transmitter is tunable from 18. 75 mc to 33. 33 mc. The multiplier stages increase the frequency by a factor of 12 by multiplying successively by 2, 2, and 3.

In high-power, high-frequency transmitters, one or more intermediate amplifiers may be used between the last frequency multiplier and the final power amplifier.

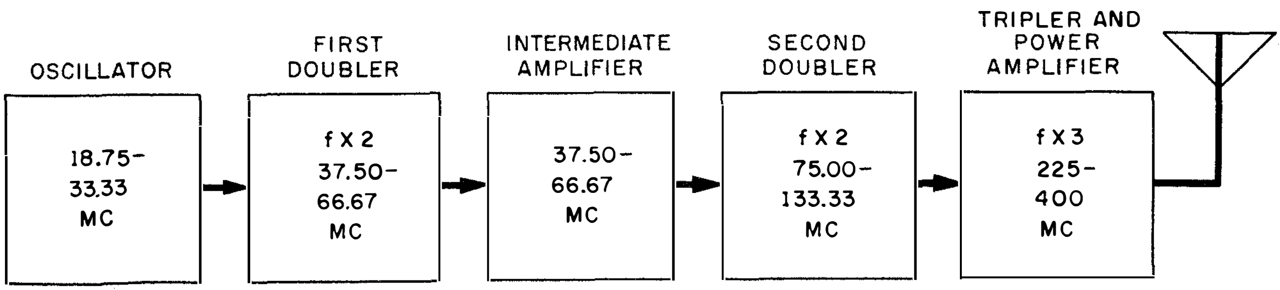
## TRANSMISSION OF INFORMATION BY RADIO

Because the high-frequency output from the radiofrequency (r-f) section of a transmitter is constant in frequency and amplitude, it does not convey any intelligence by itself. This output




76. 15

Figure 9-3. —Intermediate amplifiers increase transmitter power.




76.16

Figure 9-4.—Frequency-multiplying stages of typical VHF/UHF transmitter.

is called the carrier wave, or simply the carrier, and information to be transmitted is added to it. The process of adding or superimposing information on the carrier is called modulation.

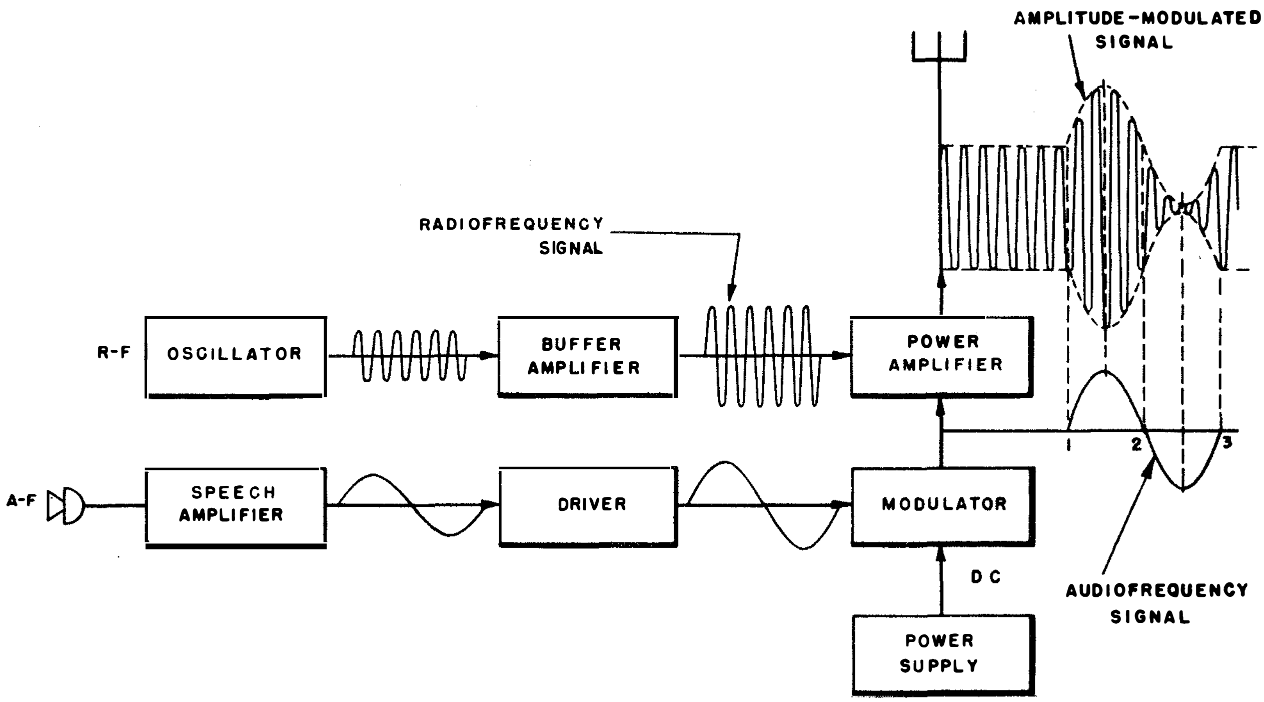
Modulation is accomplished by combining another (modulating) signal with the carrier. This process is done in such a manner as to cause the output to vary in frequency or in amplitude according to the current or voltage variations of the modulating signal. The modulating signal usually is of a lower frequency than the carrier.

### Amplitude Modulation

If the modulating frequency is impressed on the r-f output to vary its amplitude, it is called amplitude modulation (abbreviated a-m).

Figure 9-5 is a block diagram of an a-m radiotelephone transmitter, showing the waveforms for the various stages. The top row of blocks indicates the r-f section; the next row of blocks shows the a-f section; and the lower block points out the power supply, which provides all d-c voltages to the transmitter.

The r-f section (explained previously) generates the high-frequency carrier radiated by




13.53

Figure 9-5.—An a-m radiotelephone transmitter.

the antenna. The audiofrequency (a-f) section includes a speech amplifier that receives considerably less than 1 volt of a-f signal from the microphone and builds it up to several volts at the input to the driver stage. The driver stage is made up of power amplifiers that convert the signal into a relatively large voltage and appreciable current at the input to the modulator. The modulation transformer is capable of handling considerable audio power. Its output is fed to the final r-f power amplifier in such a way as to alternately add to and subtract from the plate voltage of the power amplifier.

The result of modulation is that amplitude of the r-f field at the antenna is increased gradually during the time the a-f output is increasing the r-f power. Amplitude is decreased gradually during the time the a-f output is decreasing the r-f power. In other words, during the positive alternation of the audio signal (between point 1 and point 2 in figure 9-5), amplitude of the r-f output wave is increased. During the negative alternation (between point 2 and point 3), amplitude is decreased. Amplitude modulation consists of varying amplitude of the r-f antenna current (and r-f output wave) gradually over the relatively long a-f cycle. Thus, the r-f field strength is alternately increased and decreased in accordance with the a-f signal and at the a-f rate.

Modulation may be accomplished by several methods. To Radiomen the two most important methods are plate modulation and grid modulation. When modulation takes place in the plate circuit of the power amplifier it is said to be high-level modulation. If modulation is injected at the grid of the power amplifier (or at any point of lower voltage than the plate of the power amplifier, regardless of the stage) it is called low-level modulation. High-level modulation is more efficient, but low-level modulation requires less power. Navy transmitters employ high-level modulation except in single-sideband transmitters where the high plate voltages make it impractical, and when weight is an important consideration, as it is in aircraft and portable equipment.

## Frequency Modulation and Phase Modulation

Besides its amplitude, the carrier wave has two other characteristics that can be varied to produce an intelligence-carrying signal. These qualities are its frequency and its phase. The process of varying the frequency of the carrier in accordance with the audiofrequencies of voice or music is called frequency modulation (f-m). Phase modulation (p-m) is the process of varying the phase. These two types of modulation are closely related. When f-m is used, the phase of the carrier wave is indirectly affected. Similarly, when p-m is used, the carrier frequency is affected.

The primary advantages of f-m are improved fidelity and increased freedom from static. Because of these qualities, frequency modulation is of considerable use in commercial broadcasting, but its shortcomings—frequency extravagance, short range on available frequencies, among others—have severely limited its naval communication applications. The Navy has, however, found f-m satisfactory for other purposes, among them altimeters and some radars.

## Continuous-Wave Transmission

Radiotelegraph information can be transmitted by starting and stopping the carrier by means of a telegraph key that is opened and closed to control power output from the transmitter. Messages are sent by means of short and long pulses (dits and dahs); they correspond to letters and numerals of the Morse code. Thus, in CW telegraphy the carrier is merely turned on and off and is not changed in either frequency or amplitude.

## Modulated CW Transmitters

Many Navy transmitters are designed for both CW radiotelegraph and a-m radiotelephone transmission. Another mode of operation provided by many medium- and high-frequency transmitters and nearly all VHF-UHF equipments is modulated continuous-wave (MCW) telegraph transmission.

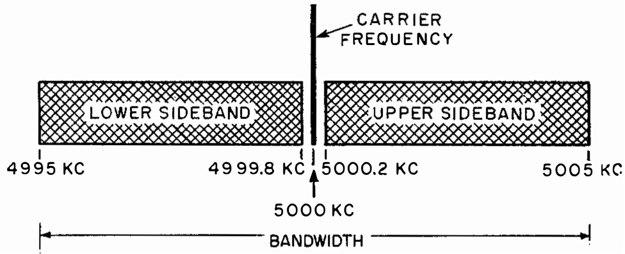
An MCW transmitter has an audiofrequency oscillator, generating a note of constant frequency used to modulate the r-f carrier. The received sound is at the frequency of the audio oscillator. The MCW telegraphy has a slightly greater distance range than voice modulation for the same transmitter. The range of MCW is always less, however, than that of CW transmission of the same transmitter.

Because of its limited range and its wide bandspread (explained in the next topic), MCW has little application in Navy communications today. It is used so seldom that newer transmitters do not even provide for this mode of operation. Instead, other modes of operation, such as frequency shift keying for radioteletypewriter, are incorporated into the newer transmitters. (Frequency shift keying is discussed in chapter 10.)

## Sidebands and Bandwidth

When an r-f carrier is modulated by a single audio note, two additional frequencies are produced. One is the upper frequency, which equals the sum of the frequency both of the carrier and of the audio note. The other frequency is the lower one, which equals the difference between the frequencies of the carrier and the audio note. The one higher than the carrier frequency is the upper side frequency; the one lower than the carrier frequency is the lower side frequency. When the modulating signal is made up of complex tones, as in speech or music, each individual frequency component of the modulating signal produces its own upper and lower side frequencies. These side frequencies occupy a band of frequencies lying between the carrier frequency, plus and minus the lowest modulating frequency, and the carrier frequency plus and minus the highest modulating frequency.

Bands of frequencies containing the side frequencies are called sidebands. The sideband that includes the sum of the carrier and the modulating frequencies is known as the upper sideband (USB). The band containing the difference of the carrier and the modulating frequencies is known as the lower sideband (LSB). Space occupied by a carrier and its associated sidebands in a frequency spectrum is called a channel. The width of the channel (called bandwidth) is equal to twice the highest modulating frequency. If a 5000-kc carrier is modulated by a band of frequencies ranging from 200 to 5000 cycles (0.2 to 5 kc), for example, the upper sideband extends from 5000.2 to 5005 kc, and the lower sideband extends from 4999.8 to 4995 kc. The bandwidth is then 4995 to 5005, or 10 kc. The bandwidth is twice the value of the highest modulating frequency, which is 5 kc. This explanation of sidebands and bandwidth is illustrated graphically in figure 9-6.




59.50

Figure 9-6. —Sidebands produced by amplitude modulation.

## Single Sideband

A mode of radio emission that has become increasingly important to the Radioman is single sideband (SSB). Single sideband is not a new term in the history of communications. It has been used extensively by the shore communication system for many years. A new impetus to the advantages of using SSB in fleet communications has resulted from the congestion in the medium- and high-frequency bands and recent developments that have reduced the physical sizes of equipments.

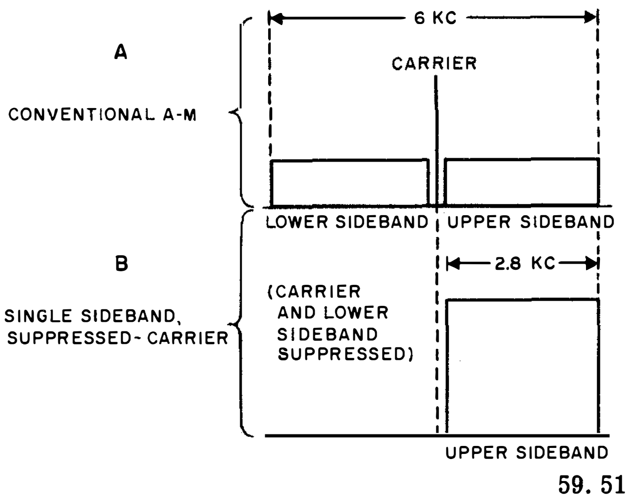
In studying sidebands, it was learned that modulation of the carrier produces a complex signal consisting of three individual waves: the original carrier, plus two identical sidebands, each carrying the same intelligence. However, the same intelligence can be transmitted in a single sideband by eliminating the carrier and one of the sidebands at the transmitter, resulting in a savings of power and frequency bandwidth.

SUPPRESSED CARRIER. —In SSB, the carrier itself is suppressed (or eliminated) at the transmitter, so that sideband frequencies are produced but the carrier is reduced to a minimum. This reduction or elimination usually is the most difficult or troublesome aspect in understanding SSB suppressed carrier. In single sideband suppressed carrier, there is no carrier present in the transmitted signal. It is eliminated after modulation is accomplished, and reinserted at the receiver for the demodulation process. All radiofrequency energy appearing at the transmitter output is concentrated in the sideband energy or "talk power."

After eliminating the carrier, the upper and lower sidebands remain. If, one of the two sidebands is filtered out before it reaches the power amplifier stage of the transmitter, however, the same intelligence can be transmitted on the remaining sideband. All power is then transmitted in one sideband, instead of being divided between the carrier and both sidebands, as in conventional a-m. This provision amounts to an increase in power for the wanted sideband. Equally important, the bandwidth required for SSB voice circuits is approximately half that needed for conventional a-m. (See fig. 9-7.)

SSB ADVANTAGES.—Advantages of single sideband over conventional amplitude modulation are numerous, but only a few of the main ones are presented in the following paragraphs.

- Minimization of distortion: In conventional a-m, the two sidebands and the carrier must arrive at the receiver with the same phase relationship as they had when transmitted. If they are not received in phase (usually because of multipath skywave propagation conditions), the signal heard is fuzzy, distorted, and possibly quite loud. (You may have heard the report expressed "Loud but distorted.") This condition may occur if one sideband experiences a slight phase shift and cancels a portion of the other sideband, resulting in distortion and loss of intelligibility. Fading or slight phase shift of the carrier can produce similar results. With the suppressed-carrier type of SSB, however, these problems are minimized because only one sideband (and no carrier is transmitted.




59.51

Figure 9-7. —Comparison of bandwidths of conventional a-m and SSB voice channels.

- Increased effective power: In a conventional a-m system, approximately one-half of the transmitter's power goes into the carrier, and the remaining half is divided equally between the two sidebands. With the suppressed-carrier SSB system, virtually all of the transmitter's power goes into the single sideband that carries the useful intelligence. This more efficient utilization of power gives the SSB voice circuit a much greater distance range than that of a normal a-m voice circuit.
- Provision for double number of channels: In the system of SSB suppressed carrier, the number of voice channels utilizing the same frequency in the radio spectrum is doubled. These two channels are referred to as upper and lower sidebands. With the scarcity of frequencies available for new assignments in the spectrum, particularly in the 2- to 30-mc range, this advantage in fleet communications is important.
- Reduction of interference: In voice systems employing conventional amplitude modulation, the carrier of the transmitting station remains on the air as long as the microphone button is depressed. If an additional station transmits while the carrier of the other station is on, squeals and howls results. They are caused by the heterodyning of two or more signals transmitting simultaneously. In SSB, as soon as an individual stops speaking into the microphone, talk power in the remaining (or single) sideband leaves the air. Even though two stations may transmit at the same time, it may be possible for a receiving station to read through the interfering station the same way it is possible to listen to more than one conversation coincidentally.

INDEPENDENT SIDEBAND.—In independent sideband (ISB) systems, the carrier is suppressed or reduced, and each sideband is modulated independently by separate information. In effect, ISB can be referred to as consisting of two single sidebands and having the same suppressed or reduced carrier. The ISB systems can accommodate either one or two 3-kc channels on the upper sideband and the same number on the lower sideband. The number of channels depends on whether these sidebands are 3 or 6 kc wide.

## REPRESENTATIVE TRANSMITTERS

Modern medium-frequency and high-frequency shipboard transmitters must be capable of transmitting over a wide range of frequencies. In addition to CW and radiotelephone modes of operation, they must be capable of handling RATT and FAX transmissions. They must be of rugged construction for long service life. Transmitters that meet these requirements, therefore, are quite complex and because of the limited space available for their installation in naval vessels, they are of compact construction.

One method of obtaining equipment compactness is to combine a transmitter and a receiver into a single unit called transceiver. A transceiver uses part of the same electronic circuitry for both transmitting and receiving, hence cannot transmit and receive simultaneously. A transmitter-receiver, however, is a separate transmitter and receiver mounted in the same rack or cabinet. The same antenna may be utilized for the transmitter-receiver arrangement, but the capability for independent operation of the equipment still exists. Both terms are used in descriptions of equipment that follow.

### Radio Set AN/URC-32

Radio set AN/URC-32 (figure 9-8) is a manually operated radio communication transceiver for operation in the 2- to 30-mc (high-frequency) range, with a power output of 500 watts. This transceiver is designed for single-sideband transmission, and for reception on upper sideband, lower sideband, or the two independent sidebands simultaneously. Separate audiofrequency and intermediate frequency (i-f) channels are provided for each sideband. In addition to single-sideband operation, provisions are included for compatible a-m (carrier plus upper sideband), CW, or fsk operation.

GENERAL DESCRIPTION.—The transceiver's frequency range of 2 to 30 mc is covered in four bands. The desired operating frequency is selected in 1-kc increments on a direct-reading frequency counter. Frequency accuracy and stability are controlled by a self-contained frequency standard. Provisions also are made for using an external frequency standard.

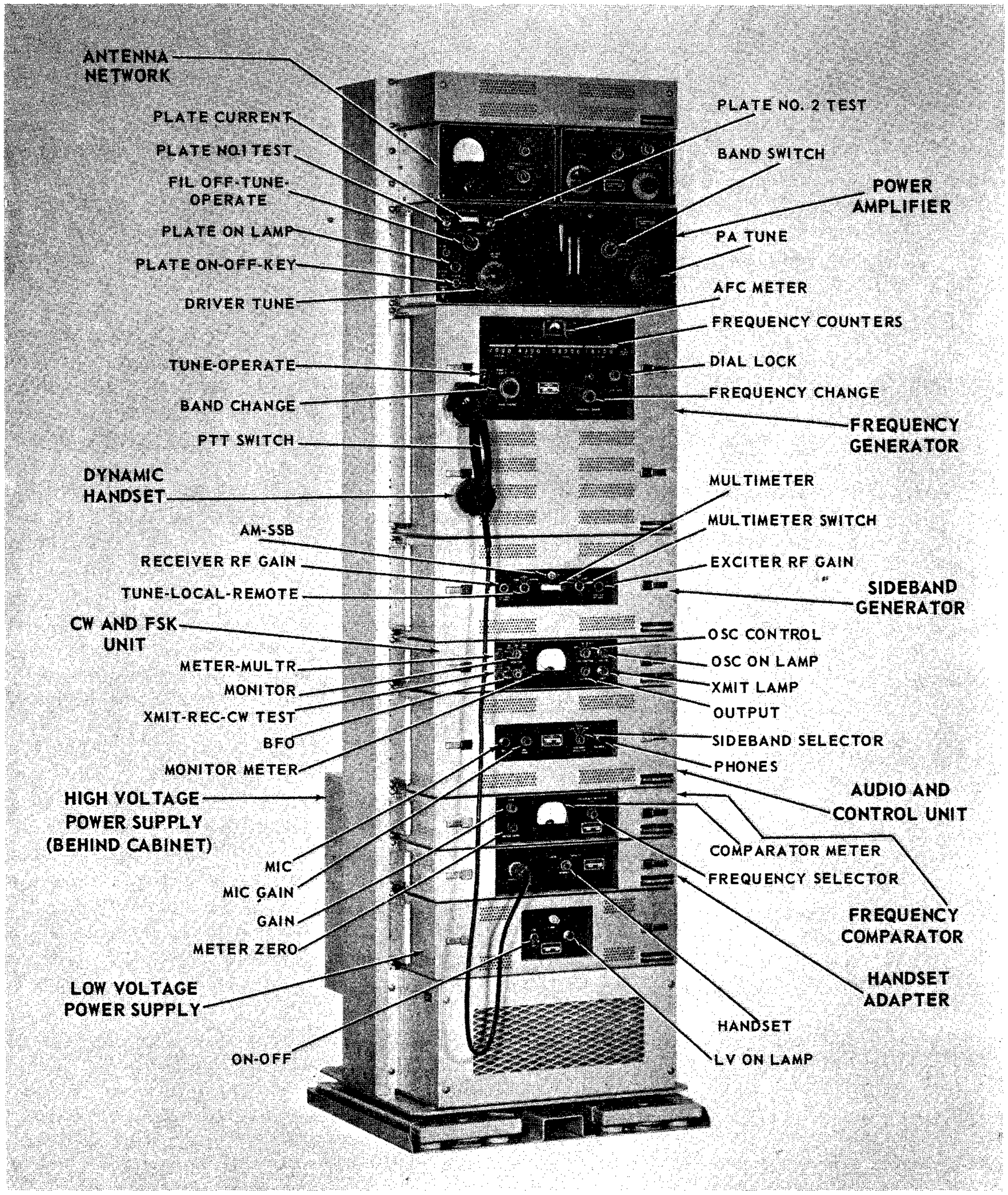
During transmission (fig. 9-9), voice input signals from the handset are fed to the handset adapter. Input signals (CW or remote audio) from a remote control unit (when used) are also applied to the handset adapter input terminals. A local-remote switch permits the operator to select either the local audio input from the handset adapter or the remote audio input. Teletypewriter signals (analyzed in chapter 10) are applied directly to the CW and fsk unit, which provides separate audio tones for the mark and space conditions. These audio frequencies are converted later to the required frequency shift signals for fsk transmission. The output from the handset adapter is amplified in the audio and control unit. Two separate audio input paths to the audio and control unit are provided through the 600-ohm remote audio lines.

The audio and control unit amplifies the audio signals and feeds the output to the sideband generator. During single-sideband voice operation (using the upper sideband), the audio and control unit output is fed through a selector switch in the CW and fsk unit. Lower sideband transmit signals are fed directly to the sideband generator. During CW or fsk operation, the CW and fsk unit supplies audio tones to the sideband generator.

The sideband generator converts the audio input to 300 kc intermediate frequency on the selected sideband. The modulated 300-kc output is fed to the frequency generator. This unit provides the necessary number of heterodyning (mixing) processes (while preserving the signal intelligence) to produce the selected carrier frequency in the 2- to 30-mc range. The output signal is amplified in the power amplifier to the required output of 500 watts and is fed to the antenna.

During the reception of modulated signals (receive operation), the antenna input signal (fig. 9-10) in the range from 2 to 300 mc is heterodyned in the frequency generator so that the output will be a modulated 300-kc signal. (When receiving SSB signals, the carrier is reinserted for demodulation purposes.) This signal is detected (demodulated) and is amplified in the sideband generator; it is further amplified in the audio and control unit, and is fed to the speaker.

During CW reception, the CW and fsk unit supplies a 300.550-kc signal to the sideband generator as a beat frequency for the received

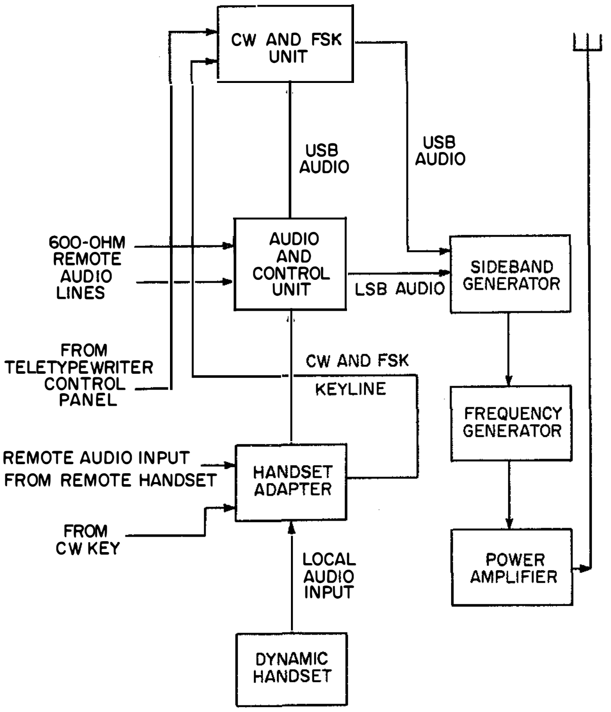



32.135

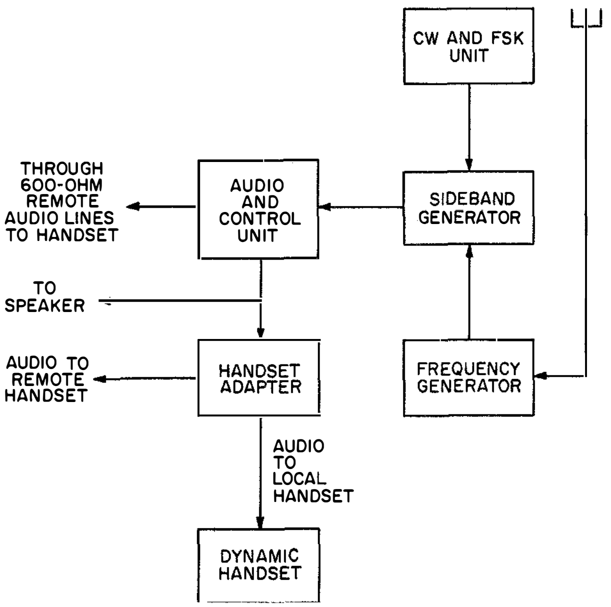
Figure 9-8. —Radio set AN/URC-32, relationship of units and operating controls.

signal. (A beat frequency is a locally generated r-f signal that is heterodyned with the carrier to produce an audiofrequency.) The beat frequency can be changed over a range of ±1 kc.

OPERATING PROCEDURE. —The following preliminary steps must be performed before turning on the equipment. (Refer to figure 9-8 for location of controls.)




32.136
Figure 9-9. —Radio set AN/URC-32, transmit function block diagram.




32.137
Figure 9-10. —Radio set AN/URC-32, receive function block diagram.

| | |
|---|---|
| Low-voltage power supply | ON-OFF switch to OFF. |
| Power amplifier | FIL OFF-TUNE-OPERATE switch to FIL OFF. PLATE switch to OFF. |
| Sideband generator | RECEIVER RF GAIN control counterclockwise. EXCITER RF GAIN control counterclockwise. TUNE-LOCAL-REMOTE switch to LOCAL. |
| Frequency comparator | FREQUENCY SELECTOR switch to OFF. |
| CW and FSK unit | XMIT-REC-XMIT TEST switch to REC. OSC CONTROL switch to OFF. |
| Audio and control unit | MIC GAIN control counterclockwise. SIDEBAND SELECTOR switch to OFF. |

Turning on Equipment. —The following procedure is observed to apply power to the equipment. If equipment is to be used only as a receiver, perform only steps 1 and 2.

1. Set OFF-ON switch on low-voltage power supply to ON position. The indicator lamp on low-voltage power supply will light when air pressure is present in the cooling system.
2. Set meter selector switch on sideband generator to the -90, +130, and +250 positions and check that meter reads between 35 and 50 db in each position.
3. Turn FIL OFF-TUNE-OPERATE switch on power amplifier to OPERATE position. Wait 30 seconds before performing step 4.
4. Depress PLATE switch on power amplifier to KEY and check that PLATE CURRENT meter on power amplifier reads 150 ma of plate current. PLATE lamp on power amplifier HV ON lamp on high-voltage power supply, and XMIT lamp on CW and FSK unit should light while switch is depressed.
5. Depress PLATE switch to KEY and alternately depress PLATE NO. 1 TEST switch and PL NO. 2 TEST switch on power amplifier, checking that PLATE CURRENT meter reads between 60 and 90 ma of plate current for each tube.

6. Operate PLATE switch on power amplifier to ON. PLATE LAMP on power amplifier and HV ON lamp on high-voltage power supply should light.

Tuning procedure. —The tuning procedure for setting the AN/URC-32 to a new operating frequency follows.

1. Set PLATE switch on power amplifier to OFF.
2. Set BAND CHANGE switch on frequency generator to the desired frequency band. The band indicator lamp will light over the selected frequency counter. The AN/URC-32 frequency bands are—
   Band 1  2.0 to 3.7 mc
   Band 2  3.7 to 7.7 mc
   Band 3  7.7 to 15.7 mc
   Band 4  15.7 to 30.0 mc
3. Release DIAL LOCK on frequency generator. Set desired operating frequency on the lighted frequency counter, using FREQUENCY CHANGE control. When selecting a frequency that is not on the band 7.7-15.6 mc, or 15.7- to 30.0-mc frequency counters, set frequency counter to the next lower frequency on the counter and set BAND CHANGE switch to ADD 1, ADD 2, or ADD 3. With BAND CHANGE switch in ADD 1 position, 1 kc is added to the frequency indicated on frequency counter. In the ADD 2 position, 2 kcs are added, and in the ADD 3 position, 3 kcs are added. When the desired operating frequency is on the frequency counter, set BAND CHANGE switch to ADD 0. Example: to select an operating frequency of 23.699 mc, set BAND CHANGE switch to BAND 4, set 15.7- to 30.0-mc frequency counter to 23.696 mc using FREQUENCY CHANGE control, and reset BAND CHANGE switch to BAND 4 ADD 3. When setting up a frequency on any band, make certain the white index line on the last dial of the 15.7- to 30.0-mc frequency counter is centered in the window.
4. Reset DIAL LOCK and momentarily depress the TUNE-OPERATE switch on frequency generator to TUNE. This action prevents the stabilized master oscillator from locking on spurious signals. The AFC meter shows the amount of correction being supplied to the master oscillator from the stabilization circuits. Hence it should not be expected to read 0 unless master oscillator is exactly on frequency and no correction is required.
5. Adjust RECEIVER RF GAIN control so that automatic gain control (AGC) does not increase gain excessively between characters in CW and FSK or between words in single-sideband voice reception. The RECEIVER RF GAIN control normally is set so that sideband generator meter (AGC) "kicks up" about 15 kb with meter switch in TGC-AGC position. If speaker, handset, or remote audio output level is inadequate, set SPEAKER GAIN control (under dust cover of audio and control unit) for desired output level. On FSK operation, adjust BFO control for proper operation of FSK converter. This action completes tuning of the receiver portion of the AN/URC-32.

NOTE: Before performing the following steps, the AN/URC-32 must be connected to an antenna system containing an antenna tuner control and a dummy load, such as the AN/SRA-22. This type of antenna tuner contains a directional wattmeter and a switch for selecting the antenna or the dummy load.

6. Set ANT-LOAD switch on antenna tuner control to LOAD. Set FIL OFF-TUNE-OPERATE switch on power amplifier to TUNE. Set meter selector switch on sideband generator to RF OUT. Set TUNE-LOCAL-REMOTE switch on sideband generator to TUNE.

NOTE: In the following steps, key to transmit by depressing PLATE switch on power amplifier to KEY.

7. With EXCITER RF GAIN control in the maximum counterclockwise position, key to transmit and turn EXCITER RF GAIN control clockwise until meter on sideband generator reads approximately 40 db.
8. Key to transmit and adjust DRIVER TUNE control on power amplifier within desired band limits to peak the PLATE CURRENT meter reading, and adjust EXCITER RF GAIN control as necessary to maintain a PLATE CURRENT meter reading of approximately 200 ma. The red index on DRIVER TUNE control must fall within the proper band limits marked on panel. If a power output reading is observed on power output meter of antenna tuner, detune P. A. TUNE control until no power

output is indicated. This action effectively disables the r-f feedback so that optimum adjustment of driver plate circuit can be obtained. Reducing EXCITER RF GAIN control for a decrease in PLATE CURRENT meter reading, as necessary, results in a sharper indication of driver tuning.

NOTE: After completing step 8, make no further adjustments on DRIVER TUNE control for the remainder of tuning procedure.

9. Set P. A. TUNE control on power amplifier within desired frequency band limits. Key to transmit and adjust P. A. TUNE control for a dip in PLATE CURRENT meter reading.
10. Set EXCITER RF GAIN control maximum counterclockwise. Set FIL OFF-TUNE-OPERATE switch on power amplifier to OPERATE.
11. Key to transmit, turn EXCITER RF GAIN control clockwise until 500 watts of forward power is indicated and redip PLATE CURRENT meter reading, using P. A. TUNE control. PLATE CURRENT meter reading should not exceed 500 milliamperes. (Caution: Do not operate ant-load switch while AN/URC-32 is keyed to transmit.)
12. Set ANT-LOAD switch on antenna tuner control to ANT and adjust antenna tuner controls for minimum reflected power. For this procedure see operating procedures in antenna tuner control technical manual.
13. Key to transmit and adjust EXCITER RF GAIN control for a forward power output meter reading of 500 watts. Reflected power meter reading should be under 10 watts. PLATE CURRENT meter reading should be between 450 and 550 ma.
14. Key to transmit and adjust EXCITER RF GAIN control for a forward power output of 125 watts.
15. Key to transmit and check the following meter readings:

    PLATE CURRENT meter ....... Approximately 300 ma.
    Forward power output .................. 125 watts.
    Reflected power ...... less than 3 watts.
    Sideband generator meter RF OUT .......... 10 to 20 db.
    Sideband generator meter TGC .................. 0 db.
16. Set TUNE-LOCAL-REMOTE switch on sideband generator to LOCAL. On AM transmit operation, readjust EXCITER RF GAIN control for 125 watts forward power. Set PLATE switch on power amplifier to ON. This step completes the tuning procedures.

### AN/WRT-1 Transmitting Set

The AN/WRT-1 is a shipboard transmitter designed for operation in the frequency range 300 to 1500 kc. This equipment can transmit CW, fsk, and voice signals, but it has no SSB capability. When used for CW and fsk transmission, the transmitter has a power output of 500 watts. Voice operation, however, reduces available power to approximately 125 watts.

Because of operating in the medium frequencies with a substantial power output, the AN/WRT-1 lends itself well for communicating over long distances during the hours of darkness. Its range is reduced to medium distances during daylight hours.

The AN/WRT-1 is similar in appearance to the AN/WRT-2 shown in figure 9-11 and described in the next topic.

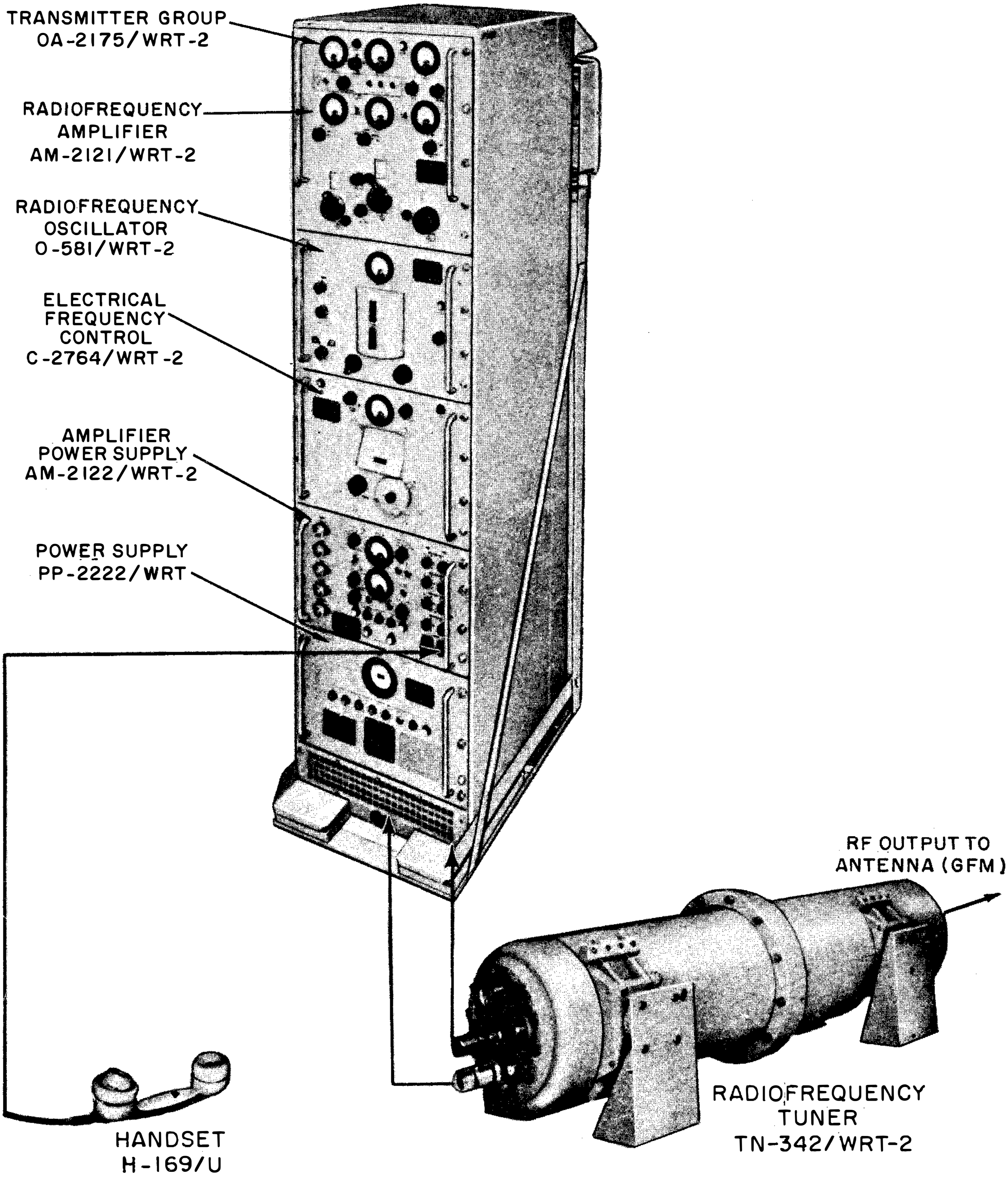
### AN/WRT-2 Transmitter

The AN/WRT-2 (fig. 9-11) is a modern HF transmitter used in surface ships and submarines. It provides complete frequency coverage in 1-kc steps over the frequency range of 2 mc to 30 mc. The r-f oscillator produces fundamental frequencies from 2 to 8 mc. Frequency multiplication produces frequencies from 8 to 30 mc.

The AN/WRT-2 transmitter has an output power of 500 watts on CW, frequency shift RATT and FAX, and conventional a-m radiotelephone. It has a power output of 1000 watts when transmitting single sideband or independent sideband.

Coupling to an antenna is through a radiofrequency tuner mounted as close to the antenna as possible. The radiofrequency tuner is constructed so that it may be installed on the weather decks of surface ships.

A front panel handset jack is furnished for local phone operation of the equipment. A built-in dummy load permits off-the-air tuning under conditions of radio silence.




32.278

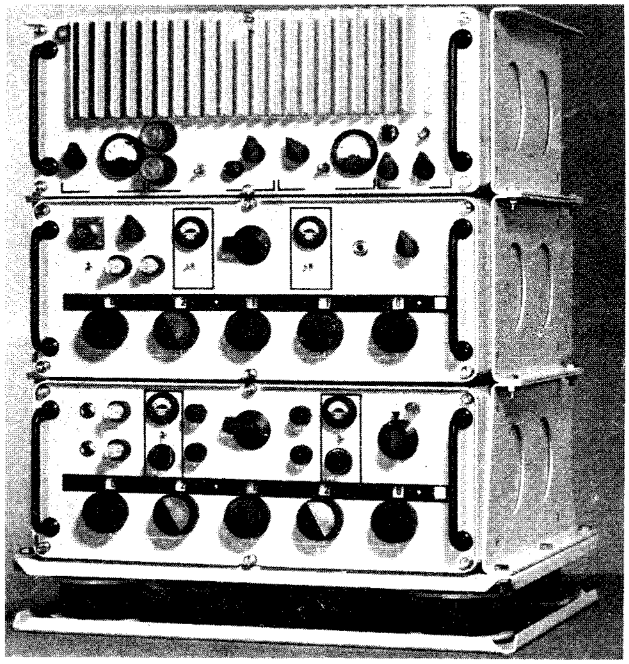
Figure 9-11. —Radio transmitting set AN/WRT-2.

AN/URC-7 Transmitter-Receiver

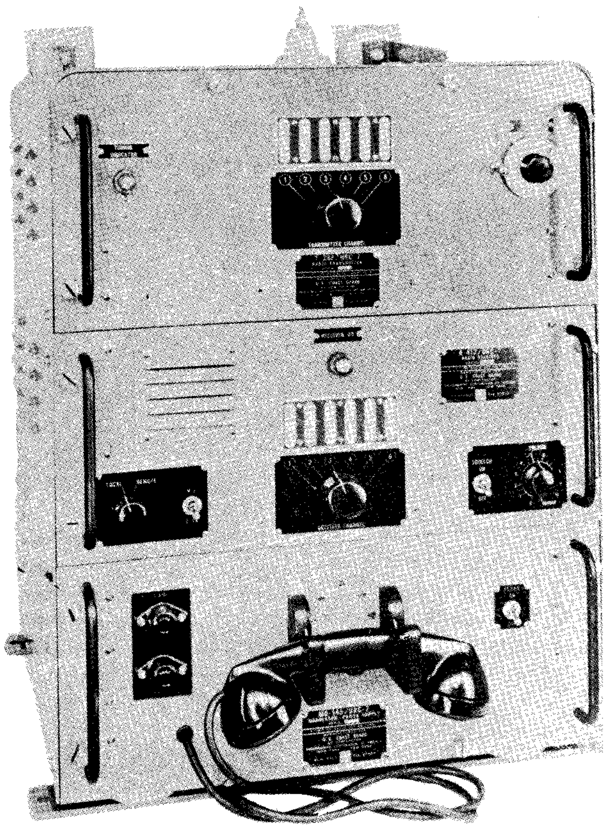
The AN/URC-7 is an amplitude-modulated radiotelephone transmitter-receiver for short- and medium-distance radiotelephone communication. Both transmitter and receiver have six pretuned crystal-controlled channels in the frequency range 2000 to 7000 kc. The transmitter has an output power of 25 watts. The transmitter, receiver, and modulator power supply are contained in a single cabinet. (See fig. 9-12.) The AN/URC-7 is used principally in service craft and auxiliary-type ships, such as tugs, transports, tankers, and ships of the amphibious force.

AN/WRC-1 Radio Set

The AN/WRC-1 (fig. 9-13) is a single sideband radio transmitter-receiver. It is capable of transmitting on any one of 56,000 channels, spaced in 0.5-kc increments, in the frequency range of 2 to 29.9995 mc. This set has a maximum power output of 100 watts. Vernier (continuous) tuning enables reception on any frequency in the 2 to 30-mc range.



76.61
Figure 9-13.—Radio set AN/WRC-1. Top unit: AM-3007/URT r-f amplifier; center unit: T-827/URT transmitter (exciter); bottom units: R-1051/URR receiver.



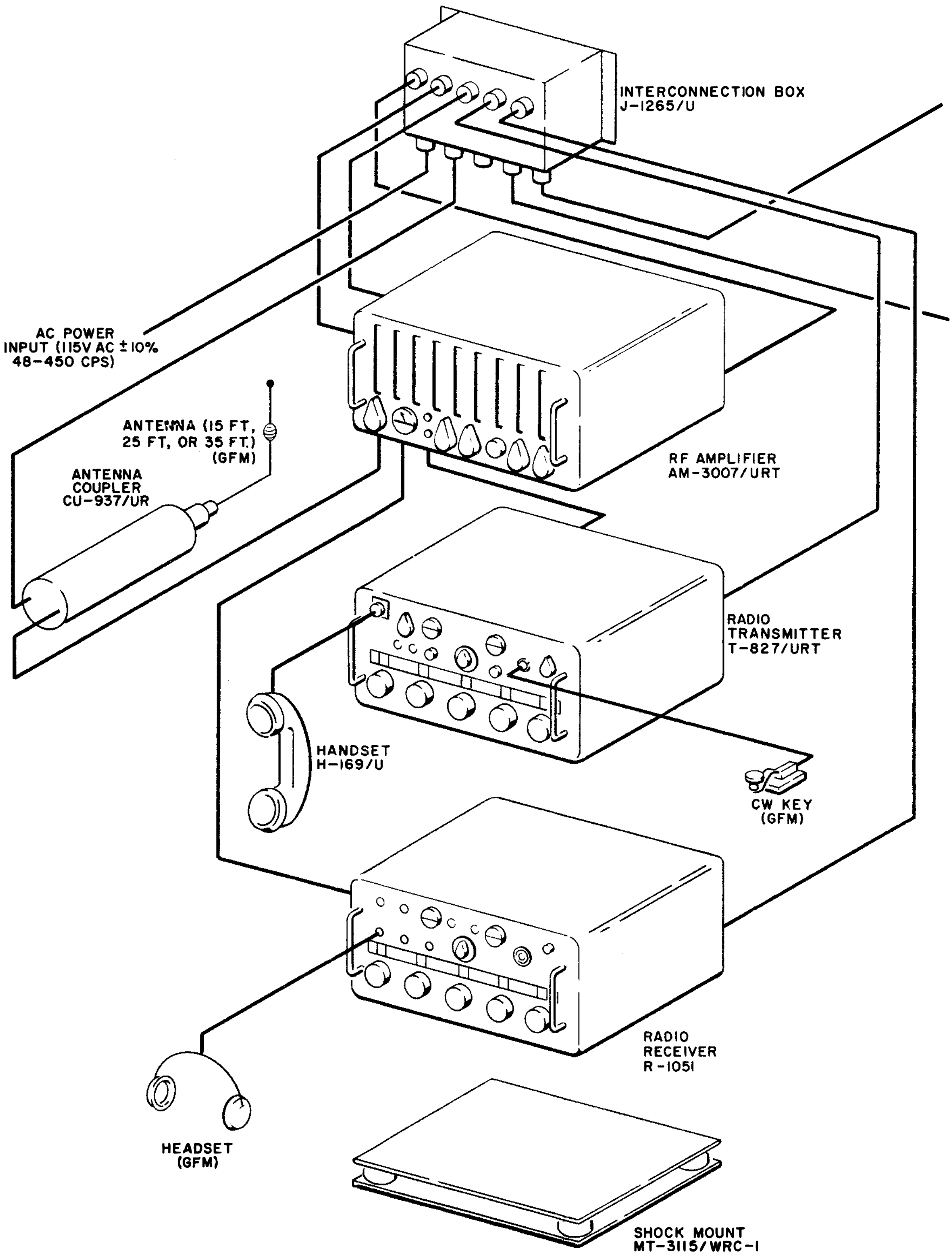
76.19
Figure 9-12.—AN/URC-7 transmitter-receiver.

The AN/WRC-1 is capable of transmitting and receiving SSB, CW, compatible a-m, fsk, and ISB signals in either a simplex or duplex operation. Figure 9-14 shows all units of the AN/WRC-1 and how they are interconnected.

The AN/WRC-1 radio set consists of four separate units. These units are the R-1051/URR radio receiver, radio transmitter T-827/URT, r-f amplifier AM-3007/URT, and an interconnection box used to connect the other three units together. Both the receiver and transmitter contain their own power supplies and can be operated as individual units.

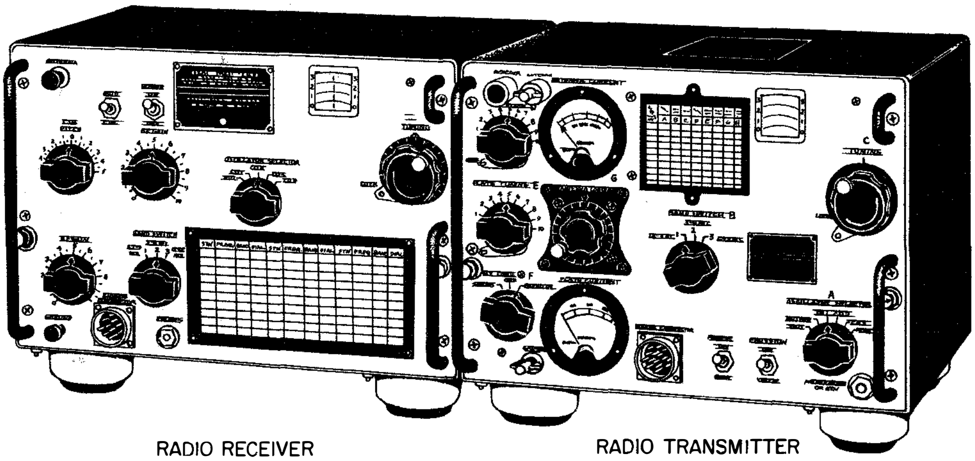
Model TCS Transmitter-Receiver

The model TCS (fig. 9-15) is a small transmitter-receiver that has been in use for many years for short-range voice communications.




76.62

Figure 9-14. —Radio set AN/WRC-1, relationship of units.




76.22

Figure 9-15. —TCS transmitter-receiver.

It has an output power of 10 watts for radiotelephone and 25 watts for CW. The TCS has a frequency range of 1.5 to 12 mc. The frequency-determining section may be either crystal-controlled or a continuously variable oscillator—whichever is more desirable. Both transmitter and receiver use the same antenna, which is switched from receiver to transmitter by a relay when the transmitter is keyed. A 20-foot vertical whip antenna commonly is used. The TCS still is used aboard many ships and also in motorboats, trucks, and other mobile and portable installations.

VHF TRANSMITTERS

Equipments in the VHF range are not used extensively any more, because no primary naval communications are conducted in this range. Most tactical voice circuits now use the UHF band. Limited installations of VHF equipment are retained for communication with allied forces who have not yet converted to UHF equipments. One of the VHF transmitters still in use (the AN/URT-7) is described here.

AN/URT-7 Transmitter

The AN/URT-7 is a crystal-controlled radiotelephone and MCW transmitter in the frequency range 115 to 156 mc. It has an output power of 30 watts and is used for short-range communications by surface ships, submarines, and shore stations. This transmitter (not illustrated) is similar in size and appearance to model TED UHF equipment (fig. 9-16).

UHF TRANSMITTERS

The UHF transmitters are used throughout the Navy. They operate in the 225- to 400-mc frequency range, and their primary uses are for tactical surface and air radiotelephone communications.

Power output requirements are relatively low because the effective range of UHF normally is limited to line-of-sight distances. Although UHF transmitters are designed also for MCW emission, radiotelephone commonly is used.

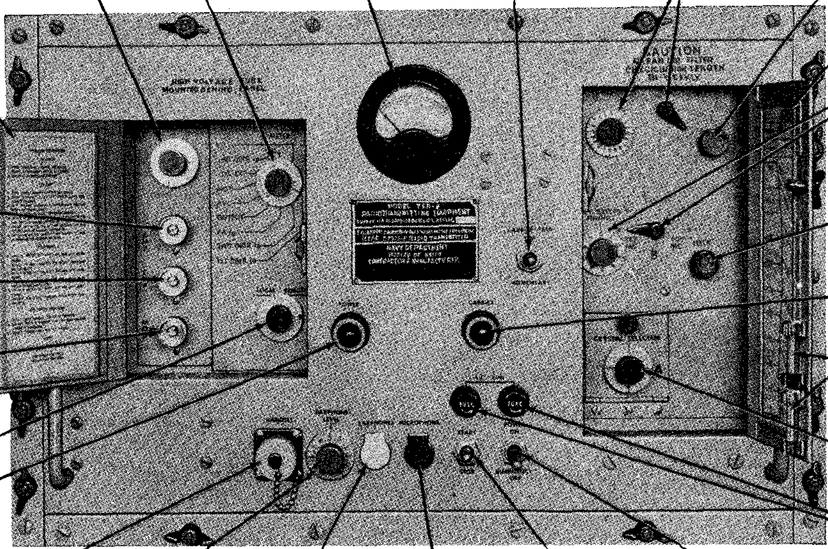
Navy Model TED Transmitter

The TED (fig. 9-16) is a crystal-controlled, single-channel, short-range, UHF transmitter for use primarily in ship-to-ship, ship-to-aircraft, and harbor communications. Its frequency range is from 225 to 400 mc. It is installed in surface ships, submarines, and shore stations.

Although mountings for four crystals are provided, permitting rapid selection of any one of four frequencies, the transmitter must be retuned each time the frequency is changed. The TED transmitter has an output power of 15 watts. An r-f amplifier, AM-1365/URT, is designed for use with the TED transmitter. This amplifier boosts the output power to 100 watts.

AN/GRC-27 Transmitter-Receiver

The AN/GRC-27 and AN/GRC-27A are UHF transmitter-receiver sets covering frequencies




32.38

Figure 9-16. —UHF transmitter, Navy model TED.

from 225 to 200 mc. This equipment is used for UHF radiotelephone and MCW communications from ship-to-ship, ship-to-shore, or with aircraft. It can be used in net operation with other radio sets in the UHF band, such as the TED transmitter and AN/URR-13 and -35 receivers.

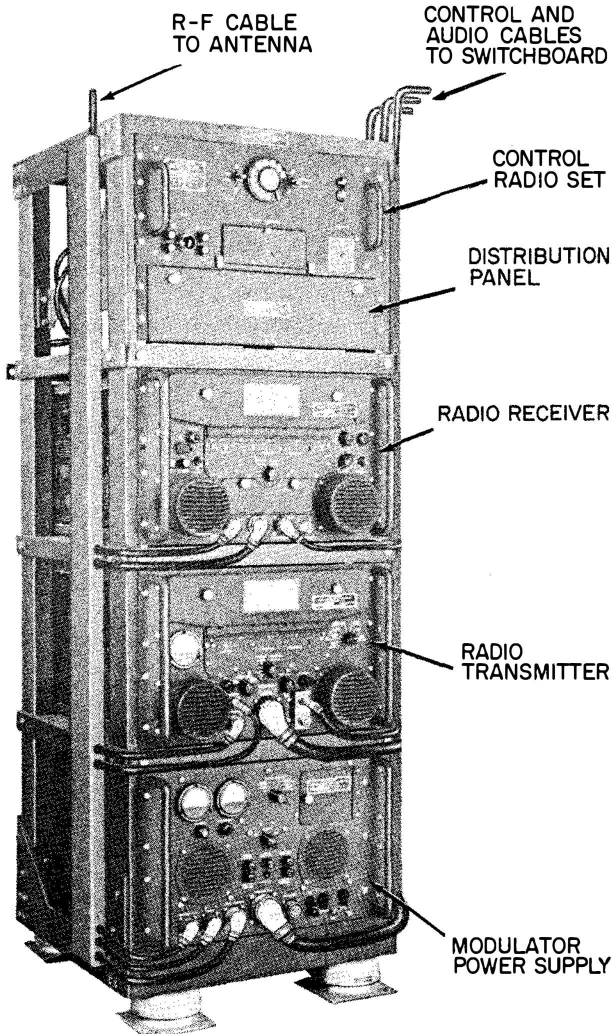
The transmitter has a power output of 100 watts. It has three crystal-controlled oscillators, using a total of 38 crystals. These crystals are located within the transmitter and do not require handling by the operator. From the combination and multiplication of these 38 crystal frequencies are produced 1750 frequencies, spaced at 100-kc intervals throughout the transmitter's frequency range. Any 10 of these 1750 frequencies can be preset manually with selector switch dials. Any 1 of the 10 preset frequencies can then be selected automatically by a telephone-type dial, either locally at the transmitter, or from a remote unit at other locations, such as CIC and the bridge. Only 2 to 7 seconds are needed to shift automatically from one channel to another in any of the 10 preset channels.

Both transmitter and receiver use the same antenna. A relay switches the antenna from one to the other. The receiver also operates on any of the 1750 channels. It is a triple-conversion superheterodyne and has crystal oscillators using 38 crystals in a system separate from (but similar to) that used in the transmitter. Here, again, automatic shifting of channels is accomplished in about 2 to 7 seconds. The receiver has AVC (automatic volume control), automatic noise limiter, and a squelch circuit.

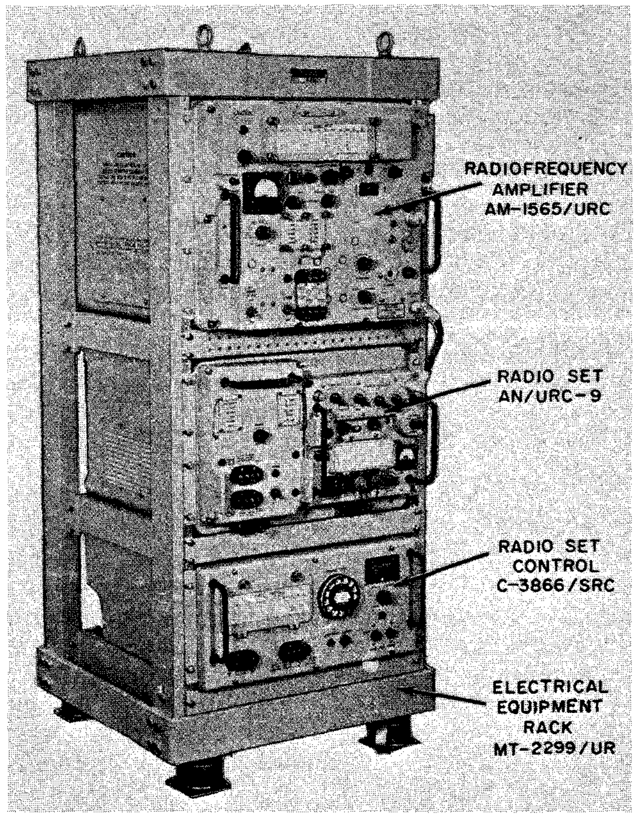
The AN/GRC-27A, the shipboard installation, is shown in figure 9-17. This set is installed principally in carriers and radar picket vessels, whose primary missions include control of aircraft.

## AN/SRC-20 and -21 Radio Sets

Radio sets AN/SRC-20 and -21 are designed for shipboard or fixed station operation. These sets provide amplitude modulation (a-m) and modulated continuous wave (MCW) on any of 1750 channels spaced 0.1 mc apart in the 225-mc to 399.9-mc range. Of the 1750 channels, 19 can be preset. Complete control, including selection of preset channels, can be exercised




32.109.2
Figure 9-17. —UHF transmitter-receiver AN/GRC-27A.




50.160
Figure 9-18. —Radio set AN/SRC-20.

from a maximum of four remote control stations. Additionally, circuits are incorporated that permit connection of two sets for two-way automatic retransmission.

The AN/SRC-20 radio set is composed of radiofrequency amplifier AM-1565/URC, radio set AN/URC-9, and radio control set C-3866/SRC. The AN/SRC-21 is composed of the latter two units only. The AN/SRC-20 is illustrated in figure 9-18.

Both radio sets have three modes of operation: normal, retransmit, and tone. The preset channels can be dialed directly on the radio control set or any one of up to four remote control units. The minimum carrier output of the AN/SRC-20 is 100 watts, with modulation capability of 80 percent. Minimum carrier output of the AN/SRC-21 is 16 watts, with a modulation capability of 80 percent.

The radiofrequency amplifier is continuously tunable over the frequency range. A dial calibrated in frequency and a logarithmically calibrated dial are provided to allow presetting the channels. The radio set is a triple-conversion superheterodyne transceiver. Automatic tuning is accomplished when frequency selector switches are set to the desired frequency. The radio control set enables a radio operator to select remotely any 1 of the 19 preset radio channels. To dial any radio channel higher than channel 10, the operator first must dial letter A, then dial the last digit in the channel number. To dial channel 14, for example, dial letter A, then number 4.

## RECEIVERS

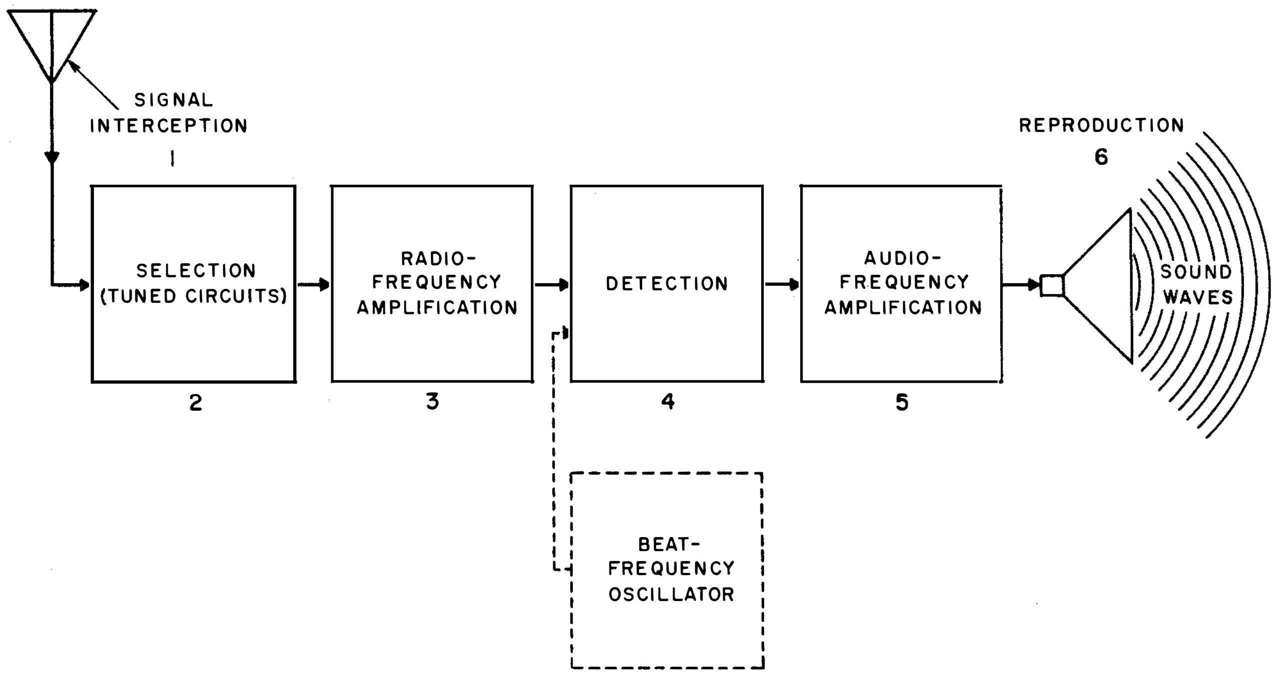
Receivers perform the function of intercepting a tiny part of the radio wave radiated by transmitters and of recovering the information contained in it.

### FUNCTIONS OF RECEIVERS

Radio receivers must perform the following six functions (fig. 9-19): signal interception, signal selection, radiofrequency amplification, detection, audiofrequency amplification, and sound reproduction. These six functions are sufficient for a-m reception, but for CW reception an additional circuit (shown by dotted lines in fig. 9-19), called a beat frequency oscillator, is required.

- Signal interception: The receiving antenna intercepts a small portion of the passing radio waves. Signal voltage of only a few microvolts is extracted by receiving antennas. This voltage is sufficient for later amplification, so long as noise energy intercepted by the antenna is substantially less than this quantity.
- Signal selection: Some means must be provided for selecting the desired signal from all r-f carriers intercepted by the antenna. Selection is made by tuned circuits that pass only their resonant frequency (frequency to which the receiver is tuned) and reject other frequencies. Thus the receiver is able to differentiate between the desired signal frequency and all other frequencies.
- Radiofrequency amplification: Usually weak signals intercepted by the antenna must be amplified considerably before the intelligence contained in them can be recovered. One or more r-f amplifiers serve to increase the signal to the required level. A tuned circuit in each r-f amplifier ensures amplification of only the desired signal.
- Detection (demodulation): If the signal is amplitude-modulated, the original intelligence must be recovered from it by separating the modulation signal from the r-f carrier. The circuit that separates the audiofrequency signal variations from the r-f carrier is called the detector or demodulator. Most detectors do not operate well at very low signal levels, which is one of the reasons why r-f amplification is required ahead of the detector.

In CW (radiotelegraphy) reception, a beat frequency oscillator (bfo) is used in the receiver circuit. The bfo provides an r-f signal that beats or heterodynes against the frequency




76.23

Figure 9-19. —Essentials of radio reception.

injected into the detector. The resultant frequency is an audiofrequency that can be heard in the headset or loudspeaker.

- Audiofrequency amplification: In general, the signal frequency in the output of the detector is too weak to operate a headset or loudspeaker. One or more stages of a-f amplification, therefore, are required to strengthen the audio output of the detector to a level sufficient to operate the headset or loudspeaker.
- Sound reproduction: The amplified a-f signal is applied to the headset or loudspeaker that translates electrical a-f variations into corresponding sound waves. For a-m, the sound output of the speaker is a close replica of the original audio sounds at the transmitter. For CW, the sound is a tone the frequency of which depends upon the frequency of the beat frequency oscillator. This tone is heard whenever the key is depressed at the transmitter in accordance with the Morse code.

### Field Strength

The amount of voltage induced in an antenna depends on the length of the antenna and the field strength of the carrier wave at that point. The carrier wave, strongest when it leaves the transmitting antenna, is attenuated (weakened) as it travels until its energy level (called field strength) is too weak to be received.

### Sensitivity

A receiver's sensitivity is a measure of how well it can amplify weak signals. Communication receivers are highly sensitive and can operate on far weaker signals than a home radio.

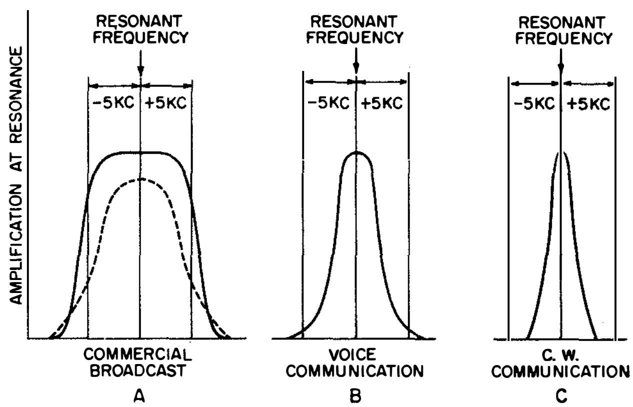
In an area of strong local interference, a receiver needs a strong signal to give good reception. If local interference has a field strength of 100 $\mu$ v per meter, a signal strength of from 500 to 100 $\mu$ v per meter is required to drown the noise. The same receiver, free of local interference, may give good reception on a signal strength of 10 $\mu$ v per meter. It is difficult to state the exact minimum field strength needed to operate a receiver satisfactorily, but many sets under ideal conditions can function on a signal strength of from 1 to 3 $\mu$ v per meter. To bring such a signal to an audible level requires an amplification of many millions of times.

### Selectivity

Selectivity is the ability of a receiver to respond to one particular signal and to reject all others. A highly selective receiver is said to tune sharply. Some types of receivers are more selective than others. A radiotelephone communication receiver tunes more sharply than a commercial broadcast receiver, for example. A CW communication receiver is even more selective. Compare the three tuning curves in figure 9-20.

Analysis of amplitude modulation, treated earlier in this chapter, showed how transmitted intelligence is contained in the sideband frequencies. Carrier waves from commercial broadcast stations contain sideband frequencies that extend 5 kc on either side of the carrier frequency. If a station is transmitting on 1140 kc, the complete carrier wave contains frequencies from 1135 to 1145 kc. If a receiver tunes too sharply, some of the sideband frequencies are lost, with a corresponding sacrifice of fidelity. The commercial broadcast receiver tuning curve shown in figure 9-20 is optimum—"at its best." The top of the tuning curve is broad and flat, and the sides are steep. Actually, most a-m broadcast receivers have tuning curves resembling the broken line. Many frequency components of voice and music contained in the signal are not reproduced by the receiving set.

Although sharp tuning in a home radio would make for poor listening, it is desirable in military sets for the sake of frequency economy and




76.24

Figure 9-20. —Tuning curves of three types of radio receivers.

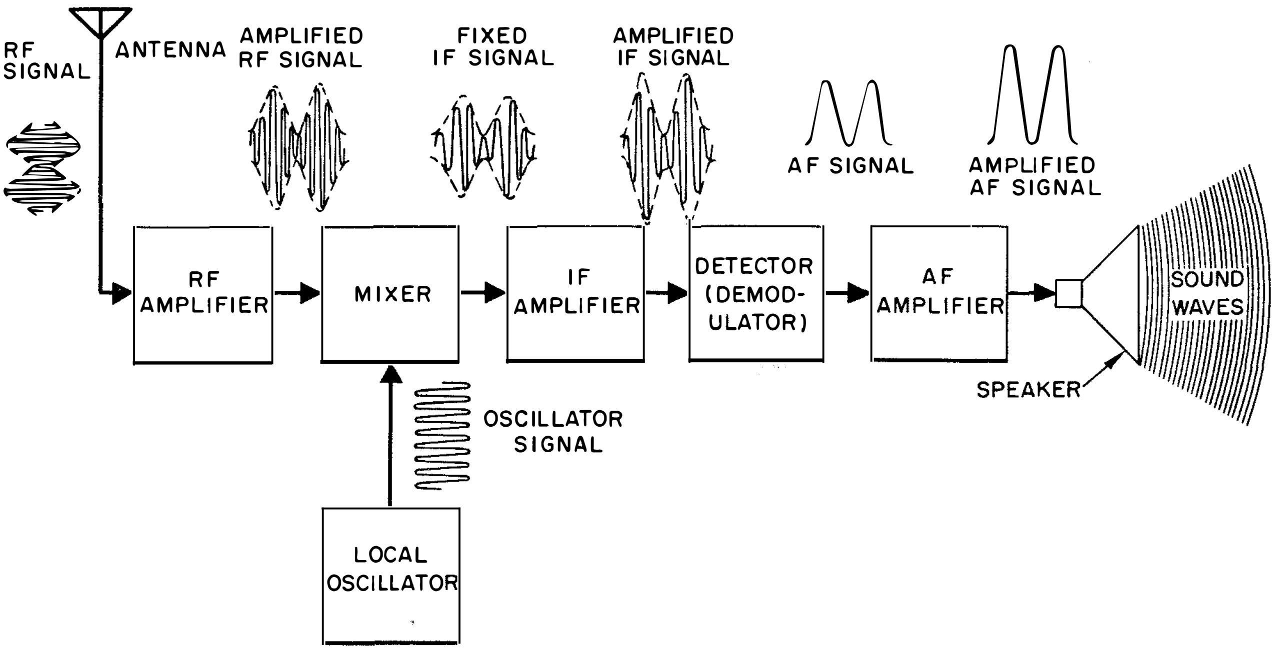
reduction of interference. Radiotelephone messages can be sent on frequencies that extend only 2 kc on either side of the carrier frequency. The voice may sound unnatural, similar to a voice on the telephone, but it can be understood.

The CW sets tune so sharply that, unless an operator is careful, he can turn his dial through the signal without even hearing it.

## BASIC SUPERHETERODYNE RECEIVER

The basic stages for a-m superheterodyne reception are shown in figure 9-21 in the order in which a signal passes through the receiver. The illustration also depicts the changes in waveshape of the signal as it passes through the receiver. Operation of the superheterodyne receiver for reception of a-m signals is as follows:

1. Modulated r-f signals from many transmitters are intercepted by the antenna. They are fed to the first stage of the receiver, which is a variable-tuned r-f amplifier.
2. The desired r-f signal is selected by the tuning circuit of the r-f amplifier. This signal is amplified; all other signals are rejected to some degree.
3. The amplified r-f signal is coupled to the mixer stage, where it is combined with the output of the local oscillator. In this process of heterodyning (mixing), two new frequencies are produced. One frequency is equal to the sum of the incoming signal and the local oscillator frequencies; the other equals the difference between the incoming signal and the local oscillator frequencies. Most receivers are designed with selective circuits to reject the sum frequency; the difference frequency is used as the intermediate frequency (i-f). It contains the same modulation as the original r-f signal.
4. The i-f signal is amplified in the fixed-tuned i-f amplifier stages and is coupled to the detector.
5. The detector stage removes the audio modulation contained in the i-f signal and filters out the i-f carrier, which no longer is needed.
6. The resulting audio signal is amplified to the level required by the loudspeaker.
7. Electrical audio variations are converted into corresponding sound waves by the loudspeaker (or headphones).




76.25

Figure 9-21. —Superheterodyne receiver, showing signal waveshape.

• Frequency conversion: Together the oscillator and mixer circuits achieve the frequency conversion of an r-f signal to an intermediate frequency. Two methods are used to produce this frequency conversion. In one procedure, a separate oscillator tube provides local oscillations. The output of this tube is injected into another tube. The incoming r-f signal also is injected into this second tube, along with the local oscillations, where they combine to produce the intermediate frequency. The tube in which the two signals are combined is called the mixer. The distinguishing feature of this method is that two separate tubes are required.

In the second method, only one tube (known as a converter) is used. The oscillator and mixer tubes are combined into a single tube that performs both functions. Chief advantage of this method is that only one tube is necessary.

Many modern Navy receivers in the HF, VHF, and UHF ranges make use of two intermediate frequencies. This method is known as double conversion. In double conversion, for example, the incoming signal first may be converted to an intermediate frequency between 5 and 10 mc, and after amplification, this frequency is again converted to a lower i-f between 2 and 5 kc. A receiver that makes use of double conversion is called a double superheterodyne receiver. A few models of receivers feature three intermediate frequencies (called triple conversion).

The specific frequency used for the i-f is not the same for all the different models of receivers. Intermediate frequency for a particular model is given in the equipment technical manual.

• CW detection: Because CW code signals are not modulated, intelligence contained in them cannot be recovered by an ordinary detection process. All that is required to make an a-m superheterodyne receiver suitable for reception of CW signals is the addition of a beat frequency oscillator (bfo), shown in figure 9-19. When the oscillator is switched on by means of the bfo switch, its output heterodynes with any incoming CW signal to produce an audio beat note. Simply by turning off the bfo the receiver can be made ready again instantly for a-m reception. All Navy communication receivers in the VHF through HF ranges have the bfo feature.

• Volume control: Volume or gain controls are provided in receivers to permit changing receiver sensitivity. This identical device is found on home radios and television sets. It is necessary in order to compensate for differences in the strength of incoming signals. Volume control can be manual or automatic. Atuomatic volume control (AVC)—sometimes called automatic gain control (AGC)—is used in all superheterodyne receivers and is desirable from several standpoints. One reason is that it prevents extreme variations in loudspeaker volume. When a receiver is tuned from a weak station (for which the volume has been turned up) to a strong station, the loudspeaker (or headset) will blast unpleasantly. Variations in signal strength due to fading also cause wide fluctuations in loudspeaker volume. Furthermore, variations in signal strength at the antenna, if not compensated for, can cause serious trouble by overloading the r-f, i-f, or detector stages of the receiver. Overloading causes distortion of the signal.

The AVC keeps the output volume at a constant level by reducing the amplification of certain stages in the receiver as amplitude of a received signal increases. It affects weak signals as well as strong ones. When a receiver is tuned, the AVC usually is switched off to afford maximum amplification of weak signals. After tuning, the AVC is turned on, if the signal is not too weak.

In some receivers a special type of AVC is used. It is called delayed automatic volume control (DAVC).

The DAVC-equipped receivers do not reduce amplification of a signal until a certain level is exceeded. In this way very weak signals are not weakened further.

• Noise discrimination: Highly sensitive modern superheterodyne receivers always have some background noise that appears in the output as hiss and crackles. Some noise arises in the receiver itself; other noises are produced by lightning and manmade interference, such as that caused by electric motors. Noise interference is bothersome at best, and at worst causes fragmentary reception. A number of devices are designed to minimize the effects of interference. Several of these devices are described here.

A noise suppressor works similar to the tone control on a home receiver. When this control is tuned for bass reception, much of the noise is filtered out and is not permitted to reach the earphones. But the noise suppressor also reduces the volume, so that on weak signals it may be necessary to throw the switch that cuts the suppressor out of the circuit.

An output limiter prevents sudden crashes of static from injuring an operator's eardrums. Output limiters are of several types, but all work as a safety valve. When the output volume of sound reaches a certain level, the limiter is activated and prevents the sound from rising any higher.

Some receivers have silencer circuits that keep the set quiet when no signal is coming in. This device is a convenience when standing by for a message, and also saves an operator the discomfort of spending a slack watch listening to static.

Most output limiters and silencers have OFF-ON switches and an output level adjustment. Specific names for these controls are not the same on all receivers. It is necessary to read the technical manual and examine the equipment before attempting to tune any particular receiver for the first time.

## REPRESENTATIVE RECEIVERS

A representative modern communication receiver, used in all types of Navy vessels, is the R-390A/URR radio receiver. A general description of this receiver is followed by an explanation of the controls used to tune it.

In this section a number of other receivers also are briefly described and illustrated.

### R-390A/URR Radio Receiver

The R-390A/URR (fig. 9-22) is a modern, high-performance, exceptionally stable receiver for both shipboard and shore station use. Within the frequency range of 500 kc to 32 mc it receives CW, MCW, a-m radiotelephone, frequency shift RATT and FAX, and SSB signals. The receiver is a superheterodyne type, with multiple frequency conversion. In the frequency range from 500 kc to 8 mc it uses triple conversion; double conversion is employed in the range from 8 to 32 mc.

34.15
Figure 9-22. —Radio Receiver R-390A/URR.

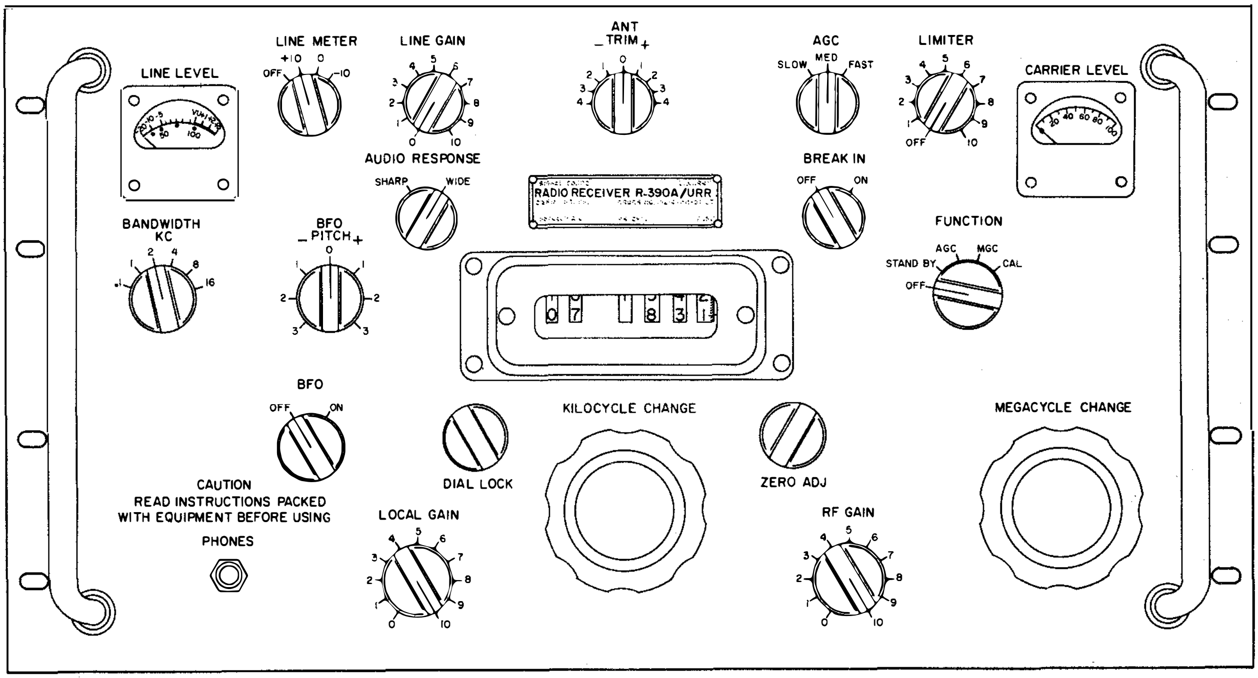
The tuning knob turns a complex arrangement of gears and shafts to indicate the frequency to which the receiver is tuned on a very accurate countertype indicator that resembles the mileage counter on an automobile dashboard. This dial is calibrated in kilocycles. The frequency-reading accuracy of this tuning dial permits use of the receiver as an accurate frequency meter.

RECEIVER CONTROLS. —Haphazard operation or improper setting of receiver controls can result in poor reception. It is important, therefore, to know the function of every control. Although much of the Navy's communication equipment is set up or tuned automatically, an operator still must do a lot to obtain proper operation from the equipment. (Most mechanical or electrical equipment is only as good as the person operating it.) Refer to figure 9-23 when studying the following descriptions of switches and controls.

- Function switch: The function switch serves several purposes. It has a number of positions, each of which is discussed. Its OFF position (self-explanatory) simply turns off power to the receiver.

When the function switch is in STANDBY position, filament supply voltages are energized, but plate supply voltages are not applied to the tubes. This condition readies the receiver for instant use without a long warmup time.

The abbreviation AGC stands for automatic gain control. Placing the function switch in the AGC position activates the circuitry, which automatically adjusts the r-f and i-f amplifier gain to compensate for variations in the level of the incoming signal. In connection with the AGC function, notice that the AGC switch at the top of the panel has three positions marked SLOW, MEDIUM, and FAST. This AGC switch adjusts the rate at which the AGC circuitry responds to a change in the signal level. The correct position of the AGC switch depends on the type of signal received.




34. 15(76)

Figure 9-23. —Front panel of R-390A/URR.

The abbreviation MGC stands for manual gain control. When the function switch is in the MGC position, the AGC circuitry is not activated, and the gain is controlled manually by means of the r-f gain control.

When the function switch is in the calibrate (CAL) position, a stable crystal oscillator introduces a signal at the input circuitry of the receiver. This signal allows the operator to calibrate his receiver; that is, to ascertain that the reading of the tuning dial corresponds to the frequency received. The calibration circuitry of the R-390A permits the operator to calibrate the receiver at each 100-kc point throughout the tuning range of the receiver. In connection with calibration, notice the ZERO ADJ knob near the frequency dial. When turned clockwise, this knob disengages the frequency indicator from the KILOCYCLE CHANGE tuning control. The calibration procedure consists essentially of the following steps:

1. Tune the receiver to a point where the frequency indicator dial shows an exact multiple of 100 kc.

2. Turn the ZERO ADJ knob clockwise to disengage the tuning controls from the frequency indicator.

3. With the function switch in the CAL position, turn the KILOCYCLE CHANGE control to give the maximum response to the calibration signal.

4. Turn the ZERO ADJ knob counterclockwise to reengage the tuning control to the frequency indicator.

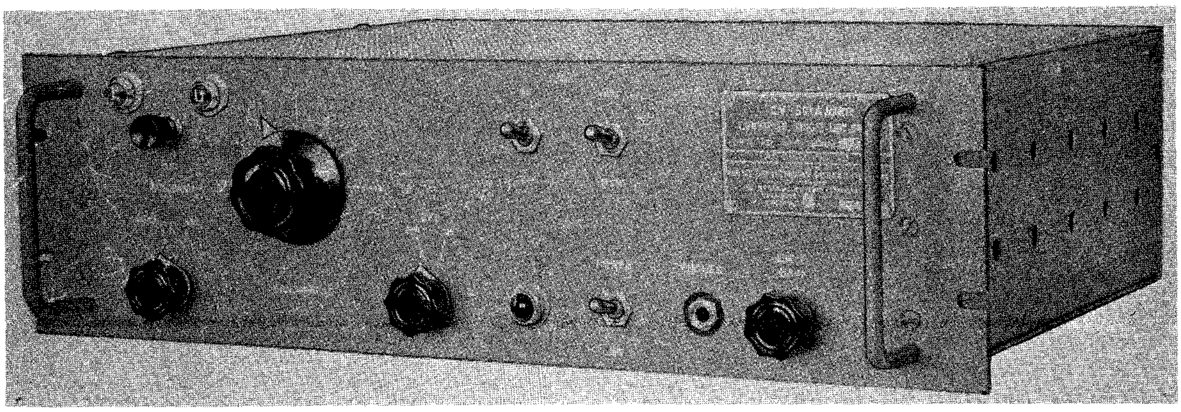
- Tuning controls: Two front panel knobs provide the tuning control of the R-390A. They are the MEGACYCLE CHANGE knob and the KILOCYCLE CHANGE knob. The MEGACYCLE CHANGE knob selects any 1-mc bandwidth of the tuning range. Turning this knob changes the reading of the first two digits of the frequency indicator. The KILOCYCLE CHANGE knob tunes the receiver to any desired frequency within the megacycle band selected by the MEGACYCLE CHANGE control. The last three digits of the frequency indicator dial provide the kilocycle reading. The tuning controls actually adjust the tuned circuits in the r-f stages and in the local oscillator in order to select the desired station frequency and to provide simultaneously the desired i-f signal to the i-f portion of the receiver. The DIAL LOCK knob is associated with the tuning controls. This knob locks the KILOCYCLE CHANGE control so that the frequency setting will not be changed accidentally.

- Bandwidth control: Some transmissions use narrower bandwidths in the r-f spectrum than others. Receivers are therefore provided with a control that allows the operator to adjust the pass band of the receiver so that only the desired bandwidth is received. On the R-390A receiver, this control is achieved by the BANDWIDTH KC switch. It adjusts the tuned circuits of the i-f portion of the receiver, thereby controlling receiver selectivity. Proper adjustment of this control helps to eliminate noise and interfering signals. If the bandwidth is set too narrow, part of the incoming signal will, or course, be lost.
- Beat frequency oscillator: Some radio transmissions, such as Morse telegraphy and FSK teletype contain no audio frequency information when they are received. The R-390A is equipped with a Beat Frequency Oscillator (BFO) to produce an audible output if required. The BFO is activated by the BFO On-Off switch and the pitch of the audio output can be adjusted by the BFO Pitch Knob.
- Gain control: The R-390A has three front panel gain controls. The RF GAIN control permits manual adjustment of the gain of the r-f and i-f sections of the receiver. The LOCAL GAIN and LINE GAIN knobs control the gain of the a-f circuits. The LOCAL GAIN controls adjust the level of the output to the phone jack. The LINE GAIN controls the level of the audio output used to operate terminal equipment.
- Antenna trimmer: The front panel control labeled ANT TRIM adjusts the input circuit in such a manner that optimum coupling from the antenna to the receiver can be achieved at each frequency.
- Audio response: The AUDIO RESPONSE control, which adjusts the bandwidth of the audio circuits, has two settings: SHARP and WIDE. The setting of this control depends on the type of signal received.
- Limiter: When the control labeled LIMITER is activated, the operator can control the amplitude of the audio output circuits to predetermined limits. The setting of the limiter control depends on the type of signals received. A low setting of the control, for example, would be desirable to prevent loud crashes of static in the output when monitoring voice signals. If the received signal is fsk-modulated, it may be desirable to remove all amplitude variations by using a high setting on the LIMITER control. For many types of reception, however, the LIMITER should not be activated.
- Break-in: The ON-OFF switch labeled BREAK IN is used when a receiver and transmitter are operated together as a radio set. In the ON position, circuits are activated for removing the antenna from the receiver and for grounding the antenna and receiver audio circuits whenever the transmitter is energized.
- Indicators: Three indicators are mounted on the front panel of the R-390A. The frequency indicator dial indicates the frequency to which the receiver is tuned. This dial is of the digital-counter type, which permits frequency to be read directly with little chance of misreading.

The CARRIER LEVEL indicator—a meter—measures the level of the r-f signal appearing at the input of the receiver. The operator will find this meter valuable in tuning to the exact frequency that gives the strongest signal. It is also used to indicate proper adjustment of the antenna trimmer. The indicator labeled LINE LEVEL monitors the level of the line audio out used to drive the terminal equipment. This meter is placed across the output circuit by the LINE METER switch. The three available values of meter sensitivity (voltage required for full-scale deflection) are determined by the setting of the LINE METER switch. This meter is valuable in maintaining the proper output level when making tape recordings.

### CV-591A/URR SSB Converter

The CV-59A/URR single sideband converter (fig. 9-24) is used to convert standard communication receivers such as the R-390/URR for SSB use. Overall selectivity of most receiving systems is greatly sharpened, rejecting un—wanted adjacent signals or interference with no detrimental effect to the desired signal. The tuning of single sideband signals is greatly simplified because final tuning is done at the converter, not the receiver. A mechanical and electrical bandspread tunes over the i-f bandpass. This effective vernier easily tunes SSB or exalted carrier a-m signals within cycles of correct tone. Either sideband is selectable, either with the bandpass tuning feature or by inverting the oscillator separation. Continuous wave, MCW, and FS signals are easily tunable with the bandspread feature. For extreme stability, the first oscillator is switched to crystal control for both upper and lower sideband positions.



109.30

Figure 9-24. —SSB converter CV-591A/URR.

The local or remote tuned VFO feature of the converter permits operation with any receiver having an i-f nominally centered at 455 kc. When the oscillator is switched to crystal control and the proper crystals inserted, however, most any receiver i-f may be accommodated.

All operational controls are located on the front panel. These controls are similar in function and effect to those found on any receiver. The BANDSPREAD control tunes the converter over a limited frequency range. A MANUAL/XTAL switch sets the first oscillator to either variable or fixed crystal operation. The BFO, AVC, and AUDIO GAIN controls perform similar functions as on a receiver. Terminals at the rear panel provide simple connections for remote control of the main features of the converter without modifications or the use of additional lines or tones. By this means it is possible to tune the converter remotely or locally across the receiver i-f passband, select sidebands with a remote indication of which sideband is in use, and still retain all of the remote control features of the remote control system. The converter may be used with remote control system AN/FRA-19(V) or AN/FRA-501, without modification to the system.

AN/SRR-11, -12, -13 Receivers

Frequency range of each receiver is divided into five bands. The frequency range of the AN/SRR-11 is from 14 to 600 kc; that of the AN/SRR-12 is from 0.25 to 8 mc; and range of the AN/SRR-13 and -13A is from 2 to 32 mc. Frequency range of AN/SRR-12 includes the standard broadcast band, and overlaps part of the frequencies covered by the other models. The Navy procured very few AN/SRR-12 receivers, and it is unlikely that this model will be encountered in the fleet. Although tuning procedures for AN/SRR-12 and -13 are the same, further discussion concerns only models AN/SRR-11 and -13. The AN/SRR-13A differs only slightly, hence statements regarding AN/SRR-13 except where specifically noted, apply to -13A as well.

The AN/SRR-11 receiver is used for guarding low and medium frequencies, such as the international distress frequency (500 kc), but its most general use is for receiving the VLF and LF transmissions of fleet broadcasts. This receiver can be used for CW, MCW, and frequency shift RATT and FAX reception. The AN/SRR-13 covers all of the HF band. In addition to receiving CW, MCW, RATT, and FAX, it is an exceptionally good radiotelephone receiver.

Both AN/SRR-11 and -13 are double superheterodyne receivers. A crystal-controlled calibrator in each receiver provides crystal checkpoints for the frequency dial. These checkpoints are spread uniformly over the tuning range of the receivers. They occur at 10-kc intervals for the AN/SRR-11 and at 200-kc intervals for AN/SRR-13. The use of the frequency checkpoints in calibrating the tuning dial is explained in the description of tuning procedures.

The frequency to which the receiver is tuned is projected on a translucent screen (tuning dial) located at the upper left of the front panels (fig. 9-25). The dial is calibrated in kilocycles on the AN/SRR-11 and in megacycles on the AN/SRR-13.

AN/WRR-2 Receiving Set

One of the latest shipboard radio receivers for the medium- and high-frequency bands is the AN/WRR-2, shown in figure 9-26. (The same receiver, with rack mounting for shore station use, is called AN/FRR-59.)

The AN/WRR-2 is a triple-conversion superheterodyne receiver covering the frequency range 2 to 32 mc. This modern receiver is intended primarily for the reception of single sideband transmissions with full carrier suppression. It can be used also to receive conventional amplitude-modulated signals of various types, including CW, MCW, voice, facsimile, and frequency shift RATT.

In order to meet strict frequency tolerances, special features provide extremely accurate tuning and a very high degree of stability over long periods of operation. Simultaneous use can be made of both upper- and lower-sideband channels for receiving two different types of intelligence, although both single sideband and conventional a-m signals cannot be received at the same time.

R-1051/URR Radio Receiver

Radio receiver R-1051/URR (fig. 9-27) is a triple-conversion superheterodyne receiver, tunable over the high frequency range from 2 to 30 mc. Tuning of the R-1051/URR is accomplished digitally by five controls and a switch located on the front panel. A display window directly above each control provides a readout of the digits to which the controls are set. The displayed frequency can be changed in 1-kc increments. The front panel CPS switch allows the operating frequency to be changed in 500-cps increments. This method of tuning provides 56,000 discrete frequencies in which the receiver is locked to a very accurate frequency standard. Each 1-kc increment can be tuned continuously by selecting the VERNIER position of the CPS switch. When using the vernier, the full accuracy of the frequency standard is sacrificed. The R-1051/URR demodulates and provides audio outputs for the following types of received signals: LSB, USB, ISB, CW, FSK, and AM. The R-1051/URR may be operated in conjunction with a transmitter, as a transmitter-receiver in systems such as radio set AN/WRC-1 previously mentioned. In this application, either simplex or duplex operation is possible. The R-1051/URR may also be used as a separate, self-contained receiver requiring only a headset, antenna, and a nominal 115-vac primary power source for full operation. The R-1051/URR is intended for ship and shore installations.

Model RBO Receiver

The RBO is a superheterodyne receiver. It provides high-quality reception of voice and music. It has three frequency bands: the standard broadcast band, 530 to 1600 kc; a shortwave band from 5.55 to 9.55 mc; and another shortwave band from 9.20 to 15.60 mc.

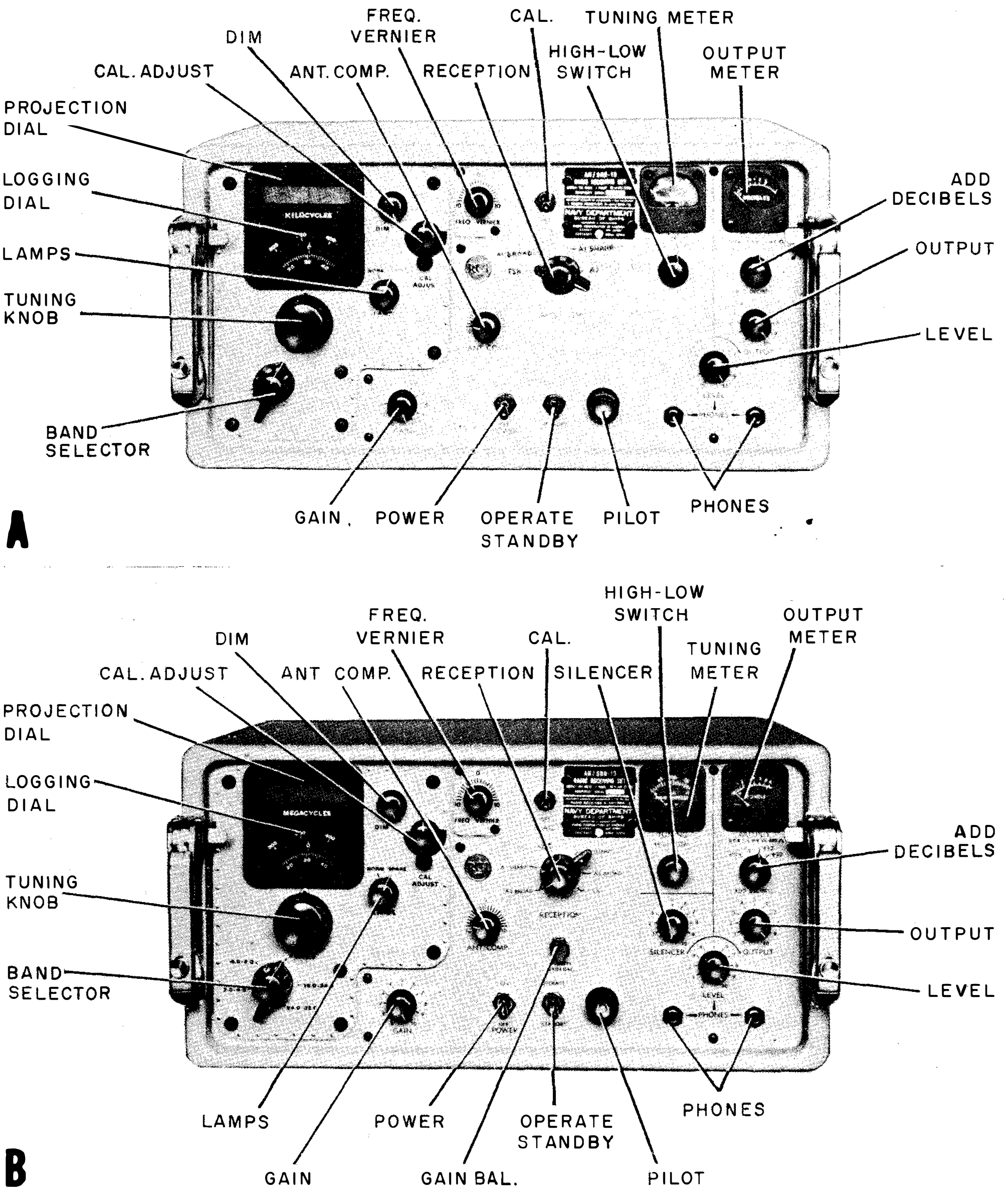
The model RBO receiver (fig. 9-28) has been the standard shipboard entertainment receiver for many years. It is installed in ships of all types.

VHF RECEIVERS

The AN/URR-21 receiver (fig. 9-29) is used aboard ship and at shore stations for receiving amplitude-modulated radiotelephone signals in a portion of the VHF band, from 115 to 156 mc. It is a crystal-controlled superheterodyne receiver. Although the receiver dial is calibrated continuously, only four channels can be tuned within the frequency range at any one time because the frequency of the oscillator is controlled by four individually selectable crystals. The four crystals are plugged into a crystal holder on the receiver chassis inside the cabinet. Special features include a front panel dial detent mechanism for rapid selection of channels, and continuous tuning of all r-f circuits by means of a single tuning control.

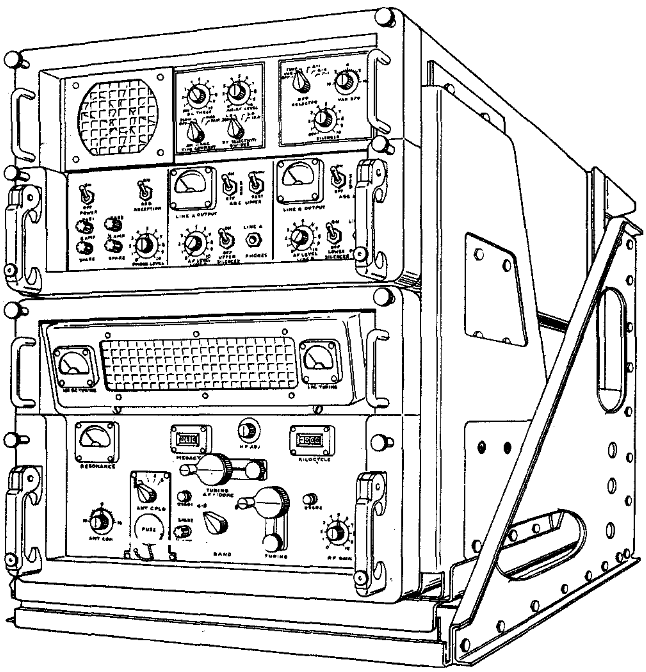
AN/URR-27 Receiver

The VHF receiver, model AN/URR-27, is used aboard ship and at shore stations for radiotelephone reception in the frequency range of 105 to 190 mc. It can also be used for MCW reception. It was designed primarily as a single-channel, crystal-controlled, superheterodyne receiver, although continuously variable manual tuning may also be used. A single tuning control permits tuning to any frequency within its range, for either crystal-controlled or manual tuning. Only one crystal at a time can be




1.159

Figure 9-25.—Receivers: (A) AN/SR-11, (B) AN/SRR-13.



50.40
Figure 9-26. —Radio receiving set AN/WRR-2.

plugged into the crystal holder, which is easily accessible on the front panel of the receiver. The AN/URR-27 (not illustrated) is similar in size, appearance, and operating controls to UHF receivers AN/URR-13 and AN/URR-35. (Model AN/URR-35 is shown in figure 9-30.)

Both AN/URR-27 and AN/URR-21 are installed as companion receivers with model AN/URT-7 transmitters.

## UHF RECEIVERS

Radio receivers AN/URR-13 and AN/URR-35 are used for radiotelephone and MCW reception in the range of 225 to 400 mc. Although the frequency range includes the upper portion of the VHF band, both receivers commonly are called UHF equipments, and are used as companion receivers with the model TED transmitter. They were designed primarily as single-channel, crystal-controlled receivers. Continuously variable manual tuning may also be used. These receivers are easy to tune. They feature single tuning controls for tuning to any frequency within their range, for either crystal-controlled or manual tuning. The AN/URR-13 is a superheterodyne receiver, whereas the AN/URR-35 is a double superheterodyne. Both receivers are similar in size, appearance, and operating controls. Only the AN/URR-35 is illustrated here (fig. 9-30). Both receivers are used aboard ship and at naval air and shore radio stations.

### AN/GRC-27 Receiver

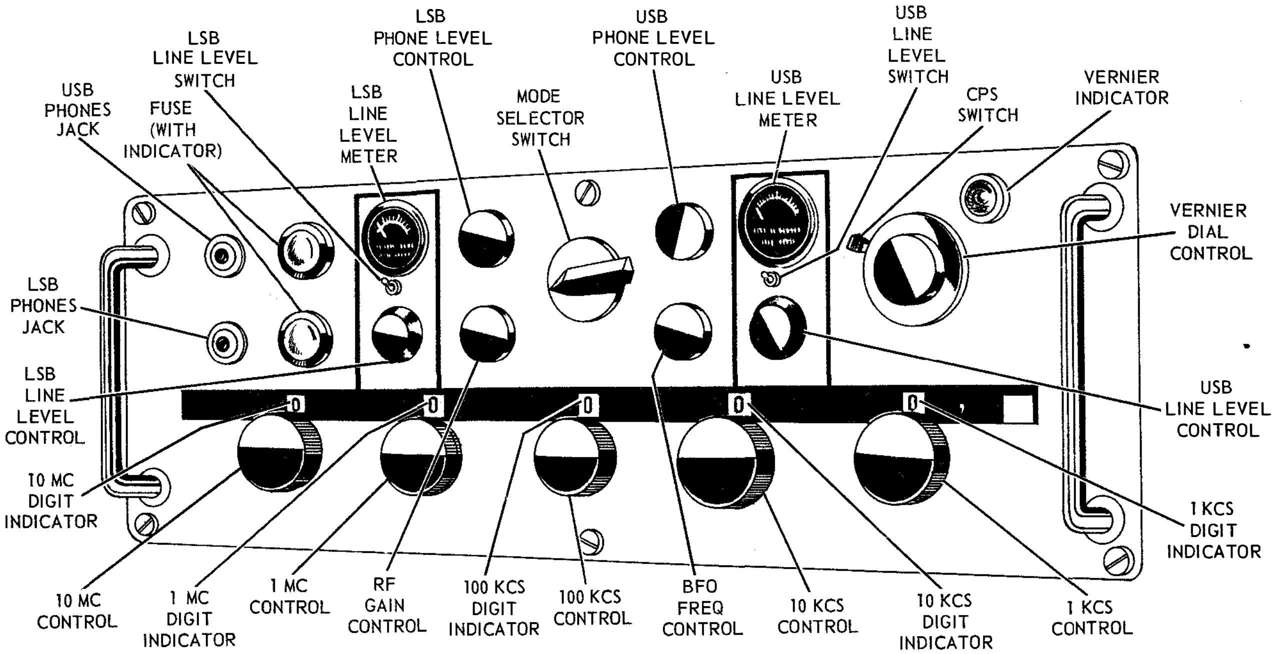
The AN/GRC-27 UHF receiver covers the frequency range from 225 to 400 mc. It is part of the AN/GRC-27 transmitter-receiver set. This component was described and illustrated earlier in this chapter.

## FACSIMILE EQUIPMENT

Facsimile (FAX) is a method for transmitting pictorial and graphic information by wire or radio and reproducing it in its original form at the receiving station. The most useful application of FAX by the Navy has been transmission of fully plotted weather charts.

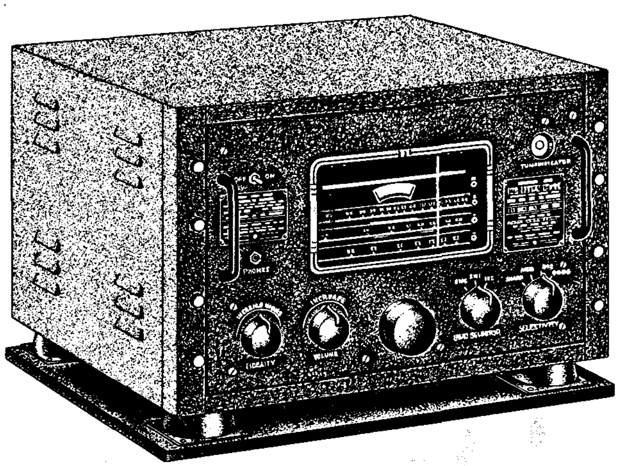
Not every ship or station has facsimile equipment aboard. In those that do have it, it is not always operated by Radiomen. Some ships having Aerographers aboard are equipped only for receiving FAX broadcasts and the facsimile recorders are operated by Aerographers. Other ships do not carry Aerographers, and operation of facsimile equipment is the responsibility of Radiomen. Because of this, a brief description of a facsimile transceiver and a recorder is included in this manual. Radiomen who are required to operate facsimile equipment should consult the equipment technical manual for complete operating instructions.

The Navy has a number of facsimile equipments in use. All operate in much the same way. The picture to be transmitted is wrapped around a cylinder on the transmitting machine. The cylinder rotates at a constant speed and at the same time moves longitudinally along a shaft. The picture is illuminated by a beam of light focused through a lens. As the beam passes over each portion of the picture, the image is reflected into a photoelectric cell. Variations in intensity of reflected light, caused by the character of the picture, create voltage variations in the tube output circuit. These voltage variations constitute the picture signal and may be sent directly over a landline circuit or used to modulate the radiofrequency carrier of a transmitter.



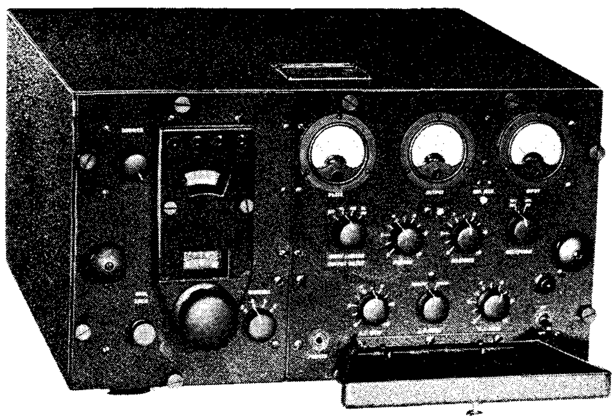

76. 63

Figure 9-27. —Radio receiver R-1051/URR, operating controls and indicators.



76. 27

Figure 9-28. —Model RBO entertainment receiver.

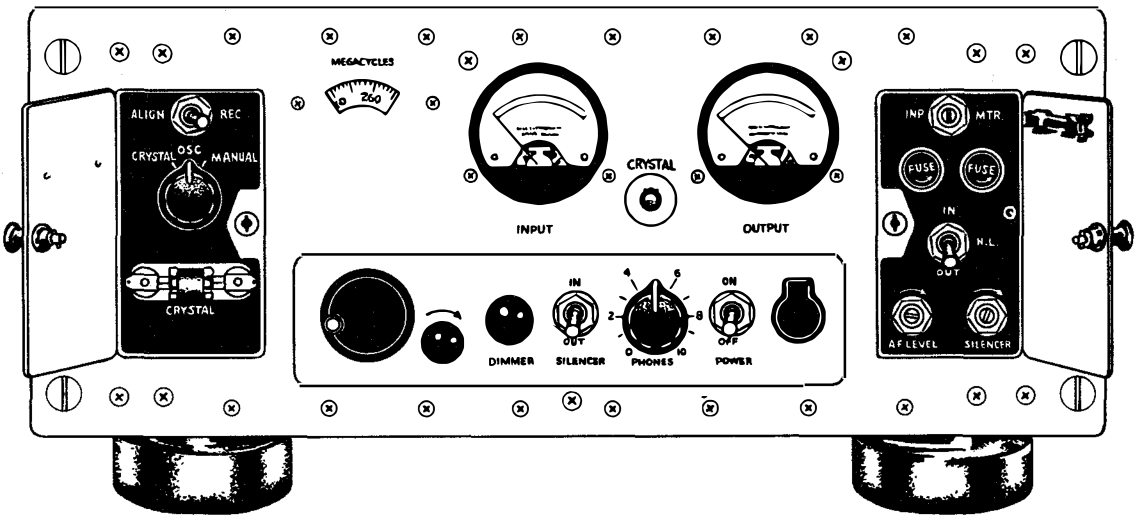


32. 56

Figure 9-29. --VHF receiver AN/URR-21.

## FACSIMILE TRANSCEIVER

Facsimile transceiver TT-41B/TXC-1B, shown in figure 9-31, is an electromechanical optical facsimile set of the revolving-drum type for both transmission and reception of page copy. Colored copy may be transmitted, but all reproduction is in black, white, and intermediate shades of gray. Received copy is recorded either directly on chemically treated paper, or photographically in either negative




32.45

Figure 9-30. —UHF receiver AN/URR-35.

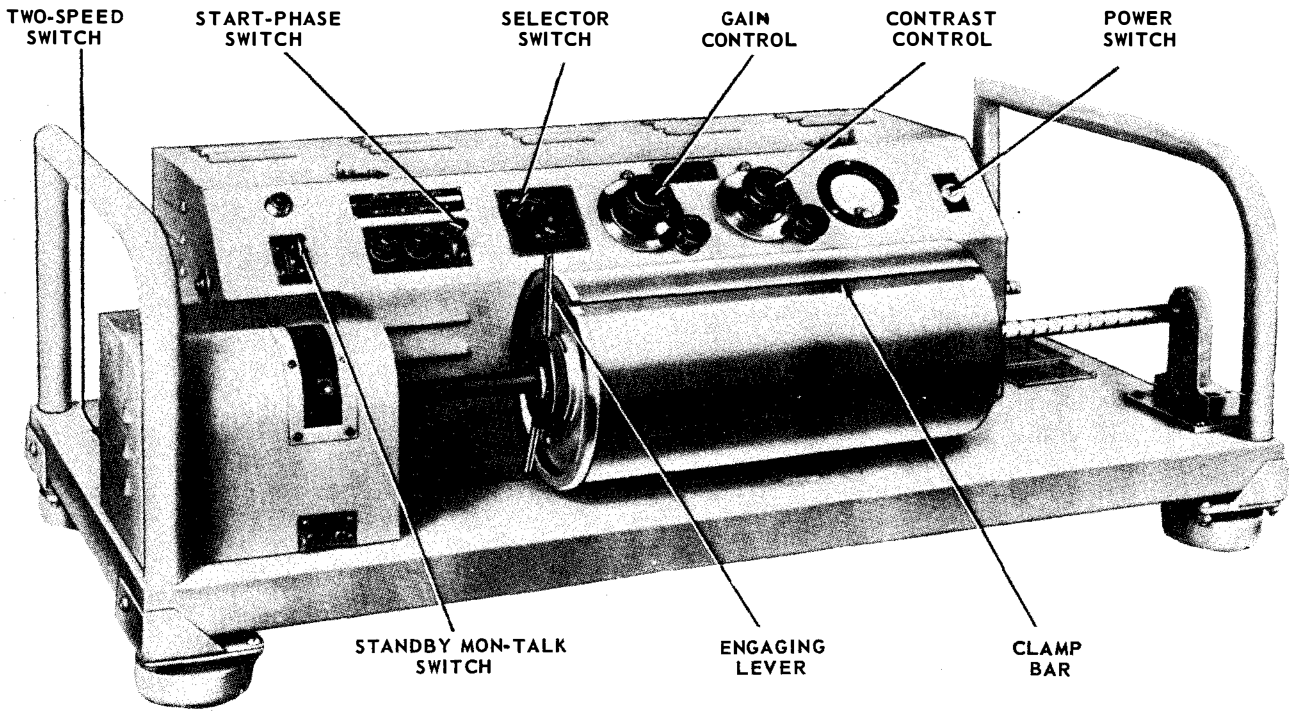



Figure 9-31. —Facsimile transceiver TT-41B/TXC-1B. 13.70

or positive form. The equipment will transmit or receive a page of copy 12 by 18 inches in 20 minutes at regular speed, or in 40 minutes with half-speed operation.

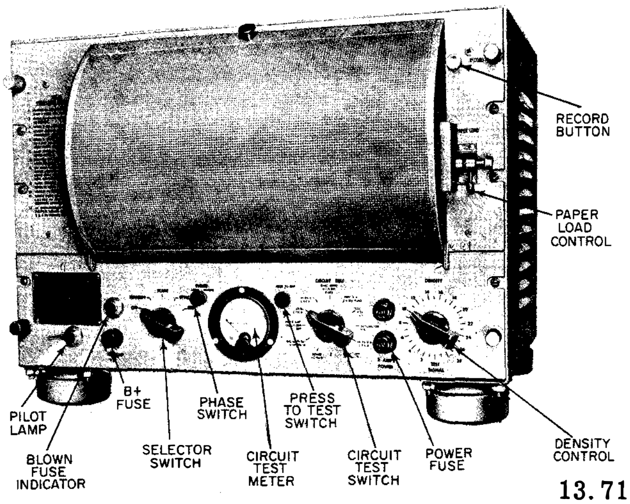
All electrical operating controls of the facsimile transceiver, except the motor speed control switch, are positioned on the sloping front panel (fig. 9-31). The motor speed control switch is on the left end of the base of the transceiver. Two mechanical controls, the drum engaging lever and the clamp bar, are located on the drum. Input and output connections are on the right end of the transceiver.

## FACSIMILE RECORDER

Facsimile recorder RD-92A/UX, shown in figure 9-32, is used for direct stylus recording only. It cannot be used for transmitting FAX, nor can it receive on photographic film, like the transceiver described earlier.

The recorder drum rotates at a speed of 60 rpm while feeding a stylus needle along the drum. One scanning line is recorded for each revolution until the complete drum is covered.

When the record button (fig. 9-32) is depressed and the selector switch is in the RUN position, the stylus needle records on paper fastened on the drum. The stylus is held in a carriage assembly that is moved across the drum to the right when engaged with a lead-screw shaft geared to the drum. When the carriage assembly reaches the right end of the recorder paper, it operates an automatic release mechanism. This action disengages the carriage mechanism from the lead screw and lifts the stylus from the paper. A return spring then pulls the carriage back to the left side of the drum so that it will be ready for the next copy.




13.71

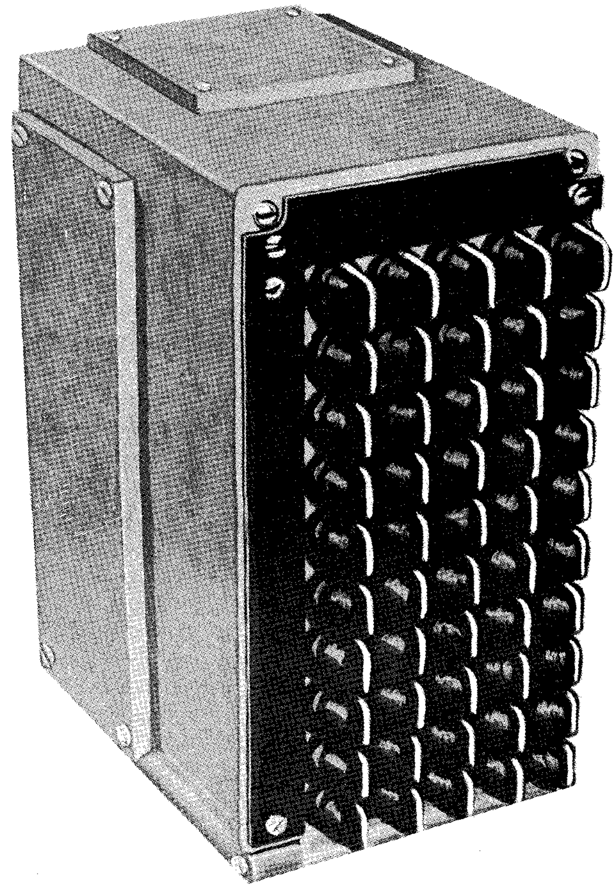
Figure 9-32. —Facsimile recorder RD-92A/UX.

## RECEIVER AND TRANSMITTER TRANSFER SWITCHBOARDS

Radio remote control transfer plug panels have become too cumbersome to be used in the vastly expanded shipboard radio installations in modern Navy ships. Control panels utilizing switches instead of plugs and patch cords are therefore installed in new construction and conversion ships. These transfer switches afford greater flexibility in the remote-control system.

## RECEIVER TRANSFER SWITCHBOARD

Receiver transfer switchboard, type SB-82/SRR, is shown in figure 9-33. The receiver switchboard has five vertical rows of ten double-pole, single-throw (ON-OFF) switches that are



36. 69

Figure 9-33. —External view of receiver transfer switchboard, type SB-82/SRR.

continuously rotatable in either direction. One side of each switch within a vertical row is wired in parallel with the same sides of the other nine switches within that row. Similarly, the other side of each switch is wired in parallel horizontally with the corresponding sides of each of the other four switches in a horizontal row. This method of connecting the switches permits a high degree of flexibility.

The audio output from five radio receivers, connected to the five vertical rows of switches, may be fed to any or all of the remote stations by closing the proper switch or switches. The knob of each switch is marked with a heavy white line to provide visual indication of the communication setup. In general, there are more remote stations than radio receivers, hence the switchboards normally are mounted in a vertical position (as in fig. 9-33). This arrangement permits the outputs from five receivers to be fed to the five vertical rows and up to ten remote stations to be fed from the ten horizontal rows of switches.

Switchboards are always installed with the knobs in the OFF position when the white line is vertical. To further standardize all installations, receivers are always connected to the vertical rows of switches, and remote stations are always connected to the horizontal rows. Identification of the receivers and remote stations is engraved on the laminated bakelite label strips fastened along the top and left edges of the panel front.

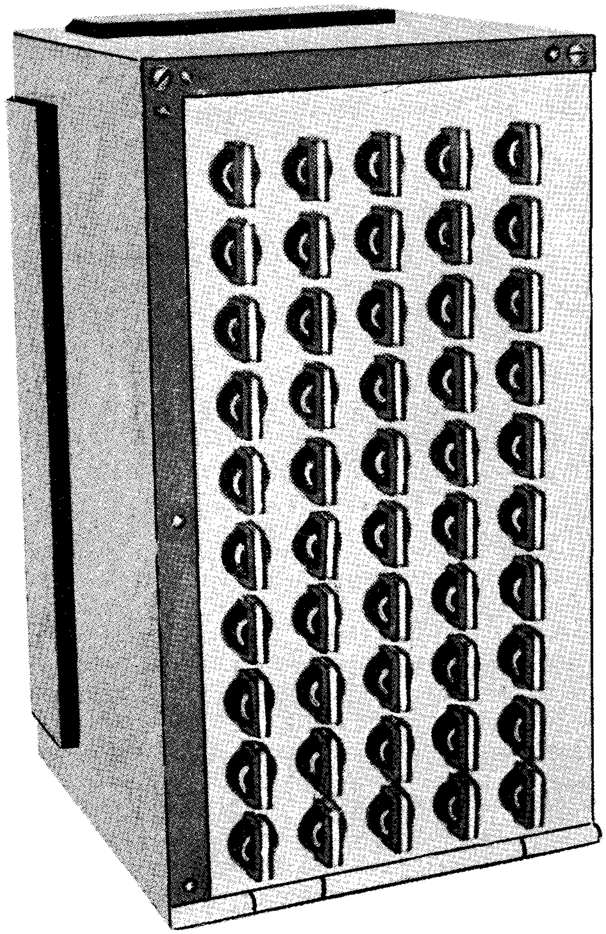
## TRANSMITTER TRANSFER SWITCHBOARDS

It should be noted that only the receiver audio output circuit is connected to the switchboard. Transmitter transfer switchboards, however, handle several other types of circuits besides audio circuits.

- Transmitter transfer switchboard, type SB-83/SRT, is shown in figure 9-34. The same parallel wiring of the switches is the same as in the receiver switchboard.

The transmitter switchboard has five vertical rows of ten 12-pole, single-throw switches. They are continuously rotatable in either direction. Radio transmitters are wired to the five vertical rows; remote stations are connected to the ten horizontal rows. Switches are in the OFF position when the white lines on the knobs are vertical.

As has been stated, the receiver switch panel carries the receiver audio output circuit only; in this respect, it is similar to the older receiver transfer plug panel. In the transmitter switchboard, however, each switch carries the start-stop indicator and keying circuits (six conductors), as in the old-style transmitter transfer plug panel. Additionally, the transmitter switchboard carries the 12-volt d-c microphone, carrier control, and carrier indicator circuits that formerly were carried in the radiophone transfer plug panel. Thus, the transmitter switchboard takes the place of two transfer plug panels (the transmitter plug panel and radiophone transfer plug panel).

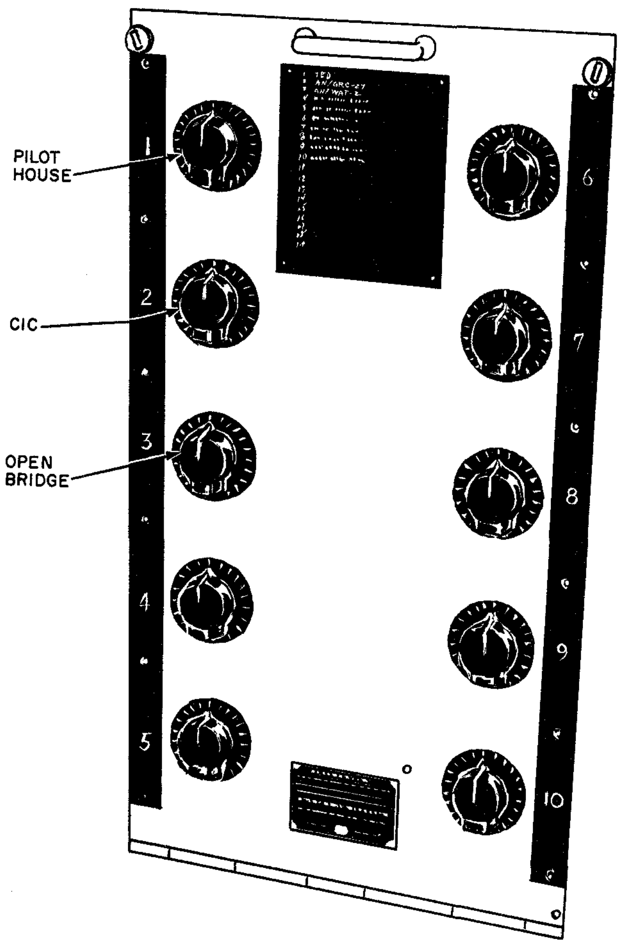


36.70

Figure 9-34. —External view of transmitter transfer switchboard, type SB-83/SRT.

A mechanical interlock arrangement prevents additional switches in each horizontal row from being closed when any one of the five switches in that row already has been closed. This arrangement prevents serious damage that is certain to result from two or more transmitters feeding a single remote station simultaneously, Although the mechanical interlock will prevent closing a second switch in a horizontal row after one switch has been closed, it will not prevent two switches from being turned at the same time. In other words, by using both hands, an operator could make the mistake of turning two switches in a horizontal row at the same time, connecting two transmitters to the same remote unit, and damaging the transmitters. One foolproof way to prevent turning more than one switch at a time is to do all transmitter switching with only one hand.

• Transmitter transfer switchboard, type SB-863/SRT is replacing type SB-83/SRT. The SB-863/SRT (fig. 9-35) has ten 20-position rotary selector switches in two vertical columns.




70.64

Figure 9-35. —Transmitter transfer switchboard SB-863/SRT.

Each rotary switch corresponds to a remote control station, and each switch position (1 through 19) corresponds to a controlled transmitter. Thus, switching control is provided for up to 10 remote control stations and 19 transmitters. When more than 10 remote stations or 19 transmitters are to be connected, additional transfer switchboards may be installed. Position 20 of each rotary switch is provided for connections to an additional transfer switchboard to control extra transmitters. The switches consist of 12 wafers that connect the start-stop indicator, keying, 12-volt d-c microphone, carrier control, and carrier indicator circuits for the various transmitters.

Any of the remote stations may be connected to control any of the transmitters in the system. To connect remote station No. 1 (fig. 9-36) to control the TED transmitter, for example, rotary switch No. 1 (S1) is placed in position 1. To control the AN/GRC-27 from remote station No. 1, switch S1 is placed in position 2. In the same manner, switch 2 (S2) is used for remote station No. 2.

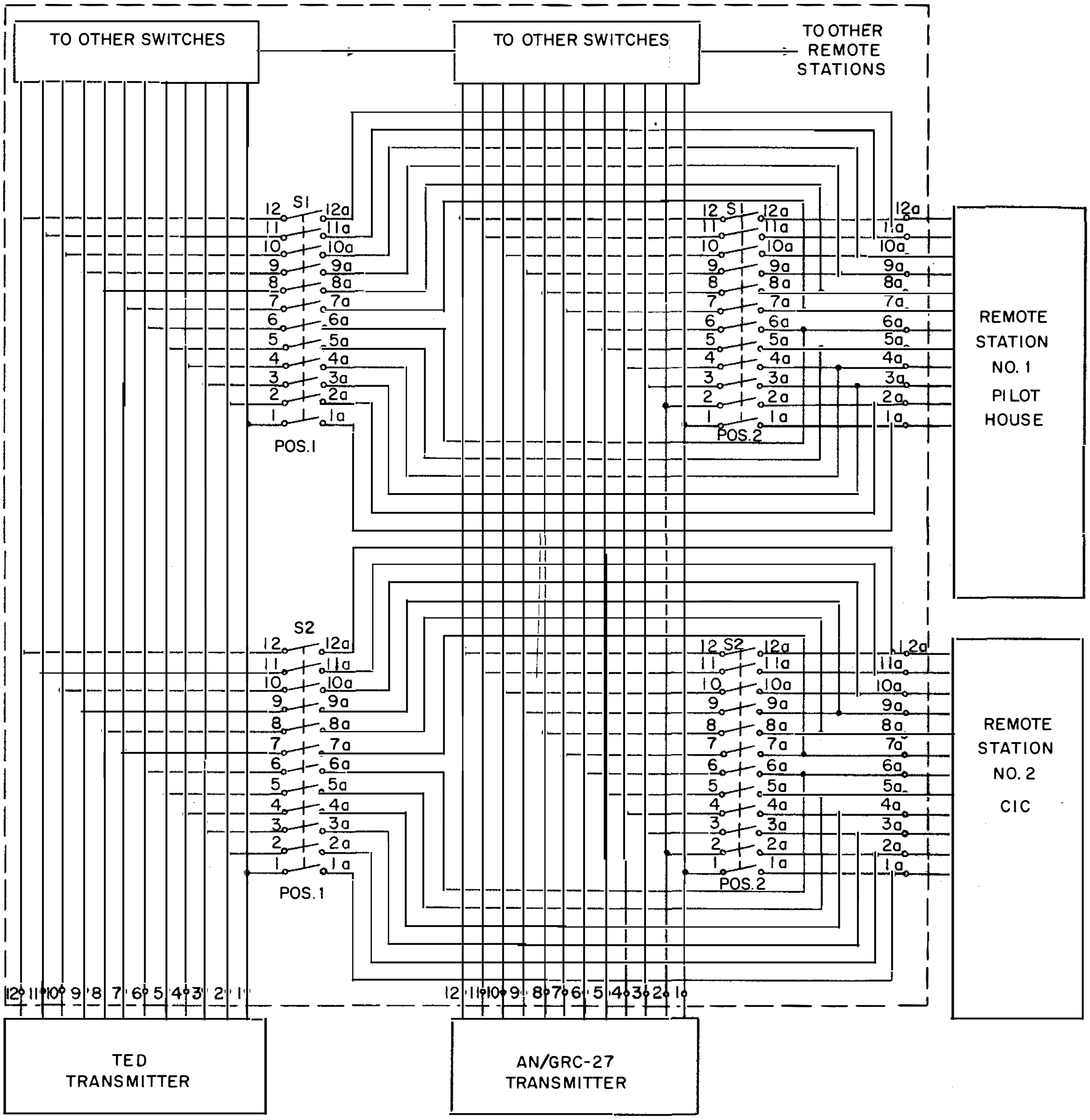
When the switchboard is installed (fig. 9-35), the remote stations assigned to each rotary switch, and the transmitters assigned to positions 1 through 19, are engraved on engraving plates. If an extra switchboard is installed, switch position No. 1 on the second switchboard is assigned to transmitter No. 20, position No. 2 to transmitter No. 21, etc. Thus, if remote station No. 2 is to have control of transmitter No. 22, switch No. 2 on the first switchboard is placed in position 20, and switch No. 2 on the additional switchboard is placed in position 3.

## REMOTE-CONTROL UNIT

To operate a transmitter from a remote location requires a remote-control unit. A typical remote-control unit, commonly called RPU (radiophone unit), is type C-1138A/UR shown in figure 9-37. This unit contains a start-stop switch for turning the transmitter on or off, jacks for connecting a handset or chestset, microphone, headphones, or telegraph key, a volume control for the headphones, and indicator lamps for transmitter-on and carrier-on indications.

## DUMMY ANTENNAS

Under radio silence conditions, placing a carrier on the air during transmitter tuning

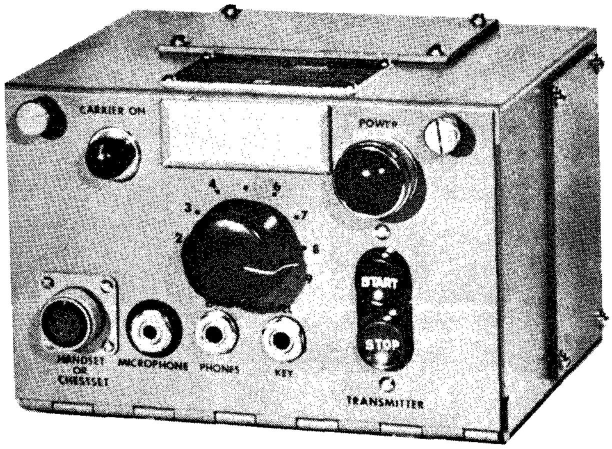



70.65

Figure 9-36. —Simplified schematic diagram of transmitter transfer switchboard SB-863/SRT, showing first two positions of rotary switches 1 and 2.

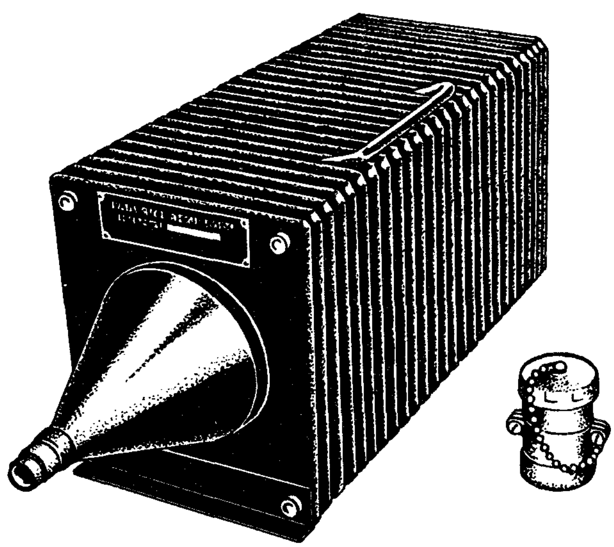
would give an enemy the opportunity to take direction-finding bearings and determine the location of the ship. Even though radio silence is not imposed, DNC 5 directs that transmitters be tuned by methods that do not require radiation from the antenna. The reason for this precaution is to minimize interference to other stations using the circuit.

One way to tune a transmitter without causing unwanted radiation is through use of previously determined and recorded calibration settings for the tuning controls. Another method is to use a dummy antenna. Dummy antennas (called dummy loads) have resistors that dissipate the r-f energy in the form of heat and prevent radiation by the transmitter during the tuning




7.40.2A
Figure 9-37.—Radiophone unit (RPU).

operation. One model, typical of most dummy loads, is the DA-91/U (fig. 9-38), which can be used with transmitters up to 500 watts. It is enclosed in a metal case that has fins to increase its air-cooled surface area. The dummy load, instead of the antenna, is connected to the output of the transmitter, and the normal transmitter tuning procedure is followed. Use of the dummy load with transmitters such as AN/SRT-15 requires manual disconnection of the transmission line at the transmitter, and connection of the dummy load. Upon completion of transmitter tuning, the dummy load is disconnected and the antenna transmission line is connected again to the transmitter.



76.29
Figure 9-38.—Dummy antenna DA-91/U.

Some Navy transmitters, such as the URC-32, have built-in dummy antennas. This arrangement permits connection of either the dummy antenna or the actual antenna by simply throwing a switch.

## RECEIVING ANTENNA DISTRIBUTION SYSTEMS

Various types of shipboard receiving antenna distribution systems are in use. Some systems are for small ships and special applications only. Filter-type multicouplers are explained in this chapter. Additional information about antenna distribution systems may be found in Shipboard Antenna Details, NavShips 900121(A).

### FILTER ASSEMBLY SYSTEM

A receiving antenna distribution system using a filter assembly is shown in figure 9-39. This type of distribution system makes possible the multiple operation of a maximum of 28 radio receivers from a single antenna. Usually it is preferable, however, to limit the total number of receivers to seven.

The filter assembly, or multicoupler, provides seven radiofrequency channels in the frequency range from 14 kc to 32 mc. Any or all of these channels may be used independently of, or simultaneously with, any of the other channels. Connections to the receivers are made by coaxial patch cords. An external view of the filter assembly is shown in part B of figure 9-39.

Separation of the frequency range into channels is accomplished by combinations of filter subassemblies, which plug into the main chassis. Each filter subassembly consists of complementary high-pass and low-pass filter sections with the common crossover frequency serving as the division between channels. The filters not only guard against interference at frequencies falling outside the channel being used, but also prevent receivers connected to alternate rows of jacks from interacting with each other when their tuning and trimming adjustments are made.

A set of nine filter subassemblies is furnished with the equipment, but only six may be installed at one time. The six filters installed are selected to cover the most-used frequency

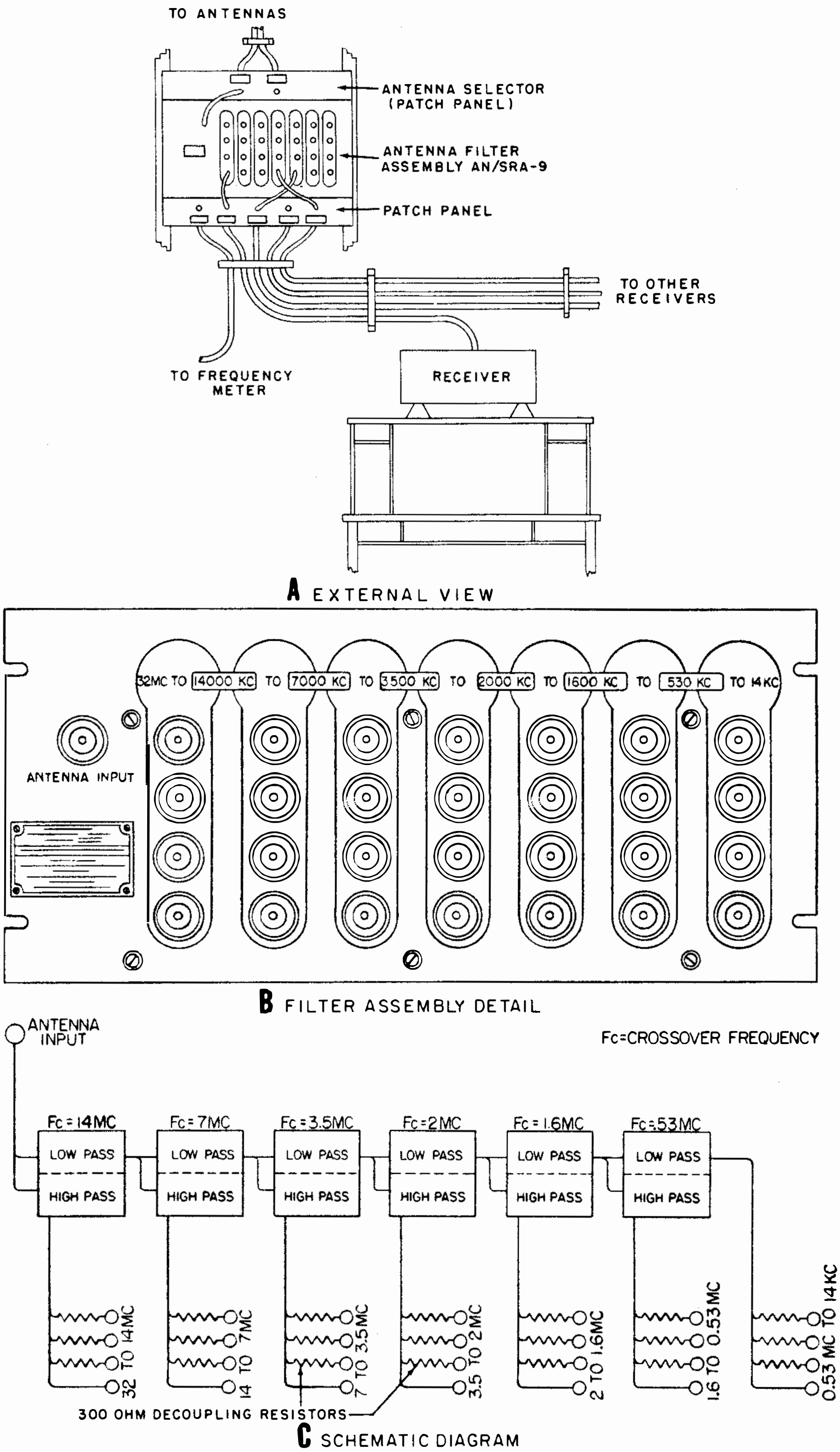



**Figure 9-39. —Receiving antenna distribution system, using antenna filter assembly.**

1.51:115

bands. Filter subassemblies are sealed units having terminal plugs for easy installation or removal. Numbers are stamped on the filters to indicate their crossover frequencies. These numbers are viewed through windows in the front panel. The six subassemblies are mounted in the order of decreasing frequencies from left to right, as viewed from the front of the panel.

The filter panel (view B of fig. 9-39) contains 1 antenna input jack, 28 output jacks, 21 decoupling resistors, and 6 octal sockets. The antenna input jack and the 28 output jacks are quick-disconnect type r-f connectors. The filter subassemblies plug into octal sockets in the rear of the main chassis (not shown in the illustration).

The bottom jack in each vertical row of output jacks is painted red to indicate that it is connected directly to its subassembly. The other three output jacks in each row are unpainted to denote that they are decoupled from their corresponding filters by 300-ohm decoupling resistors (part C of fig. 9-39).

Because Navy communication receivers normally operate throughout frequency bands that exceed the bandwidths of the filter channels, a given receiver must be connected to the particular row of output jacks that provides the signal of the desired frequency. For example, if the receiver tuning is changed from a frequency in the 7- to 14-mc band to some frequency in the 14- to 32-mc band, the patch cord would have to be moved from the output of the 14- to 7-mc filter unit to the output of the 32- to 14-mc filter unit.

The red-painted jacks at the bottom of each row are directly connected to the filter subassemblies and should be used whenever maximum signal strength is desired. The other three jacks in each row are decoupled by 300-ohm resistors and are best suited for use with relatively strong signals, because a certain amount of signal loss is inevitable. In the ideal arrangement, only one receiver is connected to each vertical row of jacks, and that receiver is connected to the bottom jack in each row. This arrangement means that seven receivers are fed from one antenna. At frequencies somewhat removed from the crossover points, the performance of each of these seven receivers should be comparable with that obtained if each receiver were connected to a separate antenna.

## TRANSMITTING ANTENNA MULTICOUPLERS

Antenna multicouplers are used also with transmitting antennas because the many transmitters installed in modern ships make it difficult to find suitable locations for the necessary additional antennas. Multicouplers permit the simultaneous operation of a number of transmitters into a single antenna. Thus, the number of antennas can be reduced without sacrificing any of the required communication channels. This arrangement permits maximum use of the best available antenna locations and reduces the intercoupling between antennas.

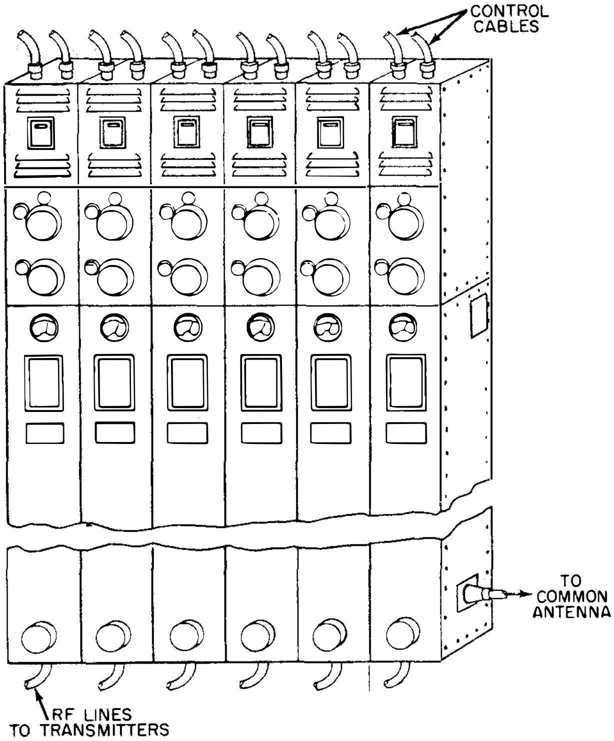
Much research and development are being conducted on multicouplers, and various types have been designed to cover different frequency ranges and to operate with different transmitter models. The information on multicouplers given in this section is of a general nature. Improvements are continually being made, thus equipments described herein will eventually become obsolete. This reasoning is essentially true of all electronic equipment.

### VHF-UHF Multicouplers

One type of VHF-UHF multicoupler (CU-255/UR) is shown in figure 9-40. When six units are used (as shown), a system is provided for operating six transmitters (or transmitter-receiver combinations) into a single antenna. One coupler is required for each transmitter, or transmitter-receiver combination. The frequency range of this particular multicoupler is 230 to 390 mc. Couplers can be tuned manually to any frequency in this range. When used with automatic tuning transmitters, such as AN/GRC-27, they may be tuned automatically to any one of 10 preset channels in this band by dialing the desired channel locally on the transmitter or on a remote channel-selector unit.

Correct adjustment of tuning controls is indicated by the meter on the front panel of the multicoupler. This meter indicates the output from the reflectometer, a device for indicating the magnitude of the power reflected back from the coupling circuit. When controls are adjusted so that the tuning indicator reads zero, it is an indication that the system impedances are properly matched and there is minimum reflected power in the system.

Type CU-332A/UR multicoupler (not shown) is identical to the CU-255/UR just described




1.266
Figure 9-40. —VHF-UHF multicoupler CU-255/UR.

except for the drive mechanism. The CU-332A/UR provides for manual tuning only, whereas the other has both automatic and manual tuning. The CU-332A/UR multicoupler is used with manually tuned UHF equipment, such as the model TED transmitter, or any other manually tuned equipment operating in the 230- to 390-mc frequency range.

The performance characteristics of VHF-UHF multicouplers require that operating frequencies on the common antenna be separated by approximately 15 mc.

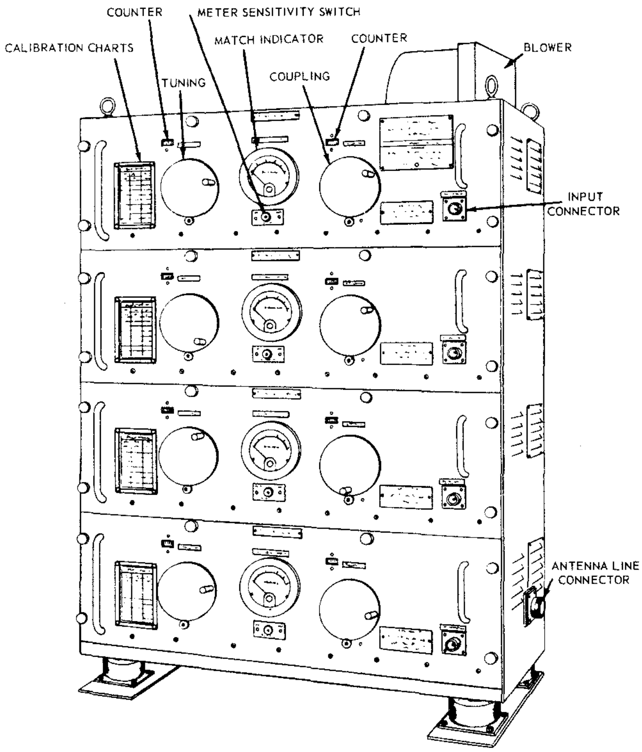
HF Multicouplers

A system of high-frequency antenna multicouplers has been developed for simultaneously operating up to four transmitters into the same antenna in the frequency range of 2 to 26 mc. These antenna couplers are made up into four channel groups. Each group operates in one of the following bands: 2-6 mc, 4-12 mc, 6-18 mc, and 9-26 mc. To obtain complete coverage from 2 to 26 mc, four coupler groups and four broad band antennas are required. These equipments are included here to illustrate the trend toward multicouplers in the HF band.

Four types of HF multicouplers are the AN/SRA-13, -14, -15, and -16. Typical of this group, the AN/SRA-15 coupler. It is illustrated in figure 9-41. It provides for simultaneous operation of four transmitters (each with 500 watts output) into a single broad band antenna. This unit covers the frequency range from 6 to 18 mc. The four transmitters connected to this multicoupler may be operated anywhere in the frequency range from 6 to 18 mc, as long as there is sufficient separation between the operating frequencies. Ten percent of the highest operating frequency is considered sufficient separation.

AN/SRA-23 Antenna Coupler Group

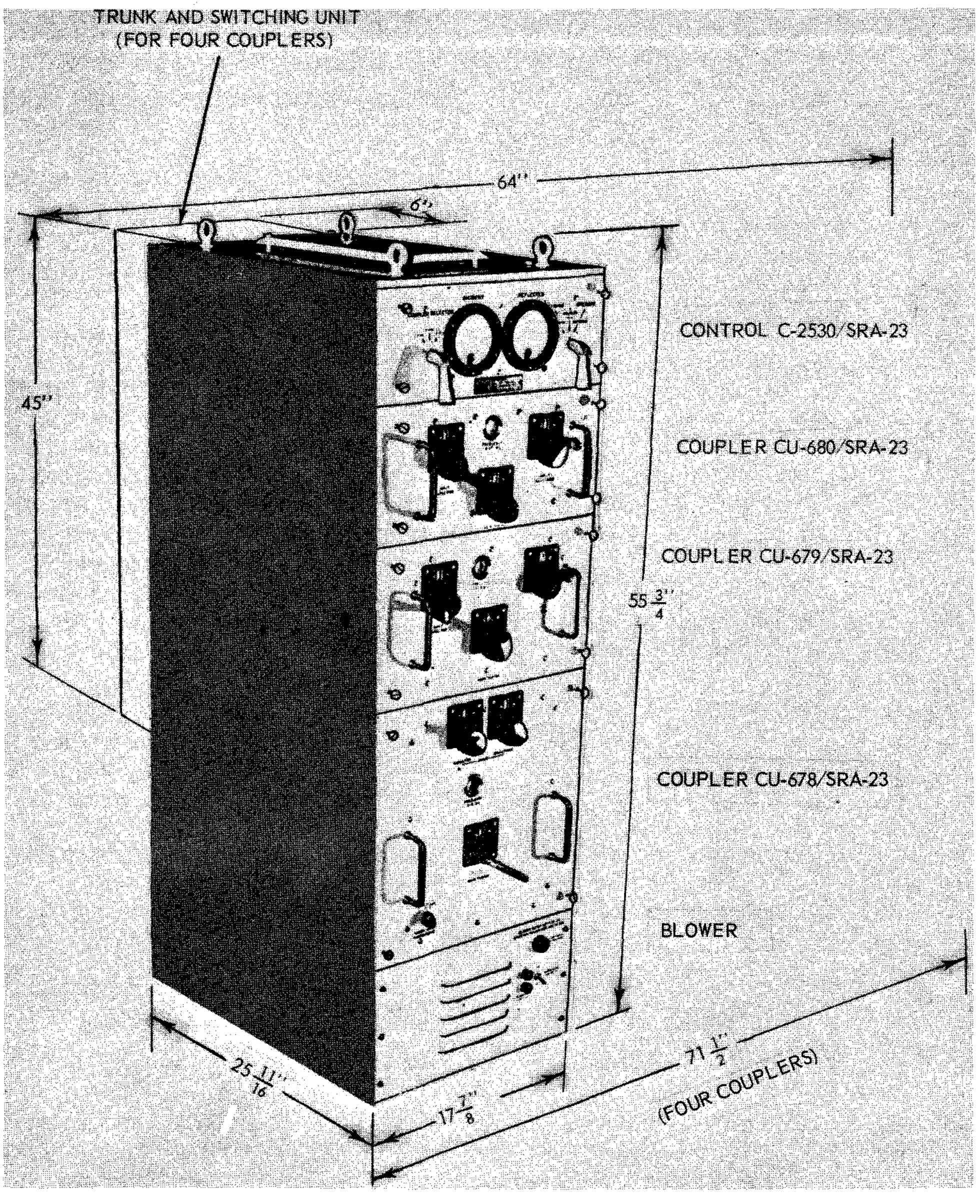
Antenna coupler group AN/SRA-23 permits simultaneous operation of up to eight 500-watt transmitters covering the frequency range of 2 to 27 mc in one broadband antenna system. A minimum frequency separation of approximately 10 percent is provided between channels. For




70.28
Figure 9-41. —Antenna multicoupler AN/SRA-23.

each transmitter in the system, one antenna coupler group is required. The coupler group consists of five major components as shown in figure 9-42. These antenna couplers are similar in principle of operation, but their circuit components differ to provide different frequency ranges. A trunking and switching unit is also supplied for combining four coupler groups into a system. This arrangement provides a switching system for selection of the desired coupler, dummy antenna load, and the desired broadband antenna. By interconnecting two four-group systems back-to-back, a four-group system can be expanded into an eight-group system.

Although the coupler was developed for use with 500-watt transmitters, it is capable of handling transmitters with 1000-watt outputs. For operation with 1000-watt transmitters, the




109.40

Figure 9-42. —Antenna coupler group AN/SRA-23.

incident power meter M401 must be recalibrated for full-scale deflection with 1000 watts of r-f power instead of 500 watts.

## FREQUENCY METERS

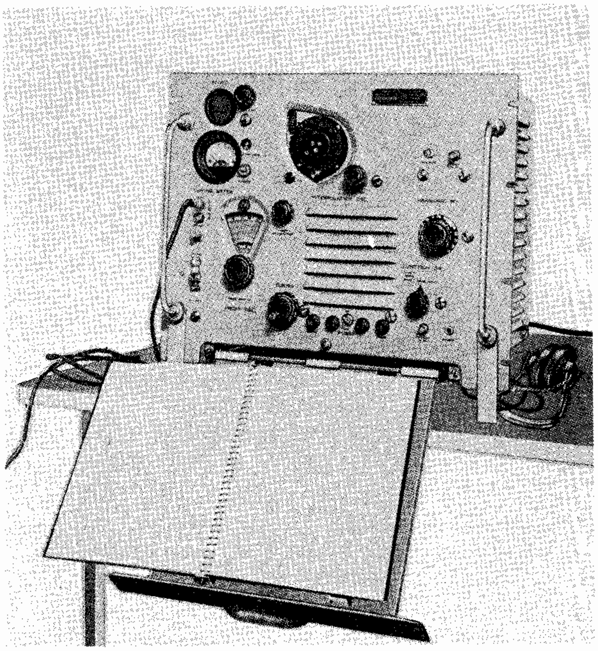
Frequency meters are used to tune transmitters and receivers and to determine the frequency of received signals.

### AN/URM-82 FREQUENCY METER

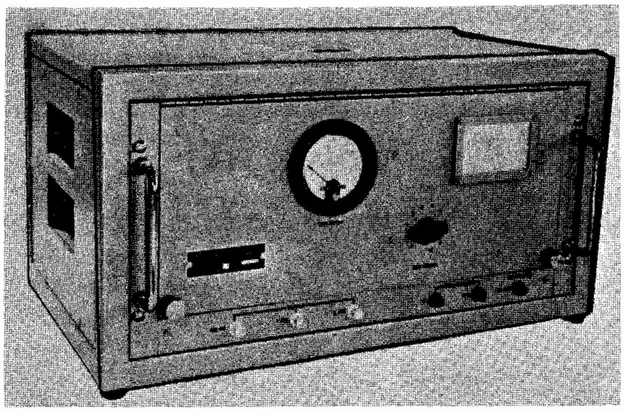
One of the frequency meters now replacing older models is AN/URM-82, shown in figure 9-43. The AN/URM-82 is a precision instrument for measuring frequencies in the range of 100 kc to 20 mc. It is used also to calibrate radio transmitters to an accuracy of .001 percent. Features of the AN/URM-82 include a blinker light and earphones, to provide visual as well as aural indications of zero beat settings. A built-in oscilloscope aids in setting the internal oscillator frequency. The calibration book is fastened to a drawer that slides under the cabinet when not in use.

### AN/URQ-9 FREQUENCY STANDARD

One of the latest frequency standards is the AN/URQ-9, pictured in figure 9-44. This high stable frequency standard is designed for continuous-duty use aboard ships and at shore facilities. It has three fixed output frequencies: 5 mc, 1 mc, and 100 kc.



76.30
Figure 9-43. —Frequency meter AN/URM-82.



120.23
Figure 9-44. —Frequency standard AN/URQ-9.

Because it is intended as a frequency standard against which other frequency-generating equipment can be compared, the AN/URQ-9 is energized and calibrated at special calibration laboratories. Once it is placed in operation and is calibrated properly, the frequency standard must not be turned off. Any interruption in its operation will cause a change in its output frequencies. Hence, the equipment is transferred to the using activity while still operating.

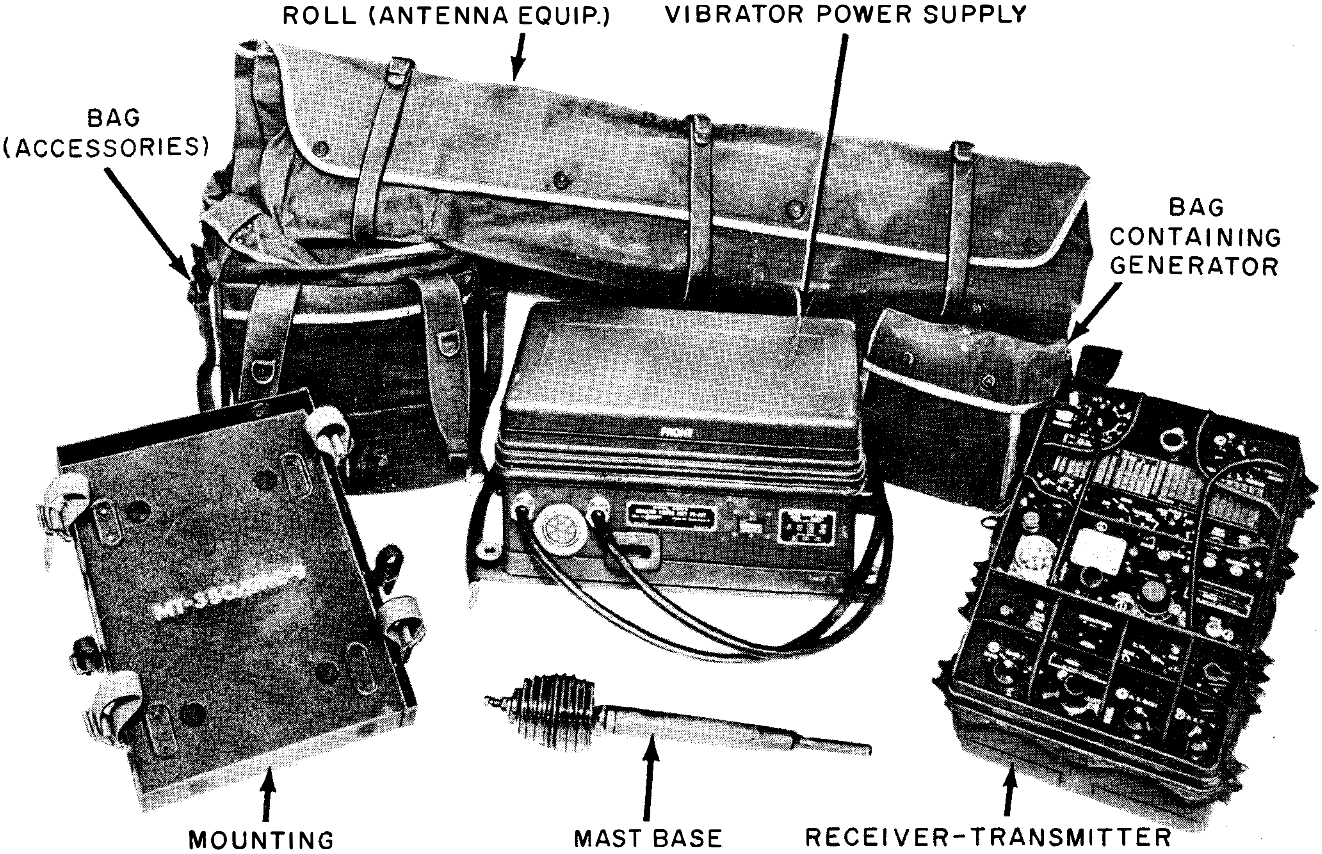
A battery, which is built into the equipment, maintains operation during the time the frequency standard is in transit. It also supplies power to the unit in the event of power failure aboard ship. When fully charged, the battery is capable of operating the equipment for approximately 2 hours.

## EMERGENCY AND PORTABLE RADIO EQUIPMENT

Several models of portable radio equipment are used in the Navy today. Included here are two of them, transceiver AN/GRC-9, and lifeboat transmitter AN/CRT-3.

### TRANSCEIVER AN/GRC-9

Radio set AN/GRC-9, a low-power radio transmitter and receiver, is shown in figure 9-45. It can be used in either vehicular or ground installations. It is carried aboard ship for use by landing parties in communicating with the ship.




76.31

Figure 9-45. —Components of radio set AN/GRC-9.

The AN/GRC-9 receives and transmits CW, MCW, and a-m radiotelephone signals in the 2- to 12-mc frequency range. Provisions are made for six crystal-controlled channels. Master oscillator tuning is also available for any frequency within the band.

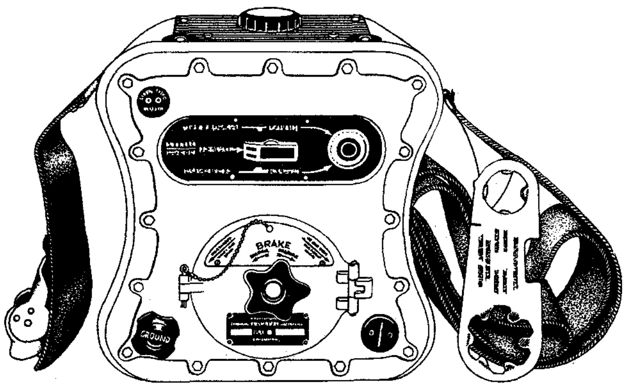
For different kinds of installations, the radio set can be operated with batteries, dynamotors, gasoline-driven generators, or handdriven generators. The output power of the transmitter varies somewhat, depending upon the type of power supply used. When powered by the handdriven generator, for instance, the output is approximately 10 watts CW and 4 watts on phone. Reliable communication range is usually about 30 miles for CW and 10 miles for phone. These values are approximations, because the range varies considerably according to terrain, atmospheric conditions, frequencies, and time of day, month, and year.

The receiver and transmitter are contained in a metal case that has a tight-fitting removable cover. These components are dirtproofed and waterproofed for complete protection while transporting the equipment and when operating under extremely adverse weather conditions.

## LIFEBOAT TRANSMITTER AN/CRT-3

Radio transmitter AN/CRT-3, popularly known as the "Gibson girl," is a rugged emergency transmitter carried aboard ships and aircraft for use in lifeboats and liferafts. It is pictured in figure 9-46. No receiving equipment is included. The transmitter operates on the international distress frequency of 500 kc, and the survival craft communication frequency of 8364 kc.

The complete radio transmitter, including the power supply, is contained in an aluminum cabinet that is airtight and waterproof. The cabinet is shaped to fit between the operator's legs, and it has a strap for securing it in the operating position.




76.32
Figure 9-46. —Emergency rescue transmitter AN/CRT-3.

The only operating controls are a three-position selector switch and a pushbutton telegraph key. A handcrank screws into a socket in the top of the cabinet, The generator, automatic keying, and automatic frequency changing are all operated by turning the handcrank. While the handcrank is being turned, the set automatically transmits the distress signal SOS in Morse code. The code sequence consists of six groups of SOS followed by a 20-second dash, transmitted alternately on 500 kc and 8364 kc. Every 50 seconds the frequency automatically changes.

Distress signals are intended for reception by two groups of stations, each having distinct rescue functions. Direction-finding stations co-operating in long-range rescue operations usually make use of 8364 kc, whereas aircraft or ships locally engaged in search and rescue missions make use of the 500 kc signals. Besides the automatic feature, the transmitter can be keyed manually, on 500 kc only, by means of the pushbutton telegraph key.

Additional items (not shown) packaged with the transmitter include the antenna, a box kite and balloons for supporting the antenna, hydrogen-generating chemicals for inflating the balloons, and a signal lamp that can be powered by the handcrank generator.

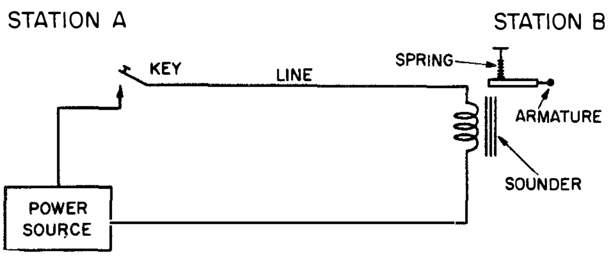
The equipment will float and it is painted brilliant orange-yellow to provide greatest visibility against dark backgrounds.

# CHAPTER 10

# TELETYPEWRITER EQUIPMENT AND OPERATION

## BASIC TELETYPEWRITER CIRCUIT

To see how intelligence is sent by teletype consider one of the simpler devices for electrical communications: the manual telegraph circuit. In this circuit, shown in figure 10-1, are a telegraph key, a source of power(battery), a sounder, and a movable sounder armature. If the key is closed, current flows through the circuit and the armature is attracted to the sounder by magnetism. When the key is opened, the armature is retracted by a spring. With these two electrical conditions of the circuit—closed and open—it is possible, by means of a code, to transmit intelligence. These two conditions of the circuit may be thought of as marking and spacing. Marking occurs when the circuit is closed and a current flows. Spacing occurs when it is open and no current flows.

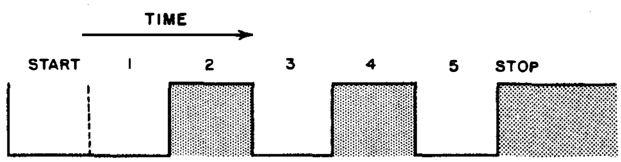



1.196
Figure 10-1. —Manual telegraph circuit.

When a circuit operates on current and no-current basis, as in figure 10-1, it is called a neutral circuit. This type normally is used to operate teletype, although the Navy's machines sometimes operate on a line condition called polar operation. This method of operation refers to the system whereby marking signals are formed by current impulses of one polarity, and spacing signals are formed by current impulses of equal magnitude by opposite polarity. In this chapter discussion of teletype equipment assumes a neutral circuit operation.

## TELETYPE SIGNAL

If a teletype signal could be drawn on paper, it would resemble figure 10-2. Shaded areas show intervals during which the circuit is closed (marking). Blank areas show the intervals during which the circuit is open (spacing). Five of these units are numbered, and are called intelligence units. The first unit is the start pulse and is always a space. The last unit is the stop pulse and is always a mark. A total of seven units are included. Start and stop pulses are a part of every teletype code character. This method of teletype communication—the so-called start-stop method—gets its name from these units. The start-stop method keeps teletype machines and signals in synchronization with each other. With this method the selecting mechanism in the receiving machine comes to a complete stop after each character.




1.197
Figure 10-2. —Mark and space signals in the teletype character R.

Different characters are transmitted from the keyboard by an automatic process that selects various combinations of marking and spacing in the five intelligence units (fig. 10-3). When reading tape, mark and space units match the holes and blank spaces on the tape. The reason is that holes in the tape allow the transmitter distributor pins to rise, sending a marking pulse. No holes in the tape prevent sensing pins from rising, thereby preventing marking impulses. Thus we have spacing intervals. The machine, without benefit of tape perforations, automatically takes care of start and stop elements.

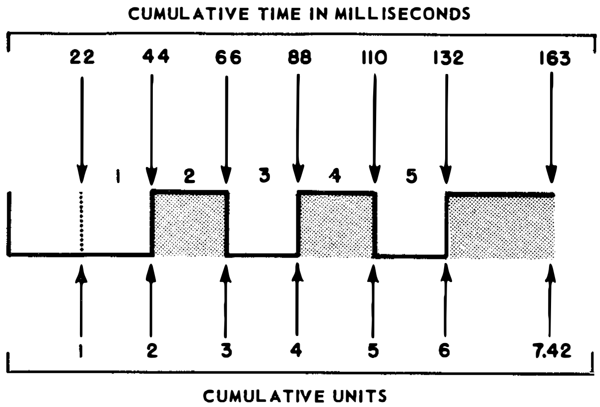
| FIGURES | - | ? | : | $ | 3 | ! | & | | 8 | ' | ( | ) | . | , | 9 | Ø | 1 | 4 | BELL | 5 | 7 | ; | 2 | / | 6 | " | BLANK | LETTERS | FIGURES | SPACE | CAR RET | LF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| LETTERS | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | | | | | | |
| NUMBERS INDICATE MARKING IMPULSES | 1 | 1 | | 1 | 1 | 1 | | | | 1 | 1 | | | | | | 1 | | 1 | | 1 | | 1 | 1 | 1 | 1 | | 1 | 1 | | | |
| | 2 | | 2 | | | | 2 | | 2 | 2 | 2 | 2 | | | | 2 | 2 | 2 | | | 2 | 2 | 2 | | | | | 2 | 2 | | | 2 |
| | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o | o |
| | | | 3 | | | 3 | | 3 | 3 | | 3 | | 3 | 3 | | 3 | 3 | | 3 | | 3 | 3 | | 3 | 3 | | | 3 | | 3 | | |
| | | 4 | 4 | 4 | | 4 | 4 | | | 4 | 4 | | 4 | 4 | 4 | | | 4 | | | | 4 | | 4 | | | | 4 | 4 | | 4 | |
| | | 5 | | | | | 5 | 5 | | | | 5 | 5 | | 5 | 5 | 5 | | | 5 | | 5 | 5 | 5 | 5 | 5 | | 5 | 5 | | | |

1.198

Figure 10-3. —Mark and space combinations for characters on the teletype keyboard.

A total of 32 combinations can be obtained from the 5 intelligence units, but, by using uppercase and lowercase, the number of characters obtainable is greatly increased. When a teletype printing mechanism is shifted to uppercase as a result of receiving a FIGS shift character, all succeeding characters received before a LTRS shift character print in uppercase—as numerals and punctuation marks. The machine does not, however, make such double use of all 32 possible combinations, because 6 are used for the functions of carriage return, line feed, figures shift, letters shift, space, and for one normally unused blank key. This usage leaves 26 of the 32 that can be employed in both uppercase and lowercase. When the 6 special functions are added, the total is 58, which is the number of characters and functions that can be sent from a teletypewriter keyboard.

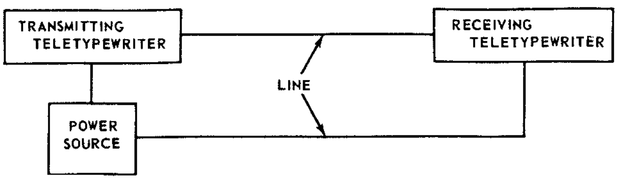
Examine figure 10-2 once more. Theoretically this diagram represents a perfect signal. The quality of each element remains the same during its transmission, and the shift from marking to spacing (and vice versa) is instantaneous. These changes are called transitions. They occur at the beginning and end of each of the solid blocks. Some are mark-to-space transitions, and others are space-to-mark transitions. For some other character combination a transition may occur between "start" and intelligence unit 1, but in any transmitted character there can be only 2, 4, or 6 transitions. Notice that the first 6 units of the signal are the same length, but the 7th (stop) unit is longer. Each of the first 6 units requires 22 msec of circuit time for transmission. This timing is based on a transmission speed of 60 words per minute. In teletype operating 75 or 100 wpm the times for all 7 units are reduced proportionally. The stop unit requires 31 msec. If a value of 1 is assigned to each of the first 6 units, then the stop unit has a value of 1.42. The total number of units in letter R (or any other teletype character) is 7.42, requiring a transmission time of 163 msec. No allowance is made for transition time, because a transition has zero time duration. See figure 10-4.




1.199

Figure 10-4. —The 7.42-unit teletype signal.

The telegraph circuit in figure 10-1 can be converted to a simple teletype circuit by substituting a transmitting teletype machine for the key at station A, and a receiving teletype machine for the sounder at station B. This arrangement is shown in figure 10-5.

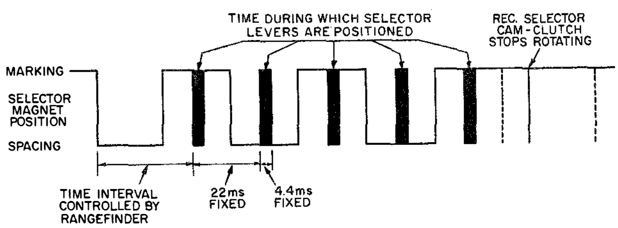



1.200

Figure 10-5. —Simple teletype circuit.

Transmitter contacts are actually a set of mechanically controlled switches that can produce a different combination of the 7.42-unit signal for any letter or function lever depressed. As we have just seen, each character consists of a 22-msec spacing unit functioning as a start pulse to release the receiving mechanism, plus five 22-msec intelligence pulses—either marking or spacing—and a 31-msec marking pulse used to stop the receiving mechanism.

The selector magnet of the receiving teletype mechanically releases a start lever when the start pulse is received, thus allowing the selector cam-clutch to rotate through 1 revolution. During this revolution, 5 selector levers in the selector unit are positioned by the operation or release (marking or spacing) of the selector magnet armature as determined by each intelligence pulse received. The time required to position each selector lever is approximately 20 percent of the time of 1 intelligence pulse, or 4.4 msec. This time, again, is based on a teletypewriter running at 60 wpm. Cams on the selector cam-clutch are so located that the time between each selector lever operation is fixed at 22 msec. During 4.4 msec of the first pulse the first selector lever is positioned; during 4.4 msec of the second pulse the second selector lever is positioned, and so forth until all 5 selector levers are positioned. (See fig. 10-6.) These selector levers control the internal mechanism of the teletypewriter so as to select and (at the proper time) print the correct character.




1.201

Figure 10-6. —Selecting intervals for letter Y.

## Bauds and Words-Per-Minute

Heretofore most discussions of teletype speed have been in terms of how many words-per-minute are transmitted. Now a more technically accurate term "baud" is being used.

The baud is officially designated as the unit of modulation rate. One baud corresponds to a rate of 1 unit interval per second. Hence, to find the modulation rate of a signal in bauds, figure 1 is divided by the time duration of the shortest unit interval present in the signal. For example, 22 msec (.022) is the time interval of the shortest unit in the 7.42-unit code at 60 words-per-minute (wpm). To find the number of bauds corresponding to 60 wpm, divide .022 into 1. Rounding off the results of this division gives the figure 45.5, which is the baud equivalent of 60 wpm.

At 100 wpm, the teletype operating speed is increased, and the signal unit time interval is decreased. An operating speed of 100 wpm is 74.2 bauds, and a speed of 107 wpm is 75 bauds—the ultimate goal for Navy teletype operation.

Conversion formulas for baud operations are as follows:

$$\text{Baud} = \frac{1}{\text{Unit interval}}$$

$$\text{WPM} = \frac{\text{Baud}}{\text{Unit code x 0.1}}$$

Many modern teletype systems utilize a stop pulse of the same length as start and information pulses. With all 7 pulses the same duration, the system would be operating with a 7.00-unit code.

The present standard for naval communications is the 7.42-unit code. In the future, however, a change is expected, to the 7.00-unit code. It should be understood that these two codes are fully compatible and will interoperate without loss of range at the receiving machine if their baud rates are consistent. For example, 100 wpm (7.42-unit code or 74.2 baud) and 106 wpm (7.00-unit code or 74.9 baud) are nearly the same baud rate, hence they will interoperate without a noticeable loss of range.

## Distortion

An ideal teletype circuit reproduces signals at the receiving end exactly as they are impressed at the sending end. Unfortunately, this ideal signal seldom happens under actual operating conditions. The reason is that signal units have a way of lengthening and shortening as they travel along the circuit. This lengthening and shortening of marks and spaces occurring during transmission reduces the quality of the signal, and is called distortion. Four fundamental types of distortion adversely affect fidelity of teletype signals.

1. Bias distortion is the uniform lengthening or shortening of the mark or space

elements, one at the expense of the other. This process means that the total time for one mark and one space never changes; only the length of the mark or space element changes. If the mark is lengthened, the space is shortened by the amount the mark is lengthened. Bias distortion may be caused by maladjusted teletypewriter line relays, detuned receivers, or a drift in frequency of either the transmitter or receiver.

2. Fortuitous distortion is the random displacement, splitting, or breaking up of the mark and space elements. It is caused by such things as crosstalk interference between circuits, atmospheric noise, powerline induction, poorly soldered connections, lightning storms, and dirty keying contacts.
3. End distortion is the uniform displacement of mark-to-space signal transitions with no significant effect on space-to-mark transitions. It is caused by the combination of resistance, inductance, and capacitance in the circuit.
4. Characteristic distortion is a repetitive displacement or disruption peculiar to specific portions of the signal. It normally is caused by maladjusted or dirty contacts of the sending equipment. It differs from fortuitous distortion in that it is repetitive instead of random. An example would be the repeated splitting of the third code element of a teletypewriter signal.

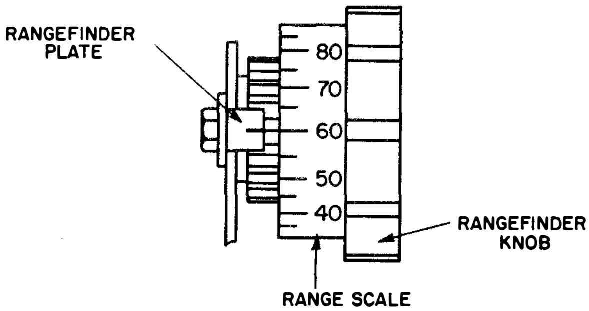
The components of distortion, with their causes and effects, have been defined here only briefly. The proper recognition, identification and correction of signal distortion is a job for maintenance personnel, using special test equipment designed for the purpose.

Orientation Rangefinder

Every teletypewriter has an orientation rangefinder. By means of the rangefinder scale, an operator can set the machine at the range of best signal reception. Low equipment range indicates only a lowered operating margin. It does not clearly indicate whether the cause is distortion or a badly adjusted teletypewriter.

Refer again to figure 10-2, illustrating the signal for letter R. Each unit or element is perfect in every respect. To print letter R, the selector mechanism could be set to operate on any 20-percent portion of each unit, and perfect copy would result. Under actual conditions, a signal is never so perfect, nor is a teletypewriter expected to operate over the entire range of the rangefinder scale. Rarely is more than 70 percent of the scale usable by the selecting mechanism. Consequently, the selection point of the rangefinder scale must be positioned so that the best portion of the element is used by the selecting system.

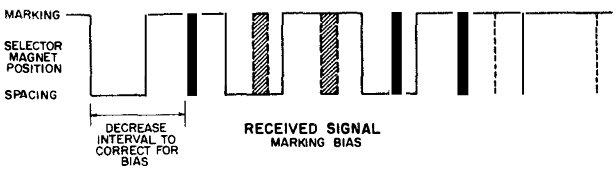
The rangefinder in figure 10-7 is located on the right side of the page printers and at the right front of the reperforators. In this type of rangefinder, the range scale is moved by rotating the rangefinder knob. The indicator mark on the rangefinder plate is the reference point for reading the scale. The following discussion applies to all types of rangefinders.




1.202

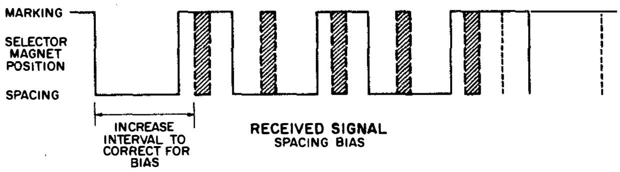
Figure 10-7. —Orientation rangefinder.

Points on the scale (0 to 120) divide the first unit of the signal only, not the entire signal. When adjusting the rangefinder, shift the selection point of the first unit with respect to the starting unit. Figures 10-8 and 10-9 illustrate this adjustment. Because all other units of the signal follow at 22-msec intervals, this shifting amounts to adjustment or orientation of the entire signal to the start pulse. Shifting the point of selection simply means the first black bar shown in figure 10-6 is moved back and forth across the first signal unit, looking for the most suitable position. The scale goes up to 120, hence an operator can shift far enough so that the selection interval moves entirely off the unit. Even if the signal were perfect, the finder still could be shifted far enough to produce errors. The object is to place the selection interval on that portion of the unit that will give the selecting mechanism a maximum margin of safety while selecting that unit and the four that follow. Chance of error is least with the selection point midway between the transitions.




1.203

Figure 10-8. —Signal with marking bias.




1.204

Figure 10-9. —Signal with spacing bias.

To determine the range limits, the finder is adjusted at the two extreme positions—at the lower and the upper end of the scale. In each position, observations are made of the typed record and a reading is taken when about one error is typed per line of copy. This ratio means about 1 error in 69 characters. Orientation ranges on properly adjusted teletypewriters, for different degrees of signal distortion, are given in the accompanying list.

| | Points |
|---|---|
| Very little distortion | 80 |
| Moderate distortion | 60-70 |
| Average distortion | 50 |
| Large distortion | Less than 40 |

As shown in figure 10-7, orientation range limits—with practically perfect signals and a teletypewriter in good condition—should be 15 and 95. In this instance, best operating results are obtained when the finder plate of the receiving teletypewriter is set at the midpoint (60) of this range.

Actually, the orientation range is determined twice: first, range of the machine (local range), then range of machine when connected to the line (line range). Setting of the finder arm is the midpoint of the sum of these two ranges.

The orientation range is obtained locally by using keyboard signals or by running a test tape through the transmitter distributor. Normally, letters R and Y are used because they give a complete reversal of impulses. Letter R is S-M-S-M-S; letter Y is M-S-M-S-M. (Other characters, such as S and G, can be selected and will also give a complete reversal of impulses.) If the range is not less than about 70 points (from about 20 to 90 on the scale), it may be assumed that the machine is satisfactory.

The difference between range determined by local test and corresponding range obtained when receiving signals over a line represents the reduction in margin due to signal distortion. The reduction is a direct measure of total signal distortion.

The manner in which typed errors occur in the neighborhood of the orientation limits may give indication of the nature of the distortion. If limits are fairly definite (copy changes from good to bad when the rangefinder is moved only a small distance) bias or distortion due to speed variations or faulty apparatus is present. If there is a certain range at each limit, over which certain characters are consistently in error, it is characteristic distortion. If limits are not definite—that is, there is a range over which errors occur, and errors do not occur consistently on certain characters—this situation indicates fortuitous distortion.

As a general rule, characteristic and fortuitous distortion cause reduction of the range at both limits. On the other hand, bias affects one range more than the other. Marking bias reduces the upper range limit; spacing bias reduces the lower range limit.

Maintenance men sometimes test distortion tolerance of a teletypewriter by applying predistorted signals. Predistortion ranges from zero to 40 percent. A well-adjusted machine types correctly when signals from a test set are distorted as much as 35 percent.

Normally, rangefinding a teletypewriter is not an everyday occurrence. It usually is performed in conjunction with maintenance of the machine. Unless something goes wrong with the circuit, rangefinding is done during maintenance periods. When rangefinding a machine, care must be taken that the machine is in good adjustment, and that range limits are read accurately.

## CIRCUIT TYPES

The word "circuit" is used in two senses in the Radioman's work. First, in the electrical sense: a continuous conductor for the flow of electrons; second, in the communication sense: a path between two or more points, capable of providing one or more channels for the transmission of intelligence. In the discussion of teletype operation, concentration is on the communication sense of the word.

A duplex circuit is a circuit between two stations that permits uninterrupted exchange of information by employing two separate electrical paths. Each station may transmit and receive simultaneously. The term full-duplex sometimes is substituted for the term duplex.

A half-duplex circuit is a single electrical path used for transmitting information from one station to another. The circuit has no provision for the exchange of information, but may comprise any number of receiving stations. Each station receives only or transmits only, depending on its intended function. Fleet broadcast is an example of a half-duplex circuit.

A simplex circuit embraces features of both the duplex and half-duplex type of circuits. The simplex circuit consists of a single electrical path over which two or more stations may exchange information. Any station may transmit and receive, but not simultaneously.

In studying amplitude modulation in chapter 9, it was learned that whenever a carrier is modulated, two sideband frequencies are produced that carry the intelligence present in the audiofrequency. Only one sideband is necessary for transmission of the signal. A transmitter in which the carrier has been suppressed may be used to send a separate message on each sideband. Messages from the two audio channels are made to modulate the same carrier, but modulation takes place in different modulators.

The output of the two modulators contains sidebands formed by heterodyning the individual audio signals with a common carrier suppressed in the output. The filters remove the lower sideband from one modulator output and the upper sideband from the other. Thus, each of the two sidebands conveys a separate message and may be used as a separate channel. At the receiving end, the carrier frequency is reinserted and the intelligence recovered.

As used in the Naval Communication System, up to 16 teletypewriter channels are transmitted through a frequency multiplexing system on one sideband of each SSB circuit. Frequency multiplexing is a process for including multiple sets of transmissions on a single bandwidth by crowding or "stacking" the individual frequencies.

To give added range to landline transmissions, repeaters are inserted in the line to renew the strength of weak signals as they pass through the wire. Repeaters are of two kinds. First, there is the "straight" repeater, which strengthens (amplifies) the signal just as it is received. Unfortunately, this type of repeater also amplifies any interference the signal may have picked up along the wire.

The other repeater is the "regenerative" type. It builds, or regenerates, an entirely new signal from one that is worn out or distorted, and eliminates the interference. Both types of line repeaters retransmit signals automatically, using a local source of power. They may be placed at the end of the line (terminal).

Repeaters cannot be used with RATT transmissions. Radioteletype is further handicapped by the same atmospheric disturbances that sometimes hamper radiotelegraph communications. Although RATT transmits on radio waves instead of wires, the basic equipments are the same as those used in landline teletype operation. The difference is that RATT requires transmitters and receivers to send and pick up signals.

## TELETYPEWRITER

A teletypewriter is little more than an electrically operated typewriter. The prefix "tele" means "at a distance." Coupled with the word "typewriter" it forms a word meaning "typewriting at a distance." By operating a keyboard similar to that of a typewriter, signals are produced that print characters in page form, called hard copy.

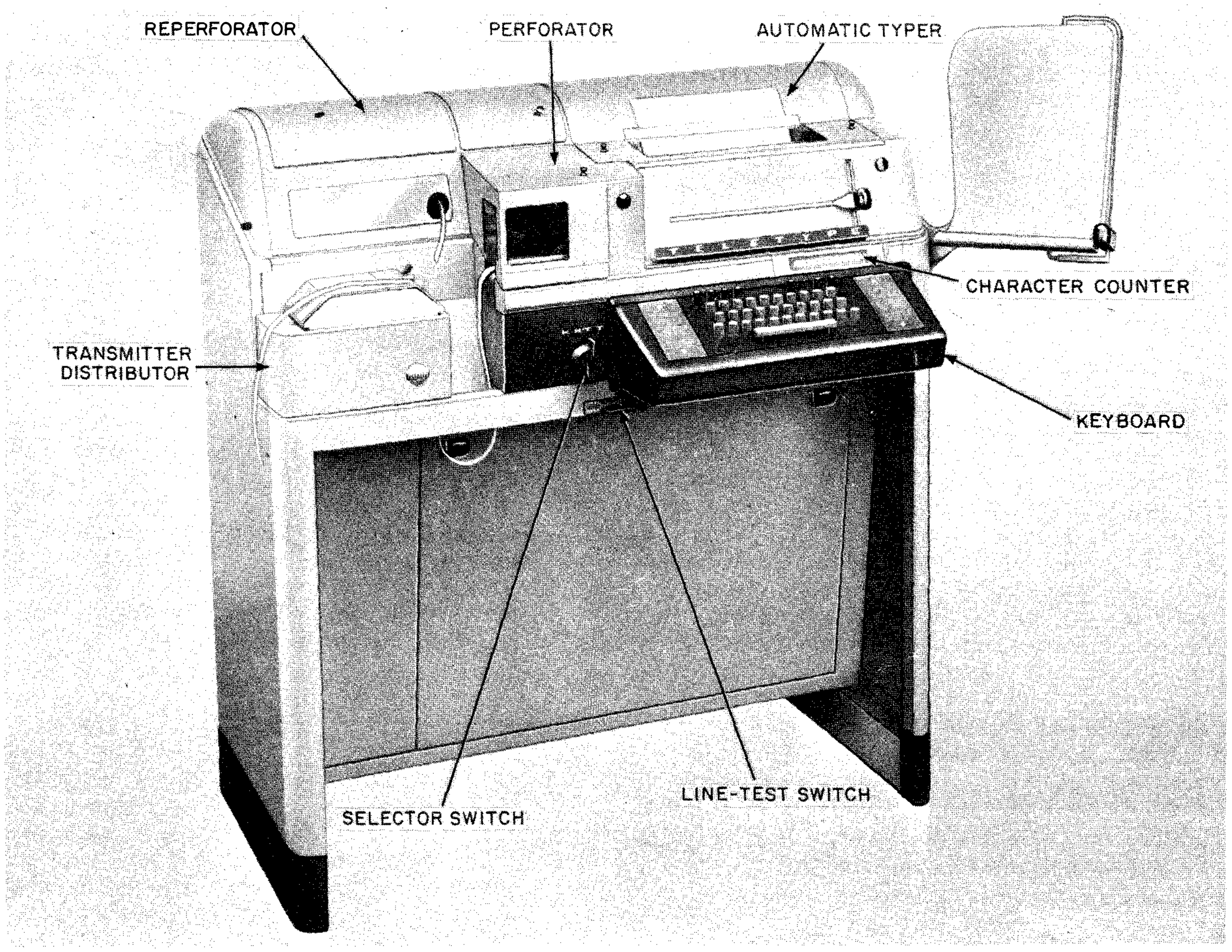
Teletypewriter characters appear at both sending and receiving stations. In this way, one teletypewriter will actuate as many machines as may be connected together. An operator transmitting from New York to Boston will have his message repeated in Boston, letter by letter, vitually as soon as it is formed in New York. The same procedure applies at all receiving stations that tie into the network. Some of the common teletype equipments are described in this section of the chapter. Model AN/UGC-6 is described first and in more detail because it incorporates all functions of the other equipments.

## MODEL AN/UGC-6

Although discussion in this chapter is confined principally to the AN/UGC-6, the reader should understand the similarity between this and other models in the series. For example, the essential difference between AN/UGC-6 and AN/UGC-5 is that the latter model does not include the typing reperforator. The AN/UGC-7 differs from AN/UGC-6 in that it has a weather keyboard (discussed later) The type box in the automatic typer unit and the type wheel in the typing perforator also have weather symbols to match the keyboard. Like the AN/UGC-5, the AN/UGC-7 does not have a reperforator. Model AN/UGC-8 resembles the AN/UGC-7, except that it has a typing reperforator included.

Equipment nomenclature is changed as a result of changes in basic components. Additionally, nomenclature changes depend upon the type of a-c motor installed. The AN/UGC-6, for instance, has synchronous a-c motors. With series governed motors (required for some installations), the model designation is changed to AN/UGC-6X.

The AN/UGC-6 teletypewriter (fig. 10-10) is a versatile communication equipment. It receives messages from the signal line and prints them on page size copy paper. In addition to




31.29A

Figure 10-10. —The AN/UGC-6 teletype.

this feature, it can receive messages and record them on tape in both perforated and printed form. With page-printed monitoring, the teletypewriter transmits messages that are originated either by perforated tape or by keyboard operation. It mechanically prepares perforated and printed tape for separate transmission with or without simultaneous transmission and page-printed monitoring.

The teletype set includes the following components: a cabinet, a keyboard, an automatic typer, a typing perforator, a transmitter distributor (TD), a typing reperforator, and power distribution panels. In operation, the components are linked together by electrical or mechanical connections to offer a wide range of possibilities for sending, receiving, or storing teletype messages. All equipment components are housed in the cabinet. Transmission signals are initiated through the keyboard or the transmitter distributor. Signals are received on the automatic typer, on which local transmission can also be monitored. The typing perforator and typing reperforator are devices for preparing tapes on which locally initiated or incoming teletypewriter messages can be stored for future transmission through the transmitter distributor.

The keyboard, typing perforator, automatic typer, and transmitter distributor are operated by the motor mounted on the keyboard. Selection of these components for either individual or simultaneous operation is by the selector switch located at the front of the cabinet, to the left of the keyboard. All these components are connected in series in the signal line, but the selector switch has provisions for excluding various components from the line. The external signal line is connected to the equipment through a line-test switch located below the selector switch on the front of the cabinet. This switch provides a means of disconnecting the equipment from the line for local testing of the components. The typing reperforator is operated by a separate motor and power distribution system. It also is connected to a separate external signal line.

Major components of the AN/UGC-6 send-receive console are described and illustrated in greater detail in ensuing topics.

### Keyboard

The keyboard (fig. 10-11) actually is a keyboard and a base combined. It provides a foundation for the motor, automatic typing unit, and typing perforator. It also supports the tape container and character counter used in connection with the typing perforator, gears for operating the automatic typer, flexible connections for operating the typing perforator and transmitter distributor, and a three-position selector switch for choosing the mode of operation of the equipment.

Two types of keyboards are used: communication and weather. The communication keyboard contains letters and punctuation marks common to the standard typewriter. The weather keyboard provides necessary symbols for transmission of weather data. Similarities and differences in the two keyboards are illustrated in figure 10-12. Observe that the lowercase characters are the same, and that letters of the alphabet appear in the same positions. The difference lies in the uppercase of the bottom two rows. A trained operator can use either the communication or weather keyboard without loss of speed or efficiency.

Figure 10-13 is another illustration of the communication keyboard, with emphasis placed on the function keys. A description of the action performed by the function keys follows.

1. The space bar, located at the front of the keyboard, is used to send spaces (as between words).
2. The carriage return key is used to return both the type box carriage and the printing carriage to the left to start a new line of typing.
3. When depressed, the line feed key causes the paper to feed upward one or two spaces, depending upon the position of the single-double line feed lever located on the typing unit.
4. The figures key is pressed to condition the machine for printing figures, punctuation marks, or other uppercase characters.
5. The letters key is used to condition the machine for printing the letters (lowercase) characters.
6. Operation of the bell key (which is uppercase action of the S key) causes a signal bell to ring locally and at distant stations.
7. Depressing the blank key twice (effective in either uppercase or lowercase) locks all keyboards in the circuit and renders them inoperative by setting up the receive condition. Restoration to the send condition is accomplished, under individual

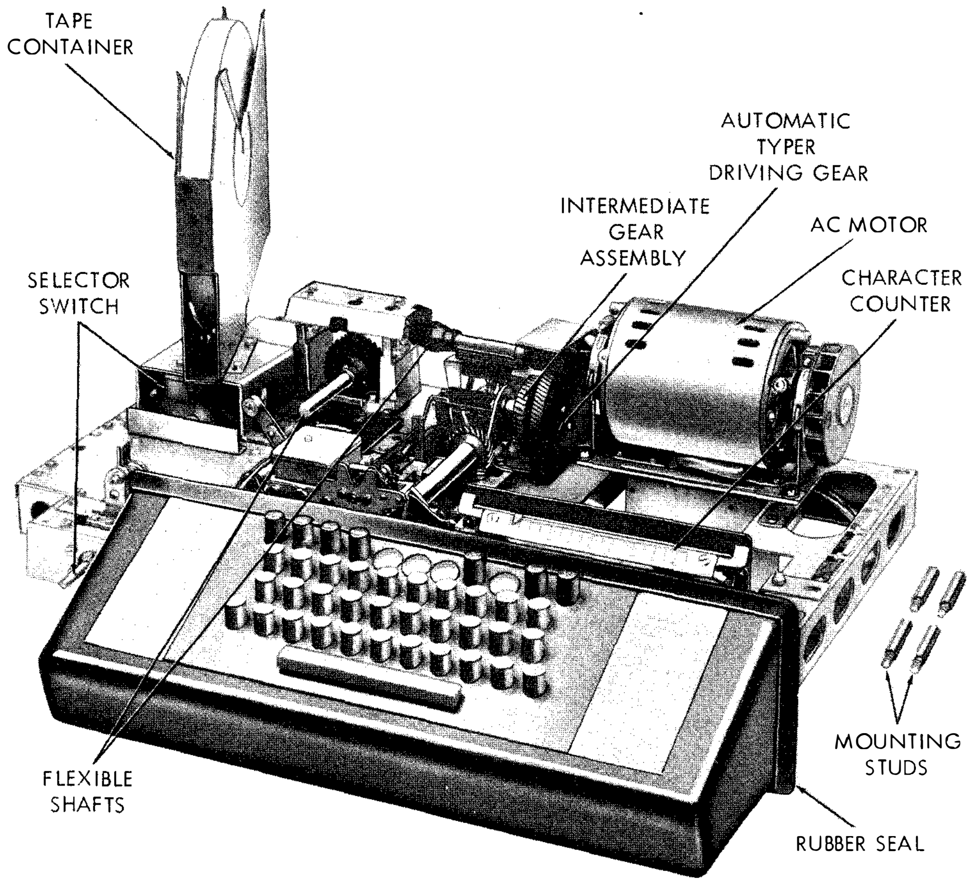



Figure 10-11. —Keyboard unit. 50.92

circumstances, through operation of the KBD UNLK key by the operator desiring to send from his keyboard.

8. To stop (break) another station's sending, depress the BREAK key for about 3 seconds. This action causes the KBD LOCK key to drop and lock keyboards on both sending and receiving machines. After a break it is necessary to operate the KBD UNLK key to free the keyboard for sending.
9. To repeat a character, depress the character key and the REPT key. The character will be repeated automatically at line speed so long as the repeat key is held down.

The five keys described next perform their functions only on the machine on which the key is operated (referred to as "local machine"), without affecting any other machine on the line.

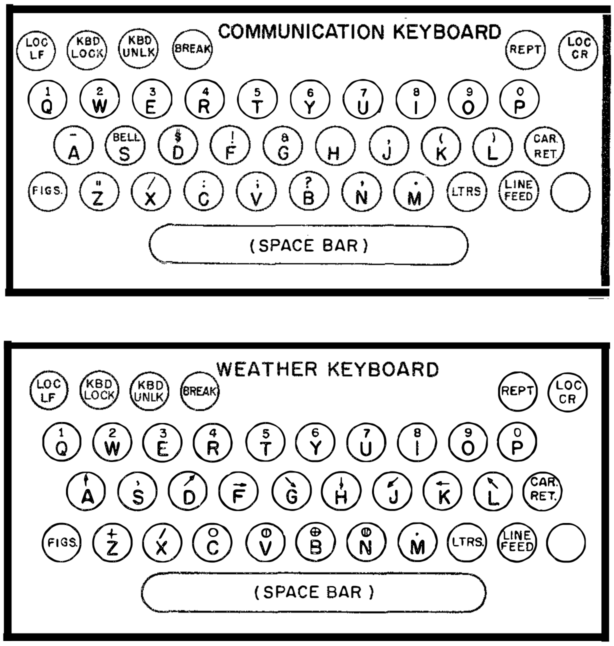
10. To feed the paper up in the local machine, depress the LOC LF key. This action feeds the paper up automatically and rapidly as long as it is held down. This key is for use in locally feeding up paper to tear off a message not fed up far enough by the transmitting station. It also is used when inserting a new supply of paper in the machine.
11. To lock the keyboard on the local machine, depress the REC key. The keyboard is now inoperative until released by the SEND key. The SEND key also drops automatically when the power switch is turned off, when the BREAK key is operated, or when a break is received. In some equipment this key is called the keyboard lock key (KBD LOCK).
12. To unlock the keyboard on the local machine, depress the SEND key. This action

raises the REC key, making the keyboard operative. Operate this key after turning on the power switch and after sending or receiving a BREAK. On some equipment this key is called the keyboard unlock key (KBD UNLK).

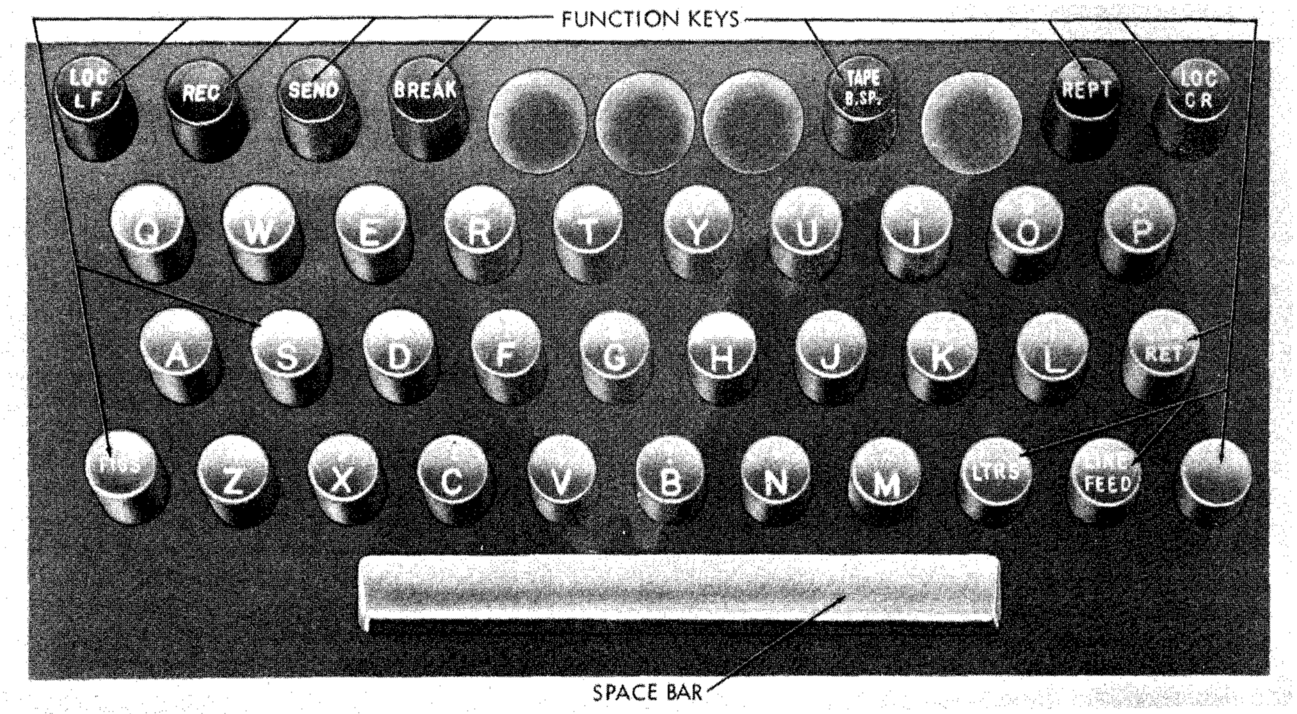
13. Depressing the tape backspace key reverses the direction of tape feed in the perforator by one space. It is used when correcting errors in tape preparation. Only equipment with perforators have this key.
14. To return the type box to the left margin on the local machine, depress the LOC CR key. This key is for use in omission of carriage return at the end of a transmission from another station.

### Typing Unit

The typing unit is shown in figure 10-14. Printing is produced by the type box, which contains the characters and symbols shown on the key tops. Operation of keys and space bar moves the type box across the platen from left




31.23
Figure 10-12. —Two types of teletype keyboards.

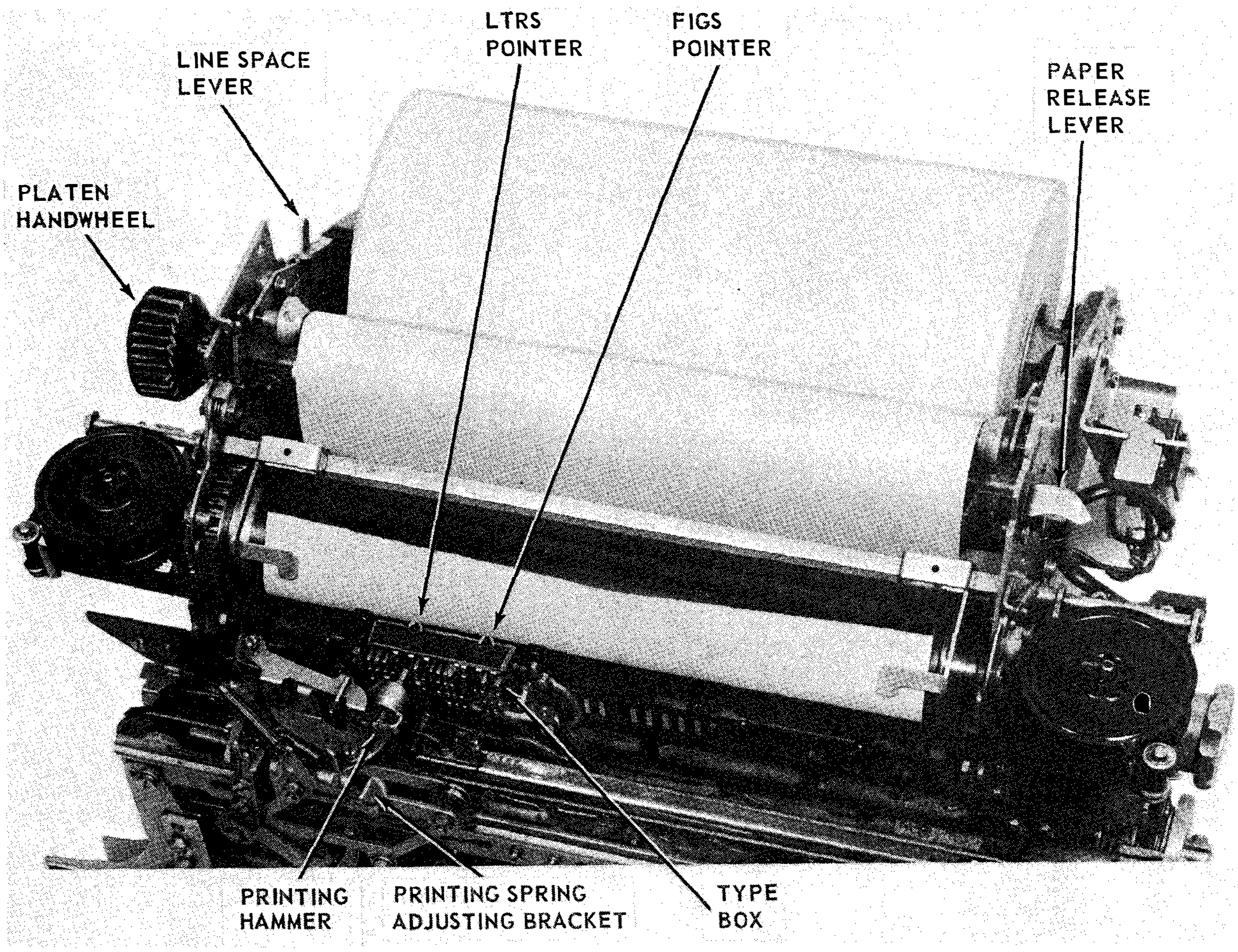



50.93
Figure 10-13. —Teletype keyboard, with emphasis on function keys.

to right. On each key stroke the type box is moved into position for the printing hammer to strike the proper type pallet, printing the character on the paper. Operation of the CAR RET key returns the type box to the left margin, and operation of the LINE FEED key moves the paper up to the next line.

The force of the printing blow is controlled by the printing spring adjusting bracket, which is set for the individual service requirement according to number of carbon copies required. Notch 1 is for one to three copies, and notch 2 for four or five copies. If copies are either too light or too dark, the force of the printing blow can be adjusted by moving the printing spring adjusting bracket, taking care not to make the printing blow any heavier than necessary to product satisfactory copies. Care should be exercised when moving the printing spring adjusting bracket higher than notch 1. Notches 2 and 3 causes more wear and tear of the ribbon, which causes excess residue in the printer.

Type pallets are arranged in four rows. The type box moves up and down in selecting the row in which is located each character to be printed. Lowercase characters are in the left half of the box; uppercase characters are in the right half. The type box moves left and right on shifting and unshifting operations, rather than in the familiar up-and-down motion of carriage shifting on the typewriter and older teletype. This combined vertical and horizontal motion brings the character to be printed into




1.218

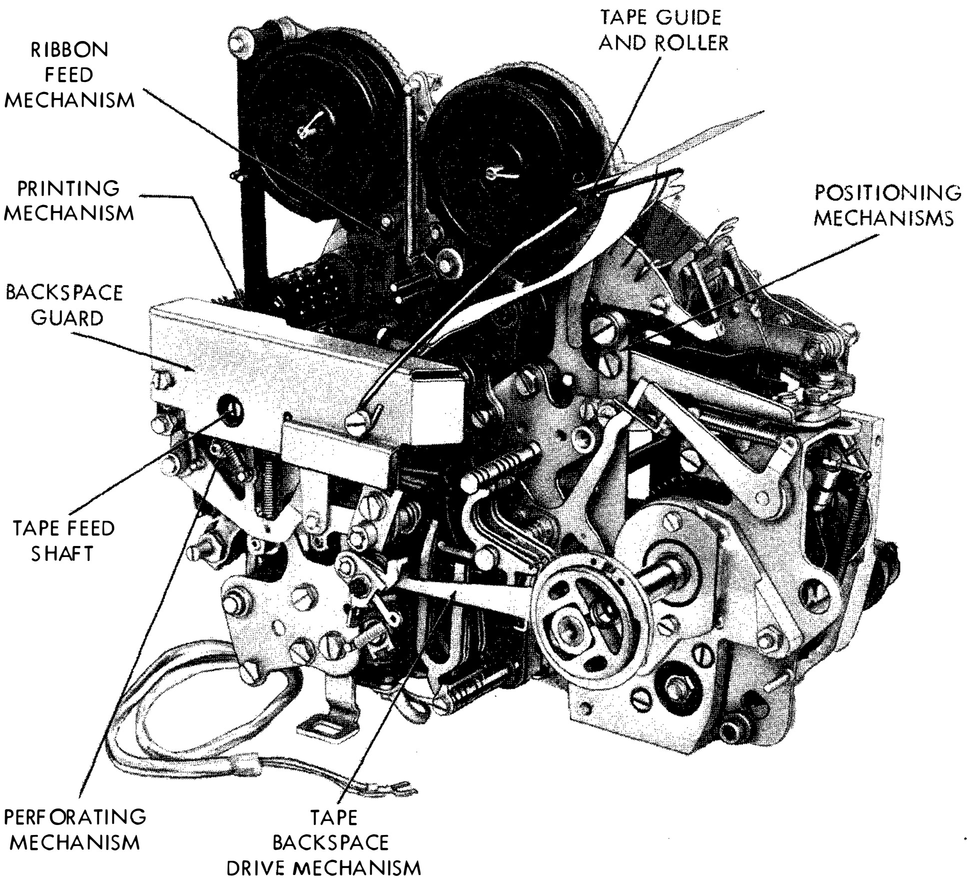
Figure 10-14. —Teletype typing unit.

line with the printing hammer. There are two pointers on the type box, the LTRS pointer on the left and the FIGS pointer on the right. When typing stops, the pointer at which the printing hammer is aimed indicates where the next character will be printed. If the printing hammer is aimed at the LTRS pointer, the type box is in lowercase. If the printing hammer is aimed at the FIGS pointer, the type box is in uppercase. An operation shifting the type box to uppercase or lowercase moves the corresponding pointer to the typing location.

Typing Perforator

Tape perforation by operation of the keyboard is accomplished by the typing perforator (fig. 10-15). The perforator is controlled by mechanical linkages to the keyboard, and is powered through flexible connections and a shaft by the a-c motor mounted on the keyboard. The tape produced by the perforator is a chadless, perforated tape with printed characters corresponding to the perforated code. Printing and perforating occur simultaneously, but the characters are printed six spaces to the right of the corresponding code combinations. Tape is supplied from a container mounted at the left rear corner of the keyboard.

Printing is accomplished by a type wheel that is controlled by positioning mechanisms and a hammer for driving the tape and an inked ribbon against the type wheel to imprint to selected characters. The positioning mechanisms select the proper characters by moving the type wheel in accordance with mechanical arrangements in the keyboard. The type wheel is retracted at the end of each operation, so that the last printed character is visible to the operator.




50.98

Figure 10-15. —Typing perforator (front view).

A perforating mechanism steps the tape, rolls in feed holes, and perforates chadless code holes corresponding to the code selected in the keyboard.

A backspace mechanism is wired electrically to the backspace key on the keyboard. Depressing the backspace key energizes a magnet that actuates the mechanism and backs the tape out of the perforator a distance of one character space. This action facilitates correcting errors in tape preparation.

### Typing Reperforator

The typing reperforator (located in the top left compartment of the cabinet) is similar to the typing perforator, with identical subassemblies for the typing and perforating mechanisms. (See fig. 10-16.) The main difference between the perforator and the reperforator is that the reperforator is not controlled by the keyboard. Instead, it has its own selector unit (similar to the one on the automatic typer) and normally responds only to a line signal recéived on a different line from the one serving the basic teletypewriter. This feature permits duplex operation of the AN/UGC-6 console. That is, the reperforator can be receiving traffic from a station on one circuit, while the other components in the console are transmitting traffic to the same station on another circuit. The reperforator also can be wired into the same signal line as the automatic type, and the AN/UGC-6 may be used as a tape factory.

Additional features of the reperforator that are uncommon to the perforator are the signal bell, low tape alarm, a mechanical variable

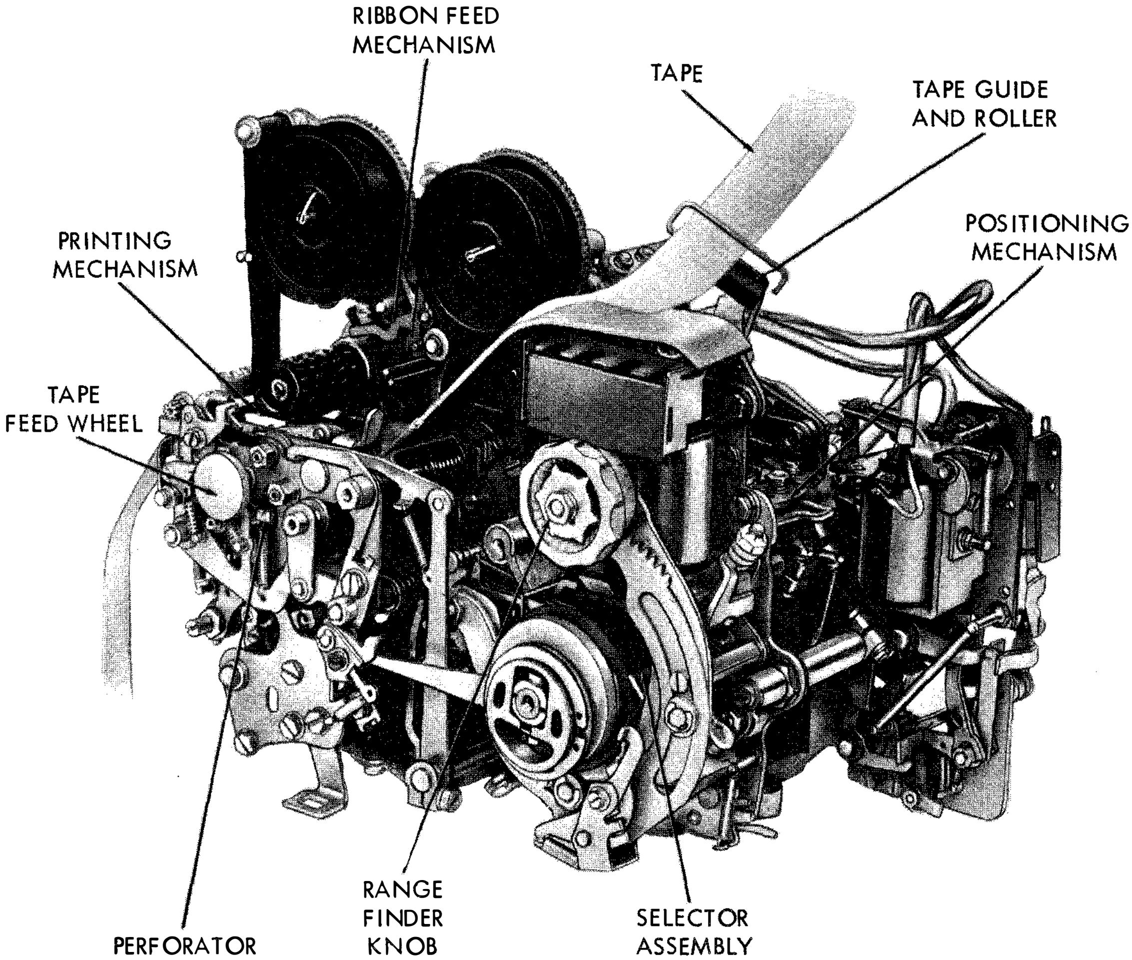



Figure 10-16. —Typing reperforator (front view). 50.102

speed drive mechanism, a blank tape feed-out mechanism, and a tape threading feed wheel.

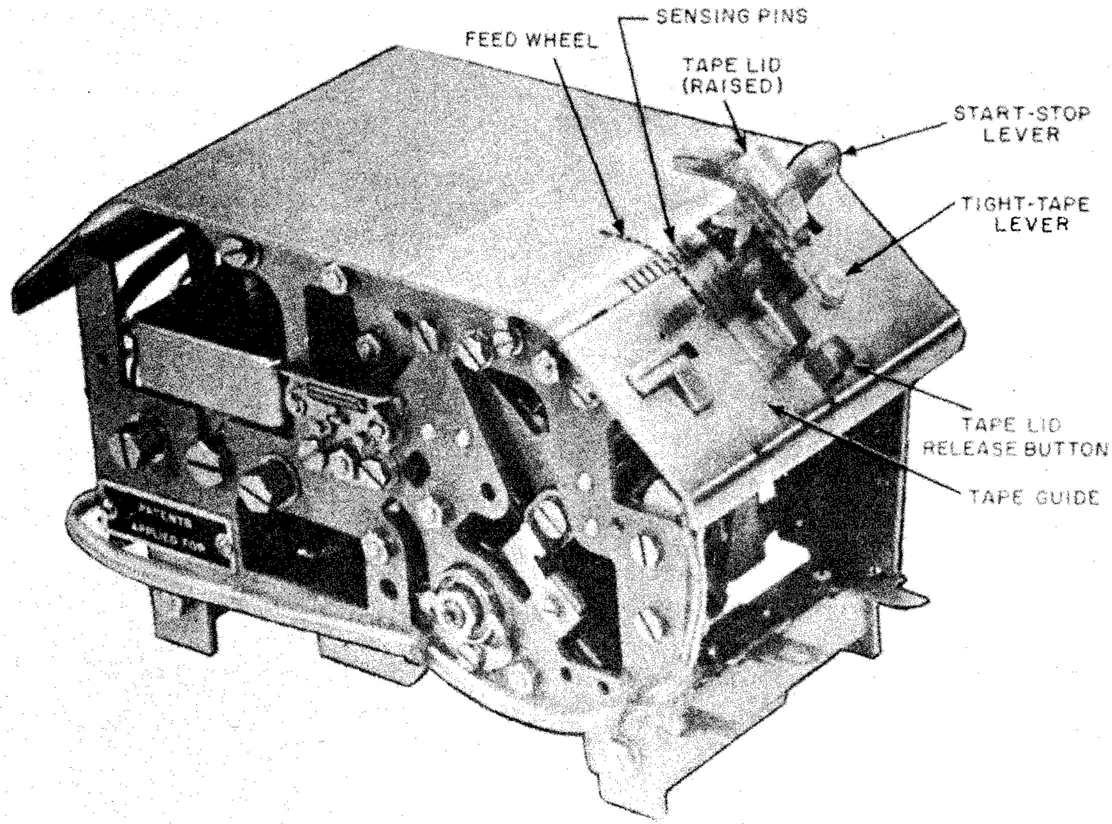
Transmitter Distributor (TD)

The transmitter distributor (fig. 10-17) is mounted on its own base in the front of the cabinet on the left side. It is a mechanical tape reader used to convert messages on standard chadless or fully perforated tapes to the electrical impulses of the teletypewriter code. These impulses are transmitted directly to the signal line or circuit. Conversion of the perforations in the tape to electrical impulses is accomplished by passing the tape over five sensing pins. These sensing pins activate a mechanical mechanism that operates a set of contacts to send out either a mark or space impulse. Choice of impulse depends on whether the sensing pins rise into a perforation or are held stationary by the tape.

The TD unit includes a start-stop switch in which are incorporated tight-tape, shutoff, and freewheeling tape features. The start-stop switch is a three-position switch. When positioned in the center, the switch is off and tape will not feed. When positioned to the right, the switch is on (or RUN position), and tape is fed over the sensing pins. When positioned to the left, the switch is in freewheeling, and tape may be manually pulled back and fed forward without any intelligence being sent to the line.

The tight-tape lever rides on the tape as it feeds through the tape guide. If the tape becomes tight or tangled, the lever is lifted and the TD stops feeding tape. Relieving the pressure on the lever automatically starts the tape feeding again.

Another feature of the TD is the end-of-tape switch. The switch is controlled by a pin protruding through the tape guide plate. As long as this pin is depressed by tape feeding through the guide, the TD is operable. When the end of the tape passes over the pin, the pin rises




76.33

Figure 10-17.—Transmitter distributor (TD).

and the TD stops transmission automatically. If the tape is torn on the bottom edge, the tape out pin also raises and stops the transmission. For this reason tapes should be handled carefully.

## OPERATING THE AN/UGC-6

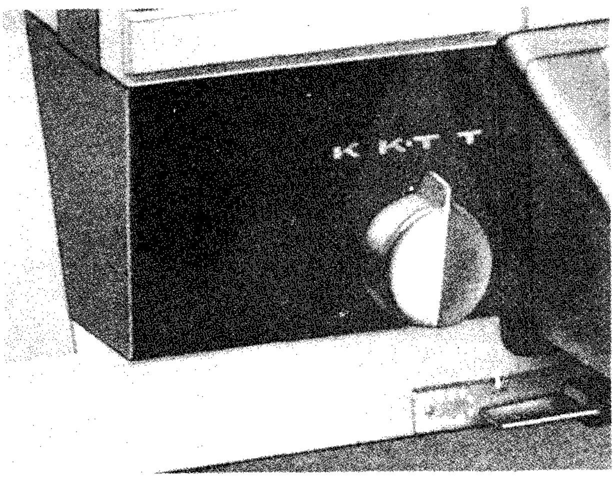
Power to the AN/UGC-6 is applied by a switch located on the front of the cabinet, slightly below and to the right of the keyboard. Rotating the switch so that the pointer is pointed up energizes the equipment (except the reperforator, which is controlled by its own power switch).

After applying power, but before operating the set, ascertain that the line-test switch is in the desired position. The switch must be in lower (LINE) position to connect the teletypewriter to distant stations. In the upper (TEST) position, the equipment is connected to a local test circuit (if wired), but no intelligence is sent to the signal line. This setting, of course, does not affect the reperforator, which is connected to its own external line.

With power applied, and the line-test switch in the LINE position, select the desired mode of operation with the three-position selector switch (fig. 10-18). From left to right, the three positions of the switch are keyboard (K), keyboard and tape (K-T), and tape (T).

### Keyboard Mode of Operation

To transmit a message directly to the line, as it is typed, rotate the selector switch to the K position. Depress and hold down the BREAK key for approximately 2 seconds to lock out all keyboards in the circuit, then depress the SEND (KBD UNLK) key to unlock the keyboard. Transmit five spaces, two carriage returns, and a line feed (in that order) to align the receiving machines to the same position as the sending machine, and start typing the message. The automatic typer monitors the transmission, providing a printed copy of the message.




76.34

Figure 10-18. —Selector switch.

In the keyboard mode of operation, the typing perforator is mechanically isolated from the keyboard, and the character counter mechanism does not function. The transmitter distributor circuits also are inoperable.

### Keyboard-Tape Mode of Operation

Keyboard operation in the keyboard-tape (K-T) mode is the same as in the keyboard mode, except that typed, perforated tape is prepared simultaneously by the typing perforator. This mode is particularly useful when a message must be transmitted on more than one circuit. An operator can transmit the message on one circuit while preparing a tape for transmission on the other circuits.

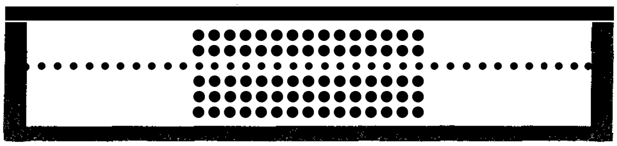
Within the line-test switch in the TEST position, the K-T mode of operation can be utilized to prepare tape for later transmission and, at the same time, to obtain a page copy of the transmission as it will appear when sent on the circuit. Care must be exercised in using this method. An operator can neither send nor receive messages during the period the machine is disconnected from the circuit.

When the selector switch is in the K-T position, the character counter moves one unit to the right with each character and spacing operation recorded on the tape. The transmitter distributor also is operable.

### Tape Mode of Operation

When the selector switch is in the T position, the keyboard and perforator are isolated from the other units. This mode of operation permits the operator to prepare tape for transmission while transmitting messages via the transmitter distributor, or receiving messages on the printer. No page copy is typed in this position, so the character counter must be observed so as to avoid too many characters for the length of the line. As pointed out previously, the counter registers each spacing character. Nonprinting functions, such as FIGS, LTRS, LF, and CAR RET, are not registered.

To correct an error when punching tape, depress the TAPE B. SP. key to move the tape back, one space at a time, until the first wrong code is over the perforating pins of the punch block. Press the LTRS key as many times as backspaced to change the incorrect codes to LTRS codes. Because it is the only character having all five perforations, the LTRS code will obliterate any other character code on the tape. This process is called "lettering out" an error. After lettering out the incorrect portion, retype that part of the message. The error will not appear on the page copy when the tape is sent. The characters still are registered on the counter, however. Therefore, when the counter indicates the end of the line, the operator still may type as many characters as were lettered out. Figure 10-19 shows a lettered-out tape.



31.24

Figure 10-19. —A lettered-out tape.

TELETYPE TAPE. —Two types of paper tape are in general use on teletype circuits. the first type is fully perforated, or chad, tape (fig. 10-20). (Incidentally, chad is the confetti (small paper disks) punched from the tape to make the holes.) The other type, only partially perforated, is called chadless. Both types of tape may or may not have printing, depending on the equipment and type of installation.

TAPE READING. —In order to read perforated tape, an operator must understand arrangement of code positions. The code is a five-unit mark-space signaling code arranged vertically on the tape, from the No. 1 position at the top to the No. 5 position at the bottom. A hole is a mark; no hole is a space. Between the second and third positions is a tape feed perforation (track) that is smaller than the code perforation (see fig. 10-21). This smaller perforation (not a part of the code) fits over the tape feed wheel that moves the tape through the transmitter-distributor. The upper side of chad tape usually has a slight roughness made by the hole-punching pins. Read the tape with this side uppermost. Use the track as a visual guide. Remember, no more then two perforations will appear above the track, nor more than three below. In figure 10-21 the positions are numbered from 1 to 5. These numbers are are only for study purposes; they do not appear on an actual tape.

The LTRS code contains perforations in all five positions. Codes besides LTRS and BLANK contain perforations in different combinations of positions. For instance, A is 1—2, B is 1—4—5, and C is 2—3—4.

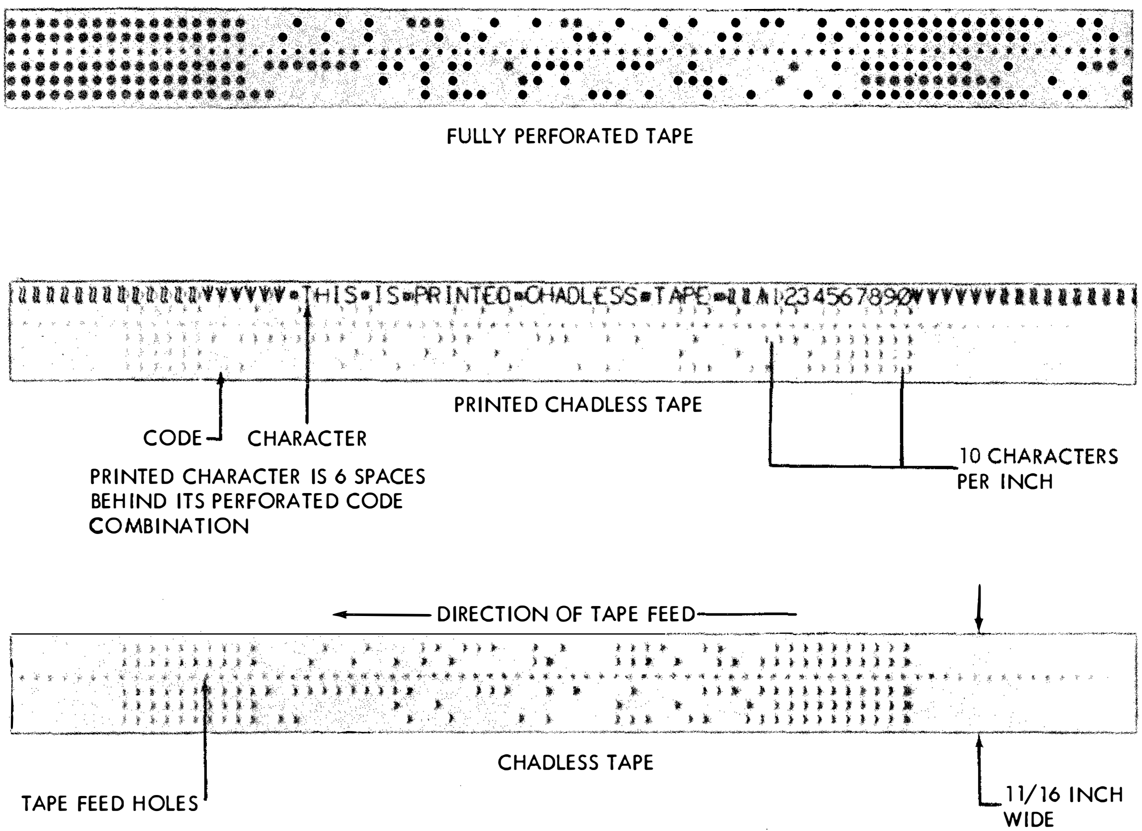
Read the perforations in lowercase until a FIGS code appears. After the FIGS code, read the tape as uppercase until a LTRS code appears, after which read as lowercase again. On circuits on which machines unshift on spacing, read codes in lowercase after the space code.

Memorize several codes at a time, learning the uppercase characters for each. Perforate strips of tape and read the codes memorized. Association of memory and eye will help one recognize codes quickly and will build reading speed.

The discussion and illustrations that follow provide a study plan for learning the code. Begin by learning the 1-hole codes: E, LF, SPACE, CAR RET, and T (fig. 10-22). Letter E is perforated in the No. 1 position, and the remainder of the positions are blank. Line feed is one perforation in the No. 2 position—and so forth, down to T, which is perforated in the No. 5 place. Keep this pattern in mind. Perforate these codes several times on a tape to help remember them.

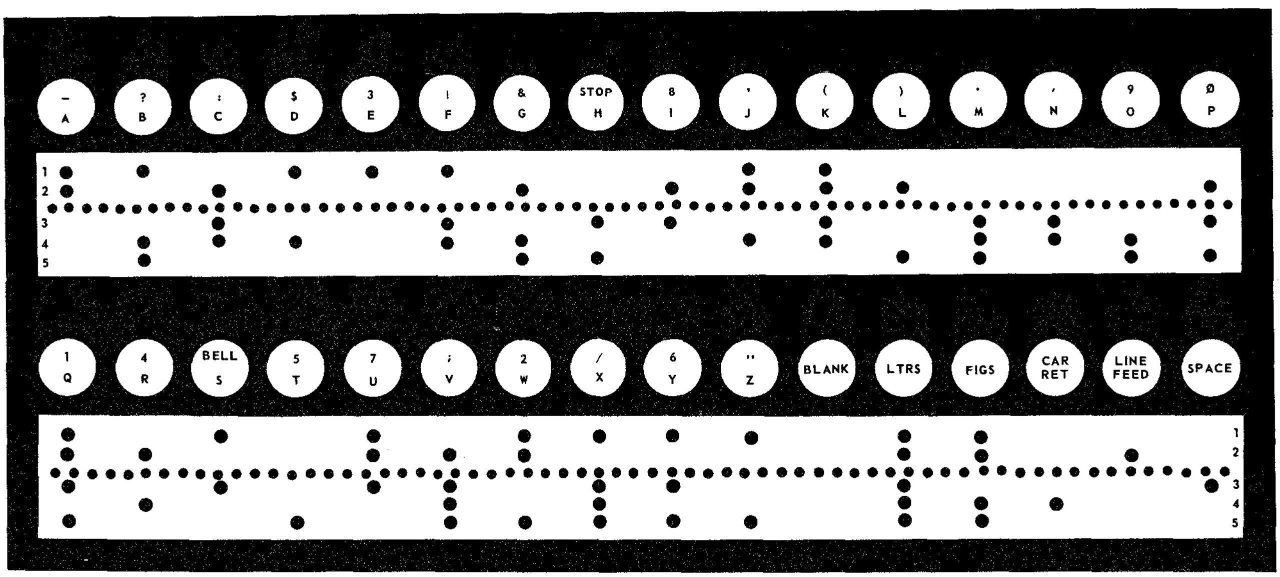
The next group is of three key letters; A, O, and N. Check figure 10-23. Letter A is represented by two holes above the track. This pattern—two holes above the track—is also characteristic of U, J, and W; read down to find the proper code. In the same way (fig. 10-24) letter O is common to M, G, and B, but this read UP to get the associated codes. The final letter of this series is N (fig. 10-25), which is read up for C and F.

With this much information mastered, get plenty of practice before learning more letters. Perforate the codes and, as reading improves, mix them to make the reading more difficult. Emphasize ACCURACY, not speed. If there is no opportunity to work with a perforator, draw the codes on 3 x 5 cards (with answers on back) and scramble them.



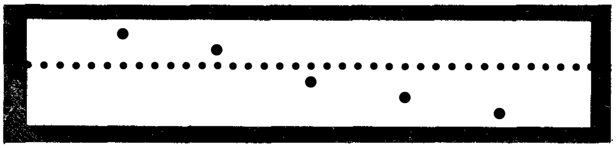

1.206(76)

Figure 10-20. —Chad and chadless tape.

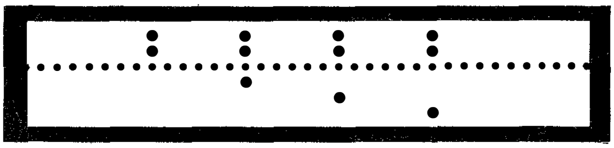



31.38

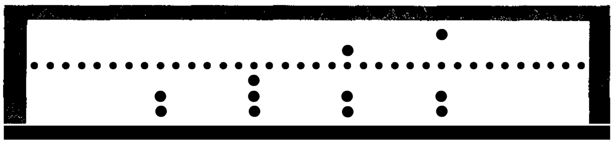
Figure 10-21. —The 5-unit teletype code.



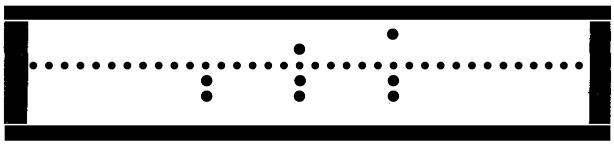
31.39
Figure 10-22.—The 1-hole codes: E, LF, SPACE, CAR RET, and T.



31.40
Figure 10-23.—Letters A, U, J, and W.



31.41
Figure 10-24.—Letters O, M, G, and B.

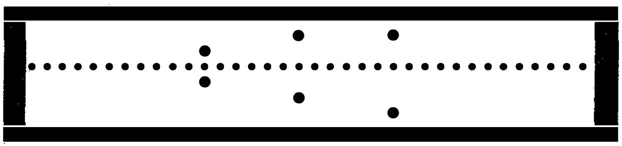


31.42
Figure 10-25.—Letters N, C, and F.

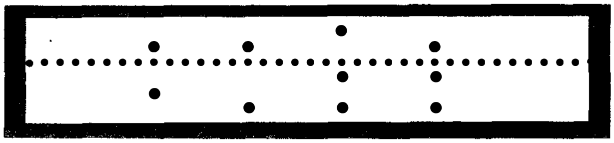
Three more sets of letters can be learned by using the track line for a guide. Read letter I (one hole above and one below the track line) and retain it as a reference point for reading D or Z (fig. 10-26). Learn R and use it to read L; learn Y and read P (fig. 10-27).

Eight letters that can be mastered by remembering them as opposites are Q and X, V and K, H and S, E and T (figs. 10-28 and 10-29). Letters E and T, remember, are also among the one-hole codes.

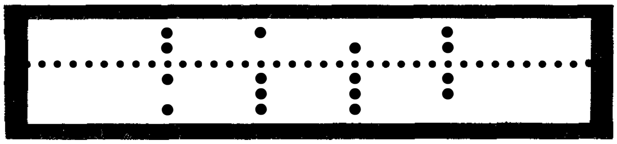
Two keys used a great deal are LTRS and FIGS, for which the machine is shifted into lowercase and uppercase. The LTRS code is easy to recognize because it is the only one with five perforations. The FIGS code resembles it in that two perforations are above the track, and two below, with only the No. 3 position blank.



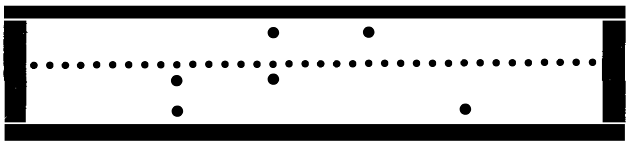
31.43
Figure 10-26.—Letters I, D, and Z.



31.44
Figure 10-27.—Letters R and L; Y and P.



31.45
Figure 10-28.—Letters Q and X; V and K.

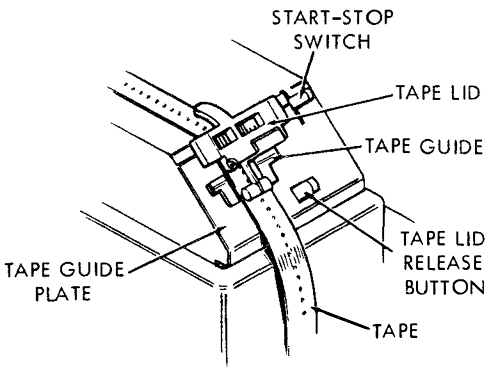


31.46
Figure 10-29.—Letters H and S; E and T.

Using Transmitter Distributor

The transmitter distributor (commonly called the TD) is operable only in the K-T and T modes of operation, and then only when the SEND key is depressed. In this discussion of the TD, assume that the selector switch is in either the K-T or T position and that the SEND key is depressed.

To place a tape in the TD, move the start-stop lever to the center (OFF) position. Release the tape lid by pressing the tape lid release button. Place the tape in the tape guide in such a manner that its feed holes engage the feed wheel with the portion of the tape having two perforations toward the rear of the TD. Insert printed tape so that the printed, chad side is up. If nontyped chadless tape is used, position the tape so that the open side of the hinged chads is to the top. With fully perforated (chad) nontyped tape, you must be careful to feed the tape from the beginning. Reversing the tape results in a garbled transmission. While holding the tape firmly in place on the feed wheel, press down on the tape retaining lid until its latch is caught. Move the start-stop lever to the left (FREEWHEELING) position, and manually adjust the tape so that the first character to be transmitted is located over the sensing pins. Figure 10-30 shows the path of the tape through the TD.




1.210

Figure 10-30.—Path of tape in transmitter distributor.

To transmit from the tape, operate the start-stop lever on the TD to the extreme right (ON) position. If the tape is inserted in the TD correctly, it feeds over the sensing pins, and the message is transmitted to the signal line.

Changing Paper

To insert a new roll of paper in the machine, first shut off the power. Press cover release pushbutton and lift cover. (Refer as necessary to figs. 10-31 and 10-32.) Push back paper release lever, lift paper fingers, and pull paper from platen.

Lift the used roll from machine and remove spindle from core of used roll. Insert spindle in new roll. Replace spindle in spindle grooves with paper feeding from underneath roll toward operator. Feed paper over paper-straightener rod, down under platen, and up between platen and paper fingers. Pull paper up a few inches beyond top of platen, and straighten it as though straightening paper in a typewriter. Then lower paper fingers onto paper and pull paper release lever forward.

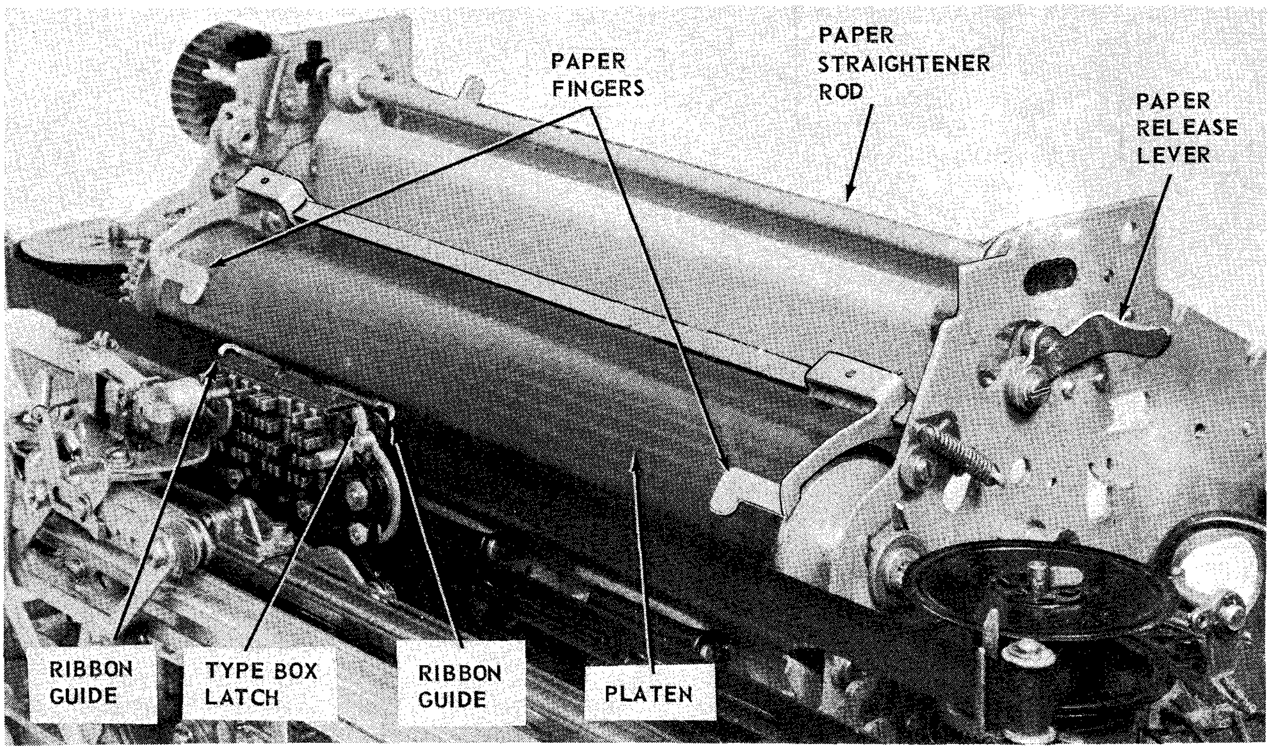
While inserting paper, avoid disturbing the ribbon or the type box latch. After paper is in place, check to see that ribbon still is properly threaded through ribbon guides. Also check to make certain that type box latch has not been disengaged. It should be in a position holding the type box firmly in place. Close cover. Open lid by pressing lid release pushbutton, bring up the end of the paper, and close lid with paper feeding out the top of it.

Changing Ribbons

To replace a worn ribbon on the typing unit, press cover release pushbutton and lift cover. (Refer as necessary to figs. 10-33 and 10-34.) Lift ribbon spool locks to a vertical position, and remove both spools from ribbon spool shafts. Remove ribbon from ribbon rollers, ribbon reverse levers, and ribbon guides. Unwind and remove old ribbon from one of the spools. Hook end of new ribbon to hub of empty spool, and wind until reversing eyelet is on the spool. If the ribbon has no hook at the end, the spool will have a barb that should be used to pierce the ribbon near its end.

Replace spools on ribbon spool shafts, making sure they settle on spool shaft pins, and that the ribbon feeds from the front of the spools. Turn down ribbon spool locks to a horizontal position, locking spools in place. Thread ribbon forward around both ribbon rollers, through the slots in the ribbon levers and ribbon guides. Take up slack by turning free spool. After slack has been taken up, check to make certain that ribbon still is properly threaded through ribbon guides, and that the reversing eyelet is between spool and the reverse lever. Also see that the type box latch has not been disengaged. It should be in position, holding the type box firmly in place.

Turn the paper up a few inches by pressing down and turning platen handwheel. Close cover. Open lid, bring up the end of the paper,




1.219

Figure 10-31. —Paper roll removed.

and close lid, with paper feeding out on top of it.

CHANGING RIBBONS IN PERFORATOR AND REPERFORATOR. —The procedure for replacing the ribbon in either the typing perforator or the typing reperforator is the same as in the automatic typer.

Open the cabinet dome lid for access to the component. Open the ribbon spool toggles and remove the old spools. Disengage the old ribbon from the reversing pins, the ribbon guide, and the rollers. Remove the old ribbon from one of the spools. Engage the hook of the new ribbon on the hub of the empty spool, and wind the ribbon on the spool past the reversing eyelet. Insert the spools on the shafts and close the toggles.

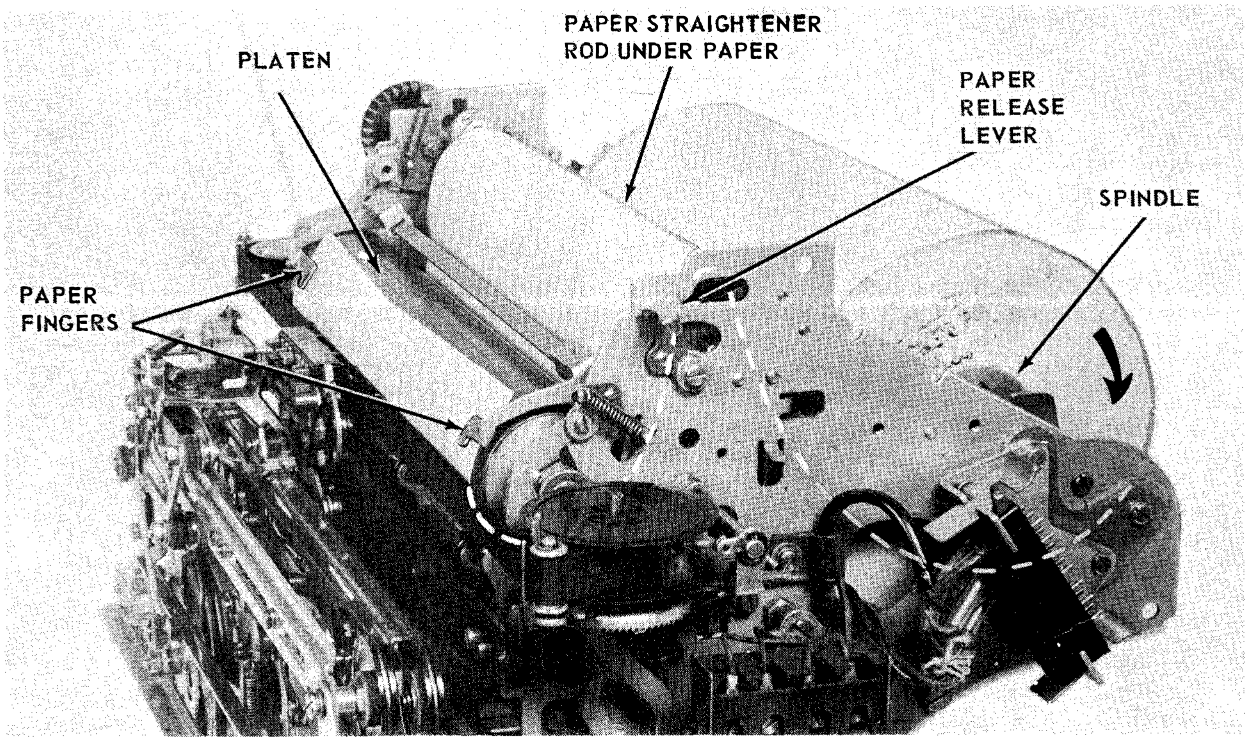
The path of the ribbon (fig. 10-35) is from the bottom of the left spool, up and over the left roller, down through the left reversing pins, through the ribbon guide under the type wheel, across the front of the unit and through the right reversing pins, under the right roller, and up and around the left side of the right spool.

Make certain that the ribbon remains in the guide slots and that both reversing eyelets are between the ribbon spools and the reverse levers. Roll up any slack in the ribbon on the spool on which the ribbon is wound.

Changing Tape

A visual indication of low tape supply is incorporated into each roll of tape. When the color of the tape changes from pale yellow to red, it is a warning that the roll is nearly exhausted and required replacement. Additionally, the warning device in the reperforator's tape container is activated when the tape supply for that unit is low. Heed these warnings! Don't miss a message by trying to use up the last bit of tape on a roll.

To change tape in the perforator, set the keyboard selector switch to the T mode of operation. Raise the perforator cover, and open the lid in the center of the cabinet dome. Tear the old tape at the point where it enters the

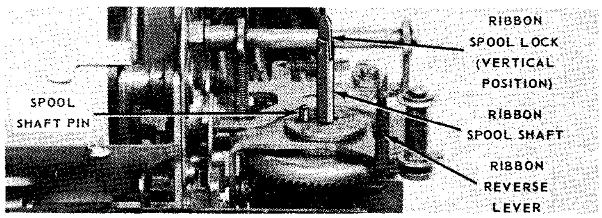



1.220

Figure 10-32. —Paper roll inserted.

tape chute (fig. 10-36). With power applied to the equipment, depress the REPT key and any character on the keyboard until the old tape is fed out of the punch block. Then, lift the tape reel from its container and remove the remainder of the old tape from the reel. Insert a fresh roll of tape on the reel. Place the reel back into its container so that the tape feeds from the front of the container and off the bottom of the reel. Thread the tape over the tape guide roller and into the chute of the punch mechanism. Depress the REPT key and any character on the keyboard for automatic feeding. Simultaneously, push the tape downward until it is engaged by the feed and die wheels. Continue feeding tape until the tape appears at the left side of the punch block. Close the lid in the cabinet and lower the cover over the perforator.

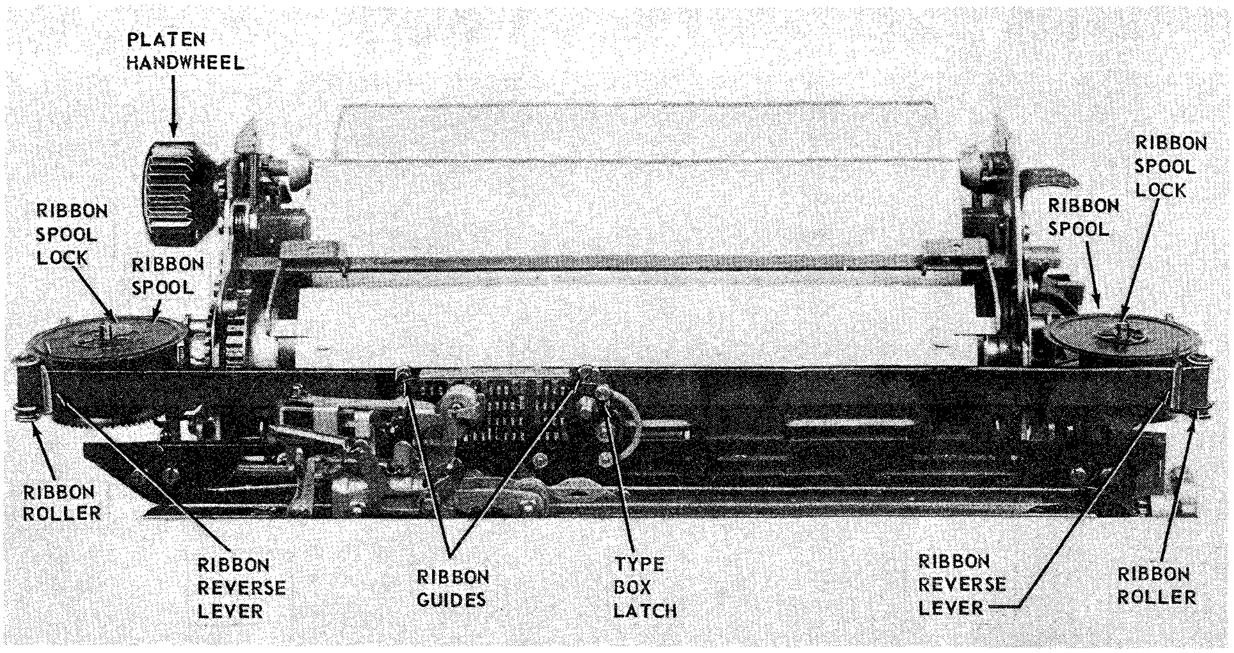
The procedure for changing tape in the reperforator is almost identical to that for changing tape in the perforator. The path of the tape through the two units is identical. (Refer to fig. 10-37 as necessary.)




1.221

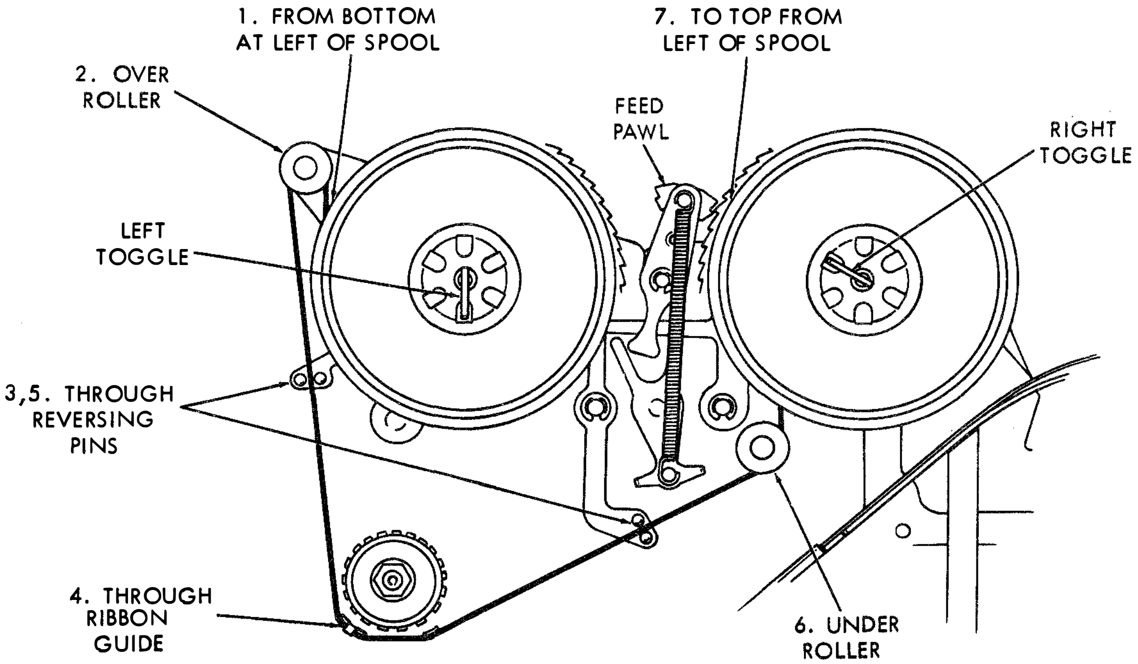
Figure 10-33. —Ribbon spool mechanism.

For access to the reperforator and its tape supply, open the left rear lid in the cabinet. Tear the tape at the tape chute and clear it out of the punch block by manually rotating the feed wheel or, if the reperforator is so equipped, by pressing the automatic tape feed button. Lift the tape reel from its container, remove the old tape, and insert a fresh roll of tape on the reel. Position the reel in its container in such a manner that tape feeds from the rear of the container and off the bottom of the reel. Make certain that the lever on the tape out switch



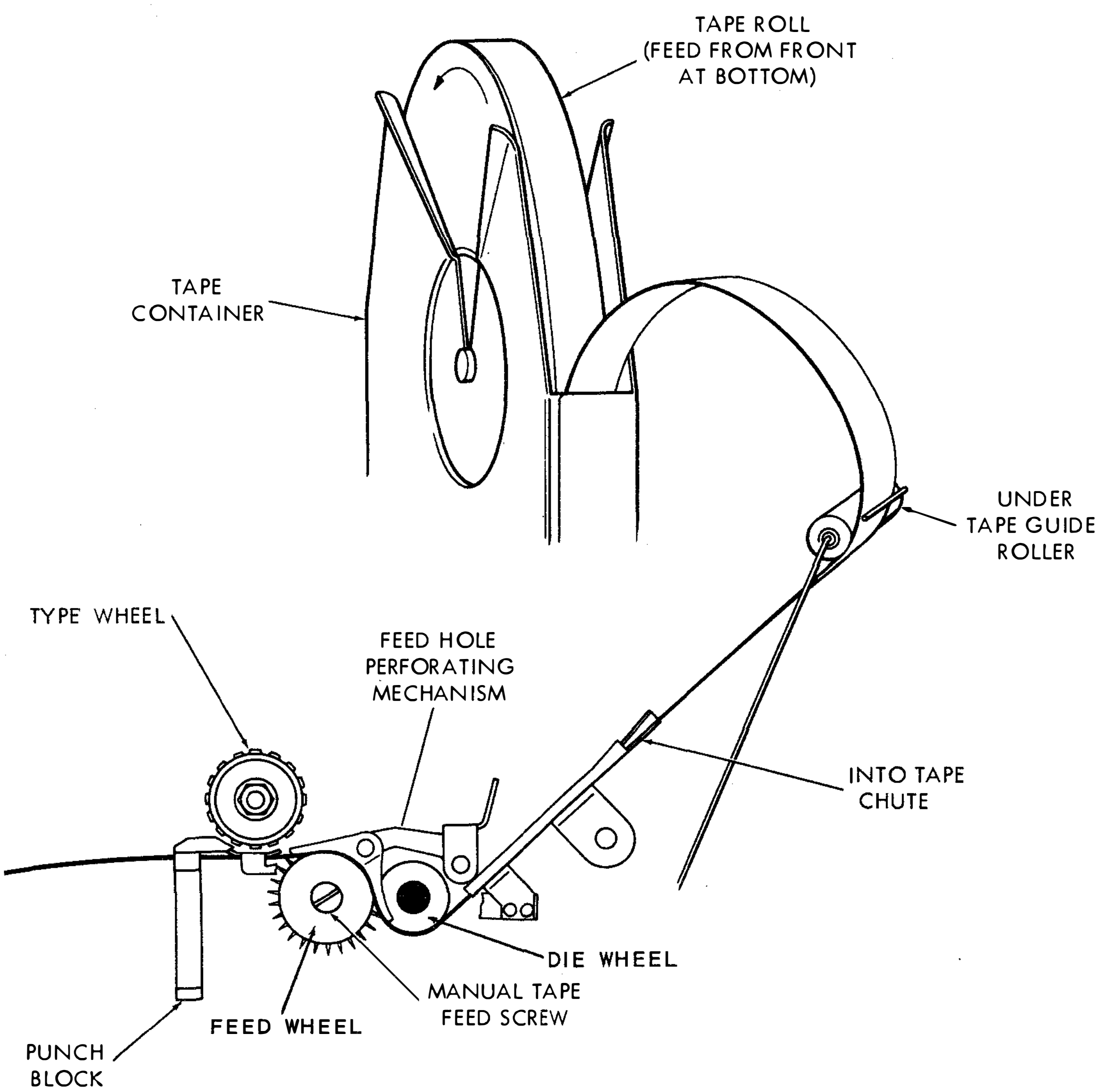

1.222

Figure 10-34. —Ribbon inserted.




1.215(76)C

Figure 10-35. —Path or ribbon in typing perforators.




1.215(76)A

Figure 10-36.—Path of tape in typing perforator.

assembly is toward the rear of the cabinet and under the roll of tape. Lead the tape over the tape roller at the rear of the tape container, to the right and over the roller mounted on the typing reperforator, and to the tape chute. Slide the tape into the chute, and rotate the tape feed wheel until the tape emerges from the punch chute at the left of the reperforator. Close the lid, making sure that the tape feeds through the hole in the front of the lid.

### Cleaning Type

When printing is smudged, the type should be cleaned. The type box must be removed from the machine. Open cover and unlock type box latch by moving it to the right (see fig. 10-38). Grasp handle on right side of type box, and raise that side up and to the left until the box unhooks on the left side and can be freed from type box carriage. Turn type box over to side with type (fig. 10-39), and clean with a dry, hard-bristle brush. Do not use type cleaning solution.

To replace type box, hold it with type toward platen and the large hook on the left. Slip this hook under stud in front of left type box roller, and push smaller hook on right side into place on stud in front of right type box roller. Hold

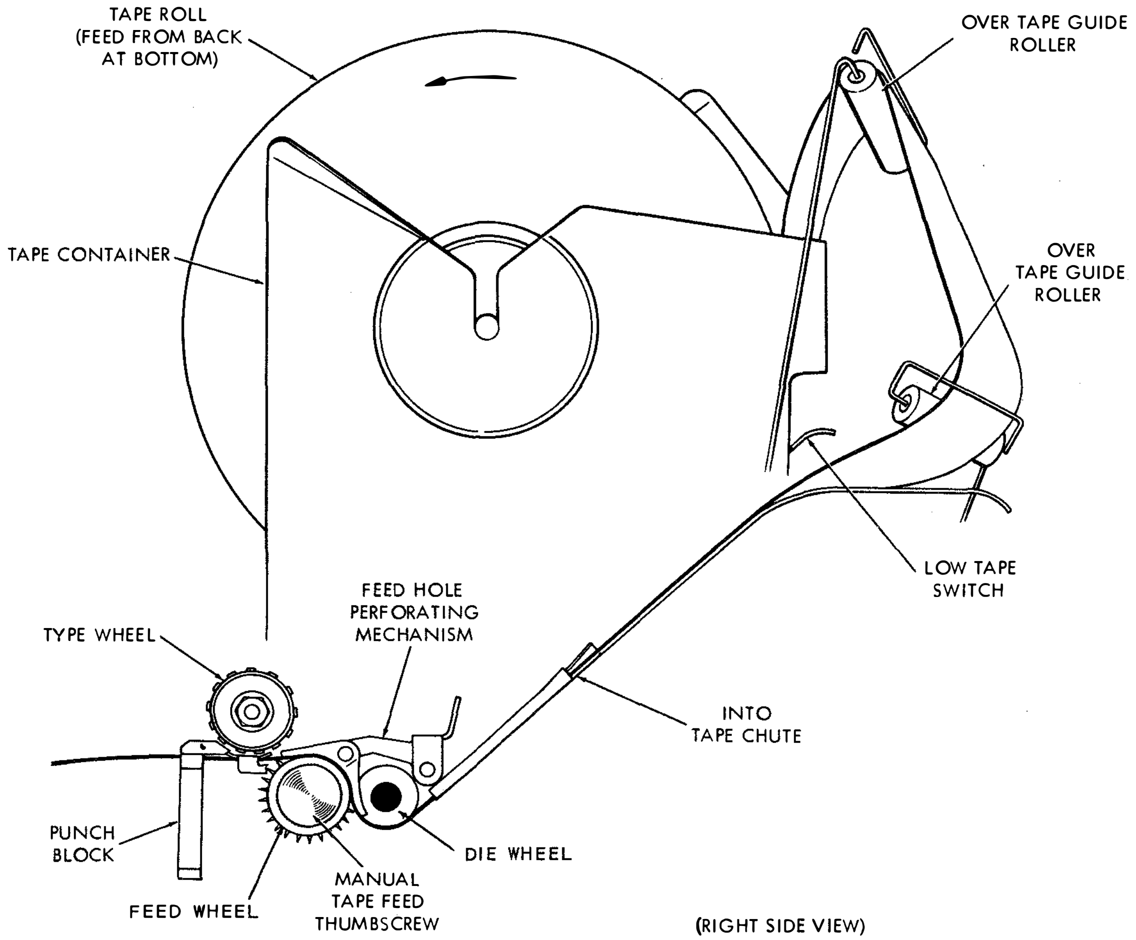



Figure 10-37. —Path of tape in typing reperforator. 1.215(76)B

type box latch in horizontal position and move to left over latching notch as far as it will go. Raise latch to vertical, and press to left until it locks into latching notch. Check to see that the ribbon still is threaded properly.

## OTHER TELETYPE EQUIPMENT

Equipments described in this section are portions of the AN/UGC-6 teletype, placed (with only minor differences) into their individual cabinets.

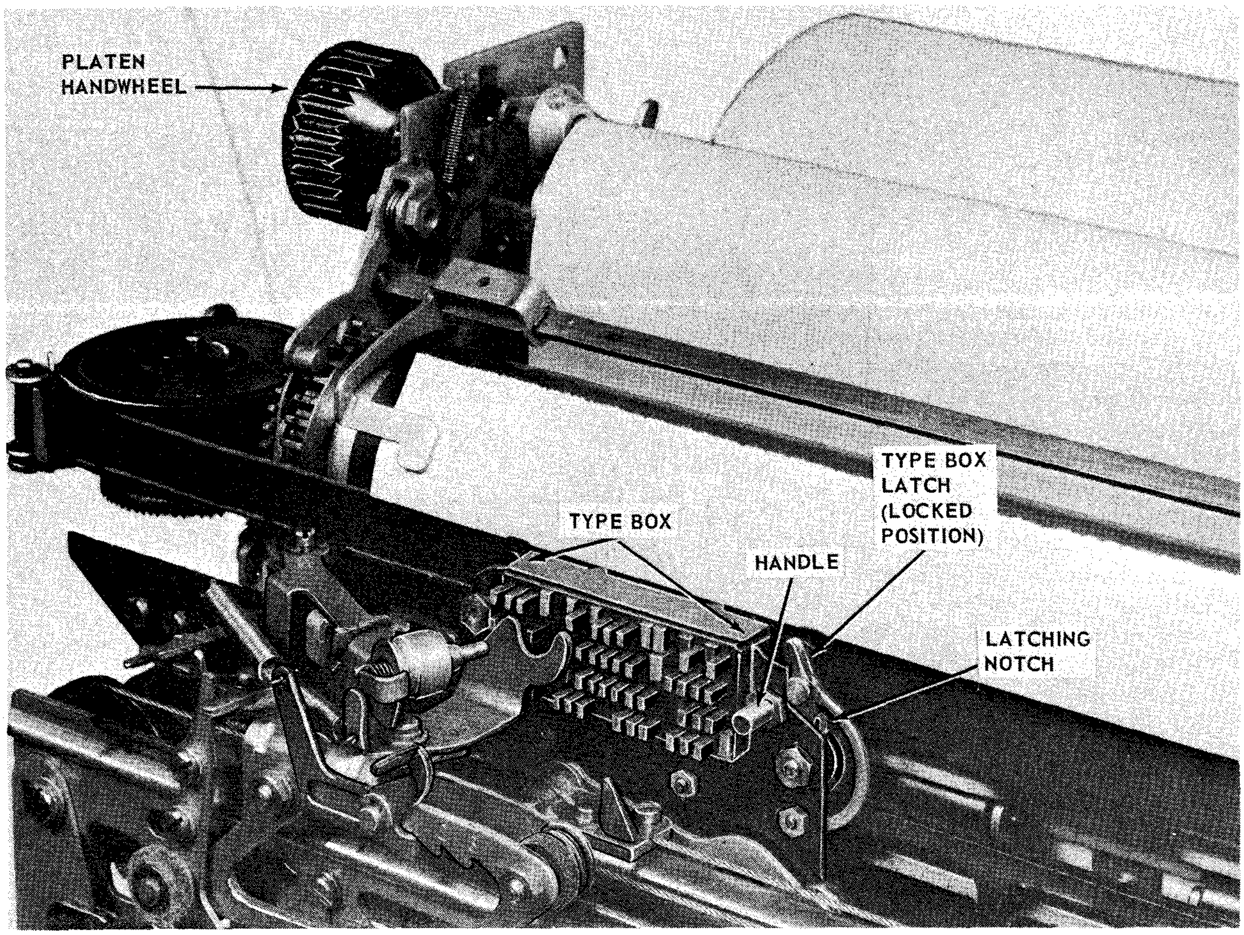
### Teletypewriter TT-48/UG

Model TT-48/UG (fig. 10-40) has an automatic typer, keyboard, and keyboard base similar to the AN/UGC-6. Because of its smaller size, it often is found on ships where the amount of space is a limiting factor. When components of the TT-48/UG are placed in the cabinet (shown in fig. 10-41), they become the TT-69/UG, which takes up even less space.

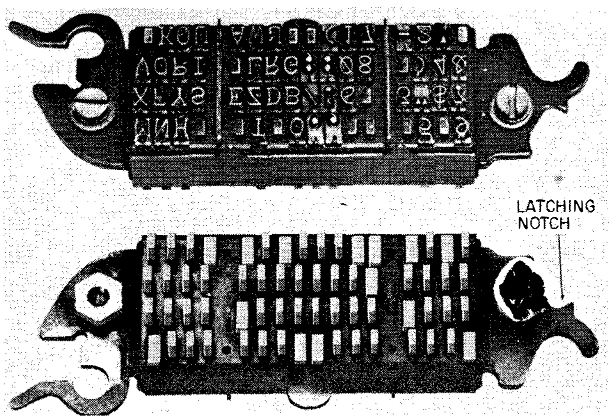
### Typing Reperforator TT-192/UG

The typing reperforator shown in figure 10-42 is designated TT-192/UG. Basically, it is the same as the one described as a component of the AN/UGC-6; it serves the same purpose and functions in the same manner. Because of space limitations, however, most shipboard installations of the TT-192/UG do not include the table illustrated.

Normally, the reperforator's wiring is terminated in a patch panel (described later) so that it can be patched or connected into any teletype circuit wired through the panel. By




31.27
Figure 10-38.—Type box in place.

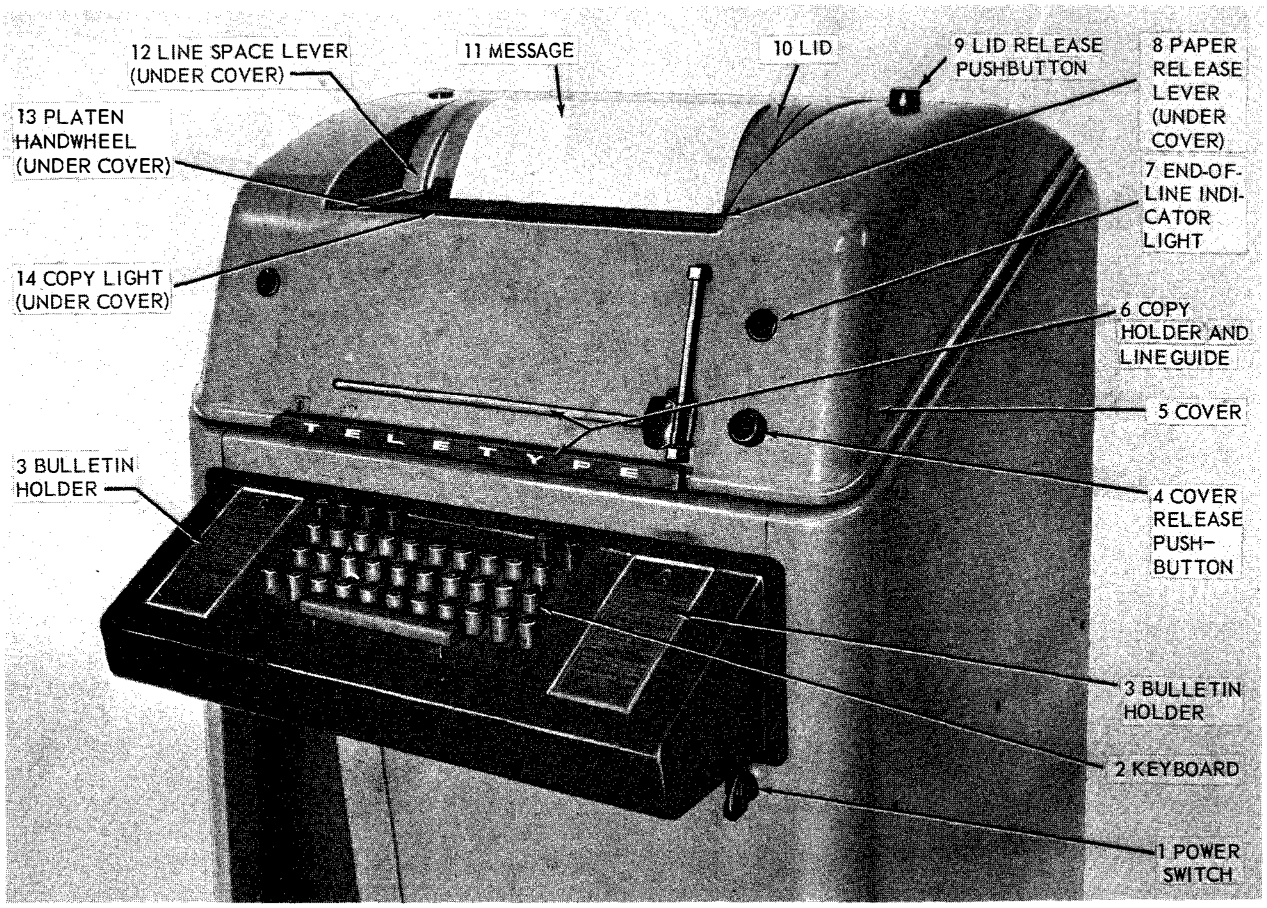



31.28
Figure 10-39.—Type box, front and back.

patching the reperforator into a circuit, a tape copy of each message is obtained, and messages requiring further processing in tape form need not be retyped by the operator.

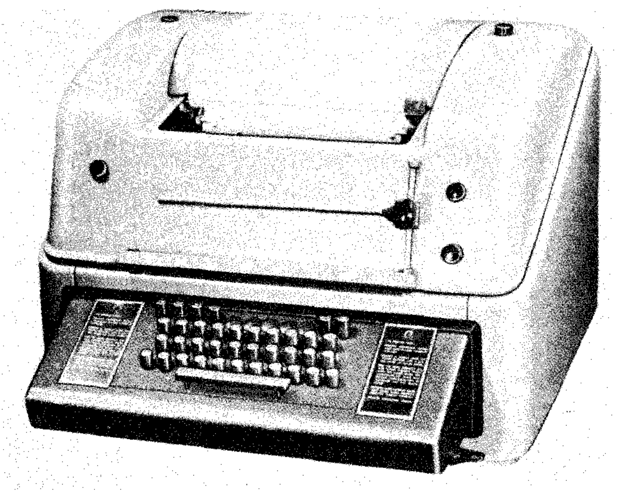
Send/Receive Typing Reperforator TT-253/UG

Because of its versatility and compactness, the TT-253/UG send/receive typing reperforator (fig. 10-43) is installed aboard ships in large numbers. In addition to its usefulness as a regular reperforator, the set can be utilized to prepare tape for transmission and to send and receive messages in the same manner as the larger, page-printing teletypewriter sets. Its use for sending and receiving messages is of course, restricted to situations where page copy is not required.




1.217

Figure 10-40. —Model TT-48/UG teletype.



76.35

Figure 10-41. —Model TT-59/UG teletype.

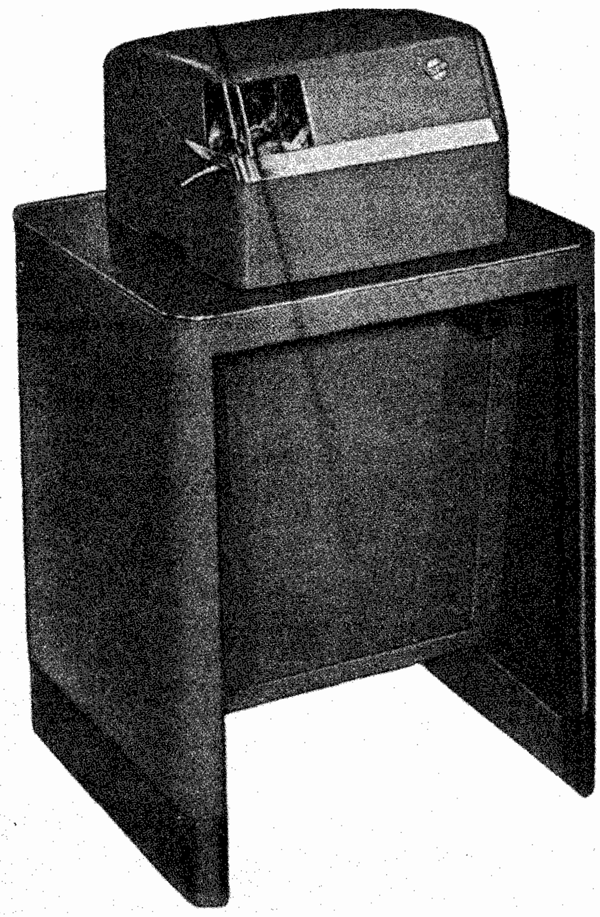
Transmitter Distributor TT-197/UG

With the addition of its own motor, the transmitter distributor described as a part of the AN/UGC-6 console becomes the TT-187/UG shown in figure 10-44. The unit is self-contained, and can be mounted in any convenient space that is large enough to accommodate its base.

Teletype Projector Unit

Teletype projector unit TT-71, shown in figure 10-45, enables the teletype message to be read simultaneously by groups of persons. It is installed in the pilot readyrooms in aircraft carriers and in teletype conference rooms ashore.

The bottom of the cabinet houses a page printer. The message is printed on a roll of transparent cellophane. An optical lens system



50.114
Figure 10-42. —Typing reperforator set TT-71.

with a 1000-watt lamp enlarges the image of the teletypewriter message and projects it onto a tilted mirror at the top rear of the cabinet from where it is reflected onto the translucent screen. The message is visible along the lower edge of the screen as it is being printed. With each successive line feed the message advances upward on the screen, one line at a time, and finally moves out of view at the top.

A tape typing unit provides a permanent typewritten record of transmissions in the projector unit, but at most installations this feature is not used because a page copy from an additional printer patched into the same circuit has been found to provide a more readable and more convenient file copy.

The projector unit uses an ordinary teletypewriter ribbon. The cellophane roll is changed exactly as a roll of paper is installed in an ordinary printer, except that the loose end must be started on an automatic takeup spool. The optical unit is focused easily, and seldom needs refocusing.

The screen size limits the length of the typing line to approximately half the normal line length. Operators must remember this limitation when typing material to be received on the projector unit. At most installations, the printer or perforating teletypewriter used for punching tapes for the projector has the end-of-line warning light and bell adjusted to warn of this shortened line length.

## ASSOCIATED EQUIPMENT

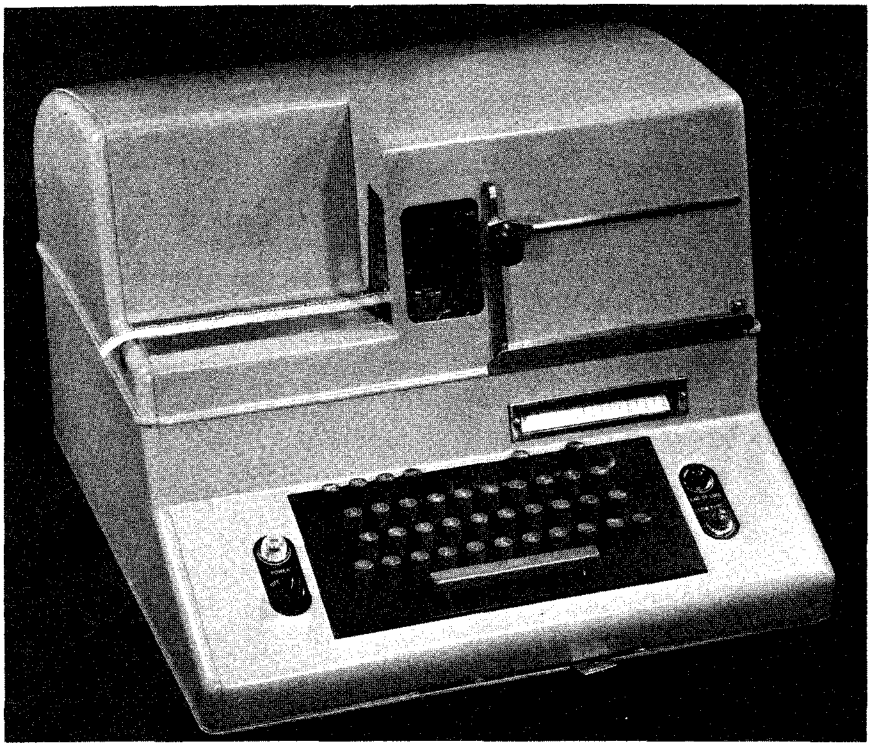
Teletype communication systems require other associated equipment in addition to the teletypewriters just discussed. Radio transmitters and receivers, such as those studied in chapter 9, are required for radioteletype transmission and reception. At this point Radiomen should become acquainted with patch panels, keyers, converters, and other equipment necessary for RATT operation.

### RECTIFIER POWER SUPPLY

Although teletype motors operate on alternating current, a source of direct current is always required for the signal circuit carrying the start-stop code intelligence. Figure 10-46 shows one model of rectifier power supply installed aboard ship to rectify alternating current, changing it to d-c power for operation of teletypewriters and converters. This rectifier furnishes a power output of 102 volts d-c at 1.0 amp. This output is enough to supply many teletypewriters operating simultaneously. The on-off switch, fuses, and voltage adjusting control are accessible through a door in the front of the cabinet.

### TELETYPE PANELS

Teletype panels SB-1203/UG and SB-1210/UGQ, shown in figure 10-47, are used for interconnection and transfer of shipboard teletypewriter equipment with various radio adapters, such as frequency shift keyers and converters. The SB-1210/UGQ is intended for use with cryptographic devices, whereas the SB-1203/UGC is a general-purpose panel. Each panel contains six channels, with each



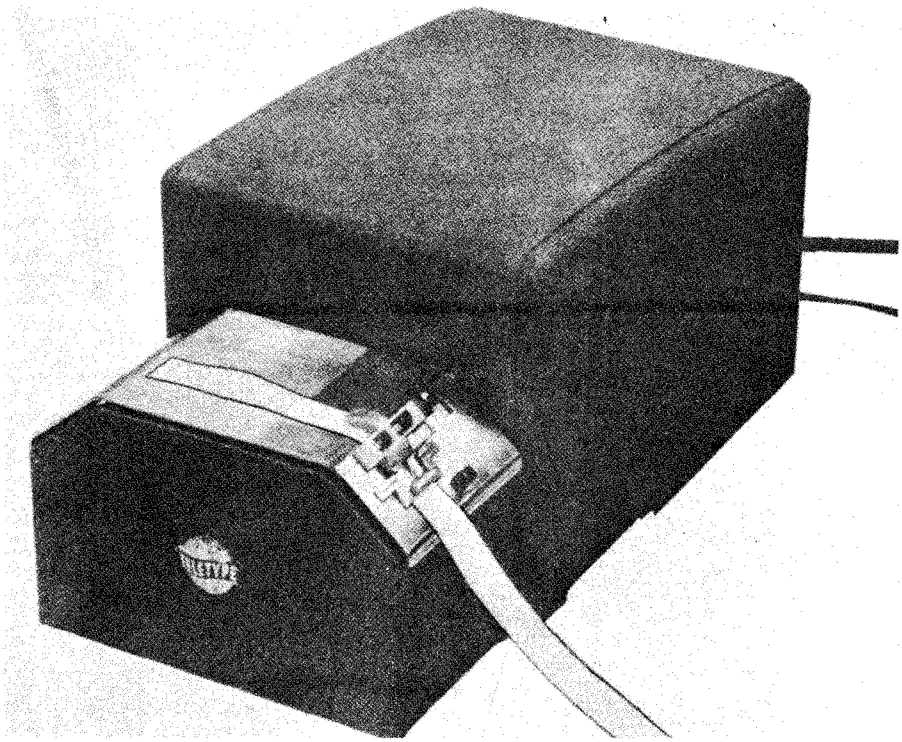
50.116

Figure 10-43.—Send/receive typing reperforator TT-253/UG.

channel comprising a looping series circuit of looping jacks, set jacks, and a rheostat for adjusting line current. The number of looping jacks and set jacks in each channel varies with the panel model. Each panel includes a meter and rotary selector switch for measuring line current in any channel. Any teletype equipment not regularly assigned to a channel may be connected to six miscellaneous jacks. The following instructions apply to operating either of the teletype panels.

1. Turn all line current rheostats counterclockwise to increase circuit resistance to maximum value.
2. Turn on the local line current supply at the rectifier unit and at the distribution panel (not shown in the illustration). The green indicator light on the model SB-1203/UG panel will come on.
3. If the desired teletype equipment is wired in the same looping channel as the radio adapter (keyer or converter) to be used, no patch cords are required.
4. Turn the meter selector switch to the desired channel and adjust the corresponding rheostat to give a line current indication of 60 ma.
5. If the desired teletypewriter (for example, in channel 1) is not wired in the same looping channel as the keyer or converter to be used (for example, channel 3), insert one end of a molded patch cord (supplied with panel) in the set jack in channel 1, and the other end in either one of the two looping jacks in channel 3.

In any switching operation between the variplugs and jacks of a teletype panel, NEVER pull the patch plug from the machine (set) jack without first removing the other end of the cord plug from the loop jack. Pulling the plug from the set jack first will open-circuit the channel and cause all teletype messages in the channel to be interrupted. The proper procedure is to take the plug out of the looping jack first, and to insert it last. This action maintains closed-circuit operation of all channels in the panel at all times. In order to take a machine out of a loop, take a dummy plug or a patch cord and insert it into the set jack of that machine. This action will remove all loop current



1.210

Figure 10-44. —Transmitter distributor TT-187/UG.

from that machine and not disturb the other machines in the line.

## TONE SHIFT KEYER/CONVERTER

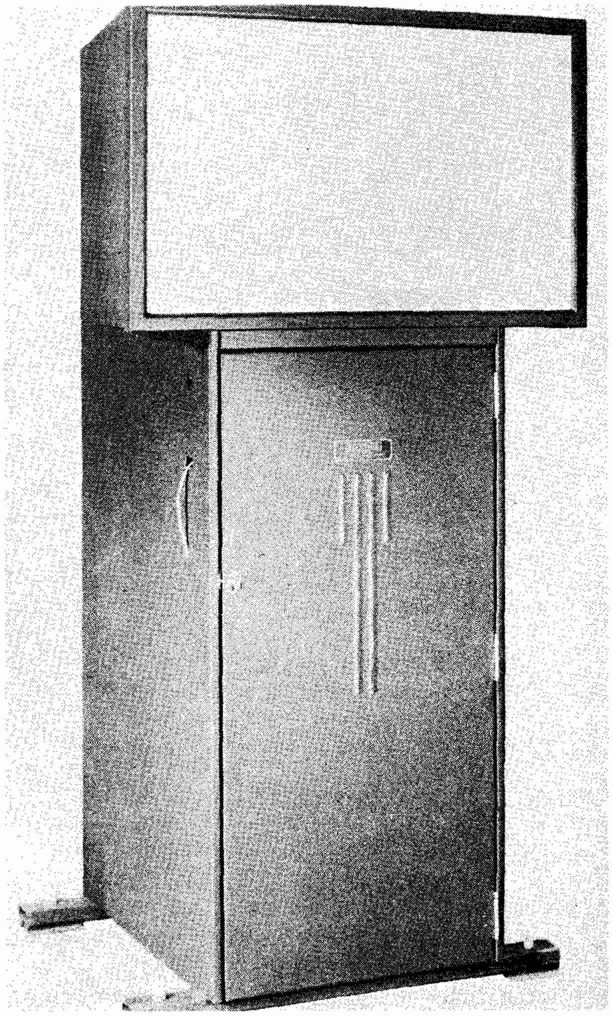
Tone shift keyer/converter model AN/SGC-1A is used for short-range RATT operation. Normally it is used for communication on UHF and VHF bands, but it can be used with any transmitter designed for voice modulation. The AN/SGC-1A is shown in figure 10-48, with blocks to indicate other equipment necessary for a complete tone shift system.

In the tone modulation transmission, the teletypewriter pulses are converted into corresponding audio tones, which amplitude modulate the transmitter. Conversion of the audio tones is accomplished by an audio oscillator in the tone converter, which operates at 700 cycles when the teletype loop is in a closed-circuit (mark) condition and at 500 cycles when the loop is in an open-circuit (space) condition. An internal relay closes a control line to the radio transmitter, which places the transmitter on the air when the operator begins typing a message. The control line remains closed until after the message is transmitted.

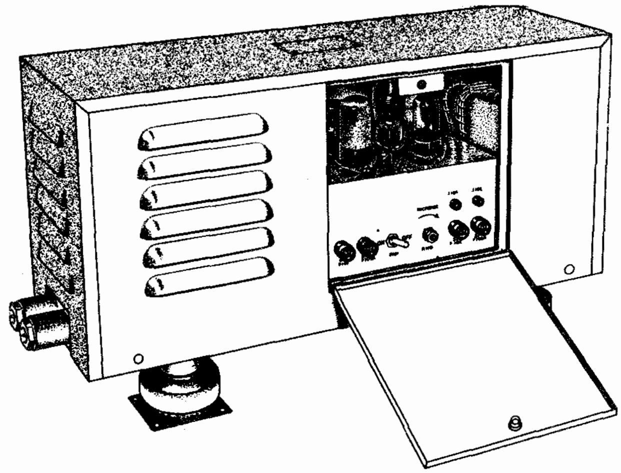
When receiving messages, the tone converter accepts the mark and space tones coming in from the radio receiver and converts the intelligence of the tones to the make and break contacts of a relay connected in the local teletypewriter loop circuit. This action causes the local teletypewriter to print in unison with the mark and space signals from the distant teletype.

The receive level control, located at the upper left on the front panel, permits adjustment of the level of the incoming tone signals from the receiver. The loop current rheostat is next to the receive level control, and is adjusted to 60 ma when the teletype loop is in the mark (or closed) circuit condition. A meter and its switch permit measurements to be taken in all the important portions of the circuit.

Two indicator lights flank the upper part of the meter. One light (green) indicates the receive condition; the other (red) indicates the transmit condition. Both lights are off when the keyer/converter is in the standby condition.



31.34
Figure 10-45.—Teletype projector unit TT-71.



31.33
Figure 10-46.—Rectifier power supply for teletype operation.

The send bias rheostat is located at the right of the meter. It permits correction of teletype distortion (for example, unequal length of mark and space signals) in the local teletype loop when sending a message.

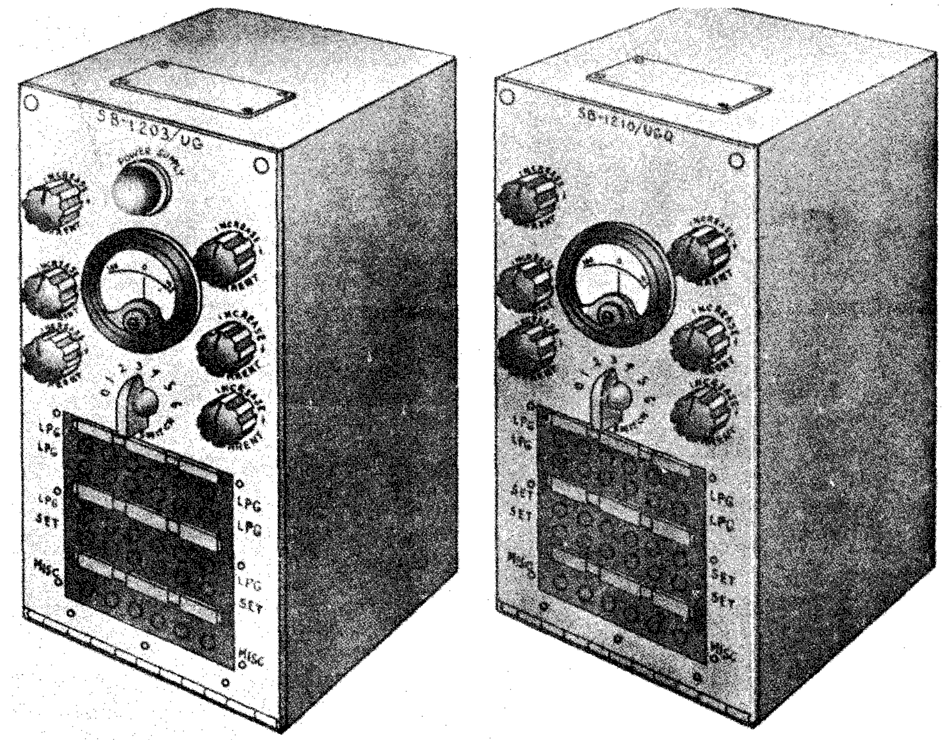
At the far right is a jack marked TTY MONITOR. A monitoring teletype may be patched into this jack, thereby placing it in series with all other teletypewriters in the loop.

The power indicator light is located at the lower left side of the front panel. The ON-OFF switch is located next to it.

The receive bias control is located at the right of the power switch. This control enables correction of distortion in the receiving tone circuit.

The control switch, located at the right of the meter switch, permits the keyer/converter to function in several ways. When the switch is on AUTO (automatic), the equipment may be in one of three conditions: receiving, transmitting, or standby. In standby, reception of an incoming mark tone causes the control circuit to change to receiving. At the end of the incoming message, the circuits shift back to standby. When in standby condition, operation of the local teletype causes the circuits to change to transmit. After the last letter is keyed, a time delay of about 3 seconds occurs, and then the circuits shift back to standby. These interlocking functions prevent the equipment from shifting directly from transmit to receive, or vice versa. Thus an incoming signal will not interrupt an outgoing signal nor will keying the local teletypewriter, when receiving, cause the circuit to shift to transmit. The normal method of operation is with the control switch in automatic position. After a station completes sending its message, it is ready for reception of any return message after a 3-second time delay.

The control switch position marked TRS is useful when making initial adjustments, but is not used in carrying on communications. The reason is that it locks the equipment in the transmit condition, making it impossible to receive any message.



70.79

Figure 10-47.—Teletype patch panels SB-1203/UG and SB-1210/UGQ.

The REC/STDBY position of the control switch prevents the equipment from changing to the transmit condition even though the teletype is operated, but it can receive messages or remain in standby.

The fourth position of the control switch is ADJ FREQ. This position is for maintenance use only, and is not used during operating periods.

Because a small time delay is incurred in operation of control circuits of local and distant terminals, the first character transmitted is usually lost. The normal 5 spaces, 2 carriage returns, and line feed functions used at the beginning of each message are more than adequate to compensate for this first-character loss.

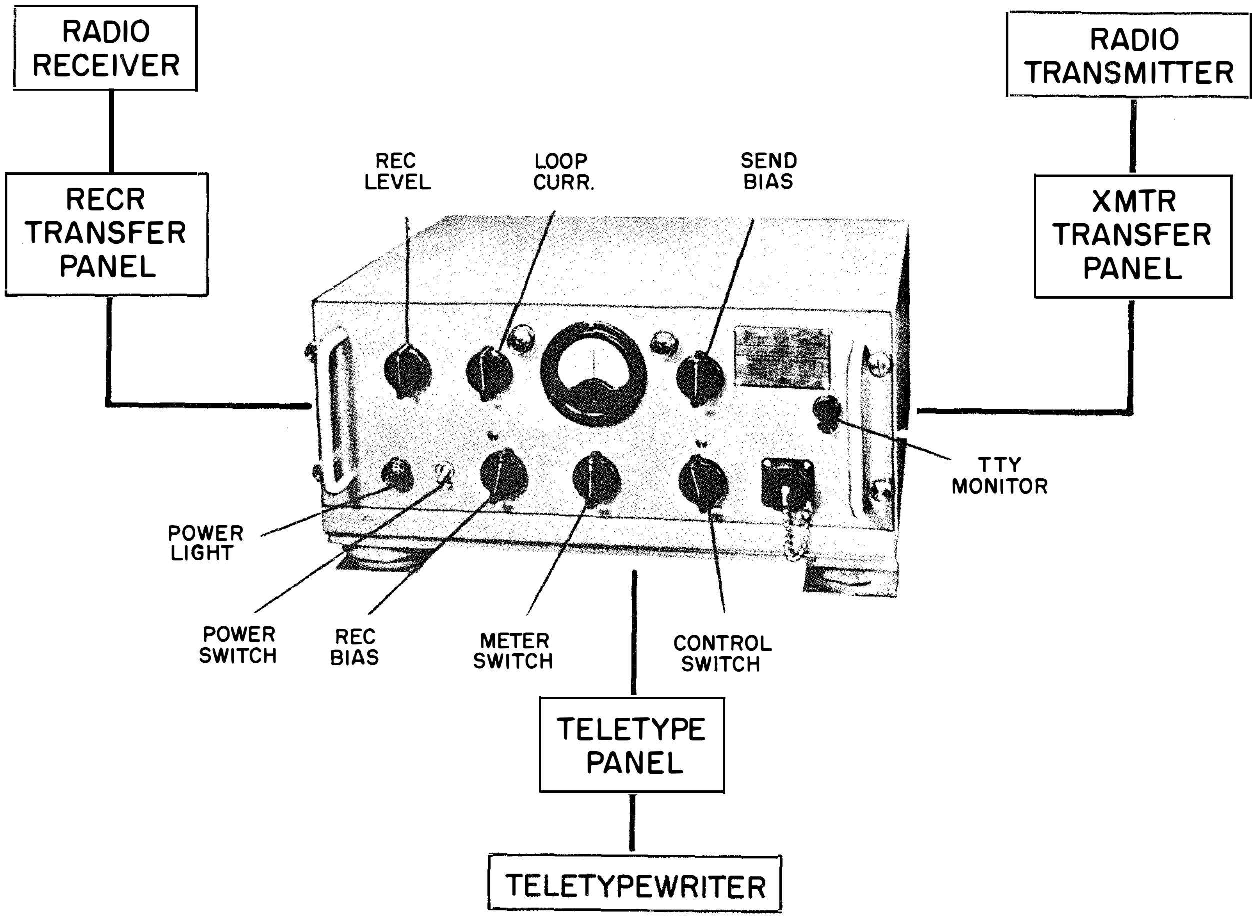
## FREQUENCY SHIFT KEYER

For frequency shift RATT transmission, a keyer is needed to replace the oscillator of a CW transmitter with a source of radiofrequency excitation that can be shifted a small amount upward and downward to produce RATT signals corresponding to the mark-space teletype code. Such a frequency shift keyer is model KY-75/SRT shown in figure 10-49.

During frequency shift keying operation, the frequency of the transmitter's carrier appears at a certain frequency during a SPACE signal and shifts a few hundred cycles higher for a MARK signal. The amount of this frequency shift deviation of the keyer is adjustable over a range from 0 to 1000 cps. Usually, the keyer is adjusted for an 850-cycle shift. This adjustment means that the MARK signal is 425-cycles above the carrier frequency, but the SPACE signal is 425 cycles below the carrier.

The procedure for setting up the keyer and transmitter for frequency shift transmission consists of adjusting the crystal oscillator and tuned circuits of the keyer to the desired crystal frequency. A signal from the teletype is then applied to the keyer where it is frequency modulated. It then is coupled to the transmitter where it is multiplied to the channel frequency.

The KY-75/SRT keyer is used also for facsimile transmission. Newer models of Navy




1. 240

Figure 10-48. —Tone shift keyer/converter AN/SGC-1A.

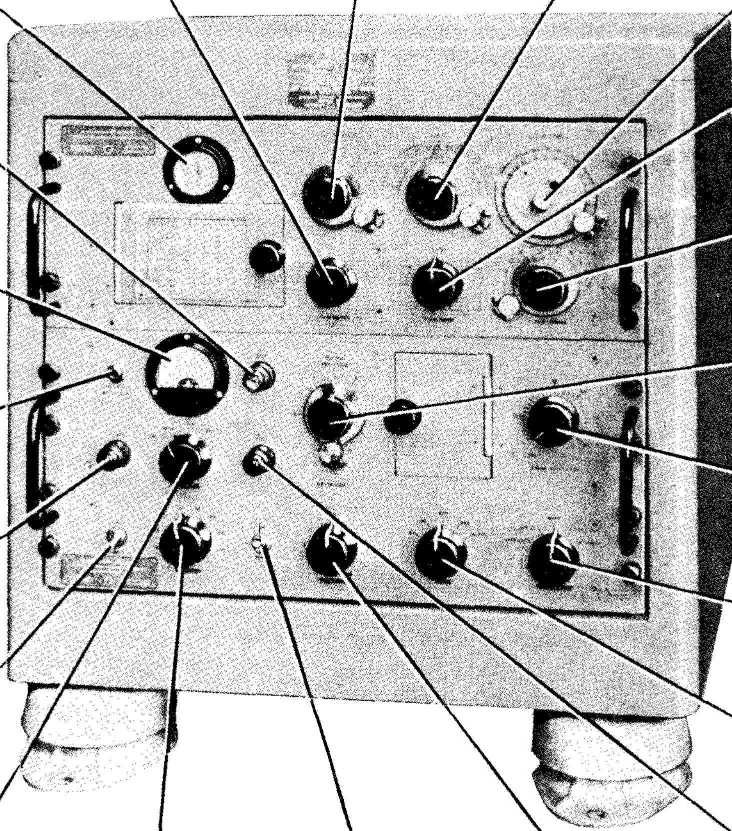
transmitters, such as the AN/SRT-15 described in chapter 9, have built-in keying circuits for frequency shift mode of operation. Thus they do not require an external keyer for either RATT or facsimile transmission.

## CONVERTER-COMPARATOR GROUPS

The AN/URA-8B frequency shift converter-comparator group, shown in figure 10-50, is used for diversity reception of RATT and FAX signals. The equipment consists of two frequency shift converters (top and bottom units) and a comparator (middle unit). Two standard Navy receivers are employed in conjunction with the converter-comparator group for either space diversity or frequency diversity reception.

In space diversity operation, the two receivers are tuned to the same carrier frequency, but their receiving antennas are spaced several wavelengths apart. Because of the required spacing between antennas, space diversity usually is limited to shore station use. In frequency diversity operation, the two receivers are tuned to different carrier frequencies that are carrying identical intelligence. Frequency diversity reception commonly is used aboard ship for copying fleet broadcasts, which are keyed simultaneously on several frequencies.

In diversity reception, the audio output of each receiver is connected to its associated frequency shift converter, which converts the frequency shift characters into d-c pulses. The d-c (or mark-space) pulses from each converter are fed to the comparator. In the




31.35

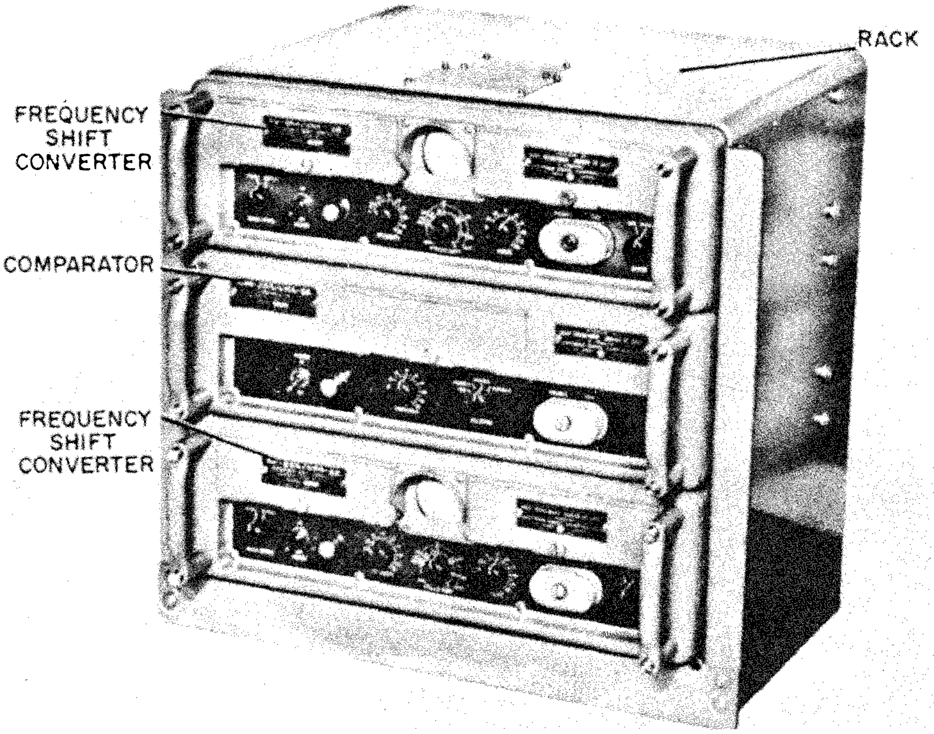
Figure 10-49.—Frequency shift keyer KY-75/SRT.

comparator, an automatic circuit compares the pulses and selects the better mark and the better space pulse for each character. Output of the comparator is patched to the teletypewriter. Converter units also can be used individually with separate teletypewriters to copy two different FSK signals.

The newest converter-comparator group is the AN/URA-17 shown in figure 10-51. This completely transistorized equipment is designed to perform the same functions as the AN/URA-8B. Although present procurement of frequency shift converters is confined to the AN/URA-17, relatively few of these installations are in use, compared with the larger number of AN/URA-8B converters. Detailed instructions for operating the AN/URA-8B and the AN/URA-17 are contained in their respective technical manuals.

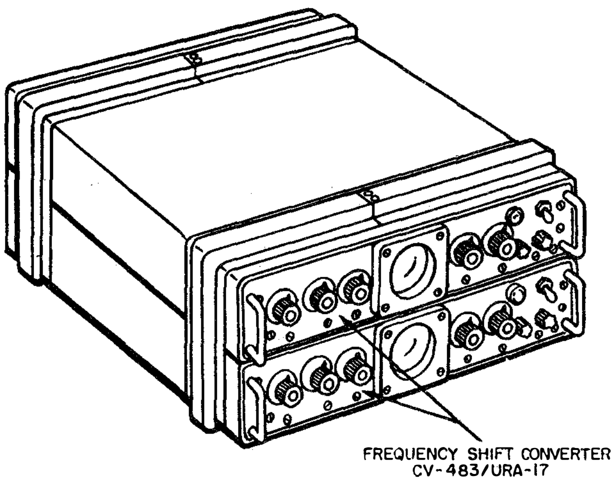
The AN/URA-17 consists of two identical converter units. Each converter has its own comparator circuitry. Hence, a separate comparator unit is not required. The physical size of the AN/URA-17 is further reduced by using transistors and printed circuit boards. The complete equipment is less than half the size of the older AN/URA-8B.

Proper tuning of the receivers employed with these converter-comparator groups is of the utmost importance. Each converter has a small monitor oscilloscope that gives a visual



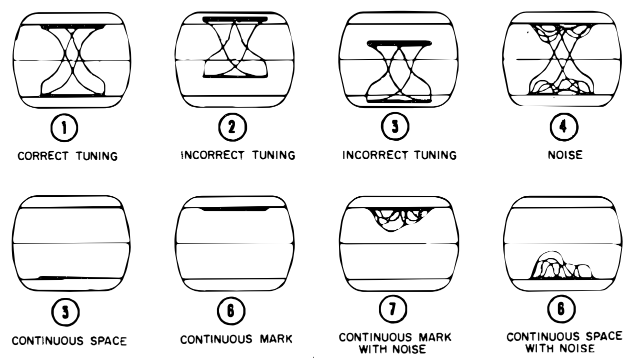

1.235

Figure 10-50.—Frequency shift converter-comparator group AN/URA-8B.




50.76

Figure 10-51.—Converter-comparator group AN/URA-17.




1.239.3

Figure 10-52.—Monitor oscilloscope patterns for frequency shift converters.

indication of the receiver tuning. Scope patterns for correct and incorrect tuning are shown in figure 10-52.

TRANSMITTER TELETYPE CONTROL UNIT

Another piece of equipment used with teletype installations aboard ship is the control unit shown in figure 10-53. This unit is mounted close to the teletype keyboard, and permits remote control of the radio transmitter. It has a transmitter power on-off switch, a power-on indicator lamp, a carrier-on indicator lamp, and a three-position rotary selector switch.

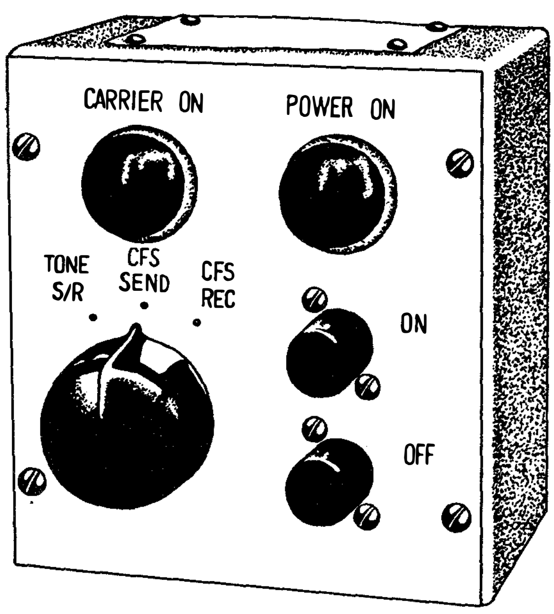
The TONE S/R switch position is used for both sending and receiving when using tone shift keyer/converter AN/SGC-1A. When using carrier-frequency shift mode of operation, the operator must switch to CFS SEND position for transmitting, and to CFS REC position for receiving.

ELECTRONIC MULTIPLEX TERMINAL SET

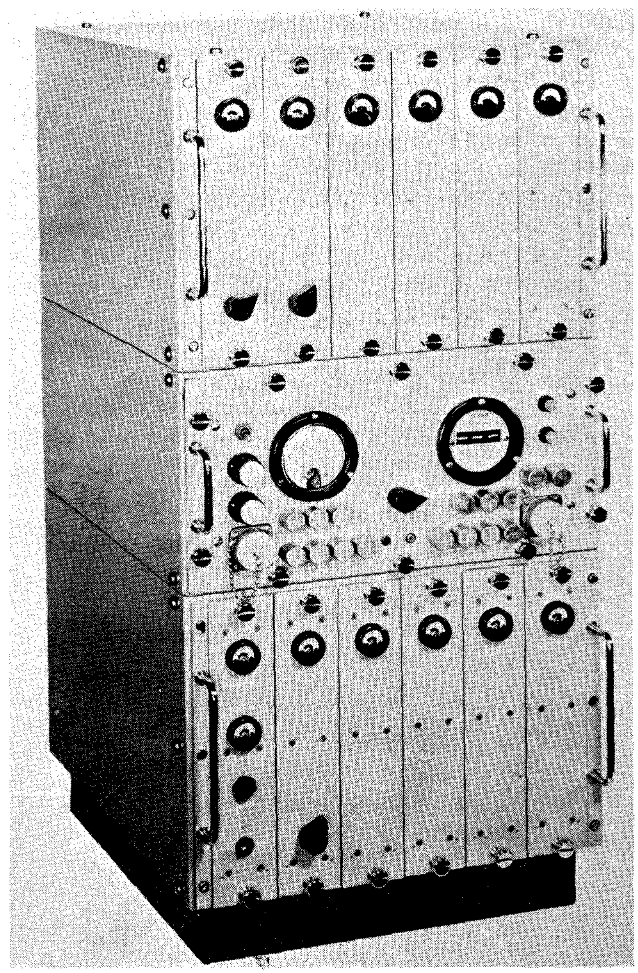
Model AN/UGC-1 (fig. 10-54) is a send-receive electronic time-division multiplex terminal set. It is used chiefly for teletype communications over long-range, high-frequency radio circuits using frequency shift keying.

Time-division MUX (multiplex) is the transmission of the intelligence of several teletypewriter circuits on a time-sharing basis in a character-by-character sequence. Teletype signals can be fed into the MUX equipment simultaneously from two, three, or four teletypewriters. The same information is then transmitted from one MUX equipment to the receiving group at the distant station in a time sequence with one character from each channel at a time. The receiving MUX then distributes the information to the proper teletypewriter circuits in their original on-off direct-current form. Up to four characters are therefore transmitted over a single circuit during the time ordinarily required by one.

As shown in figure 10-54, AN/UGC-1 consists of one piece of equipment divided into two sections: the telegraph transmitting group and the telegraph receiving group. This terminal equipment does not however, take the place of the radio transmitter and receiver. The transmitter and receiver still are required as in any other methods of RATT transmission and




1.244.1
Figure 10-53. —Transmitter teletype control unit.



31.37
Figure 10-54. —Transistorized electronic multiplex telegraph terminal set AN/UGC-1.

reception. In the simpler RATT systems described previously, the AN/UGC-1 transmitting section may be considered as the keyer, and the receiving section as the converter.

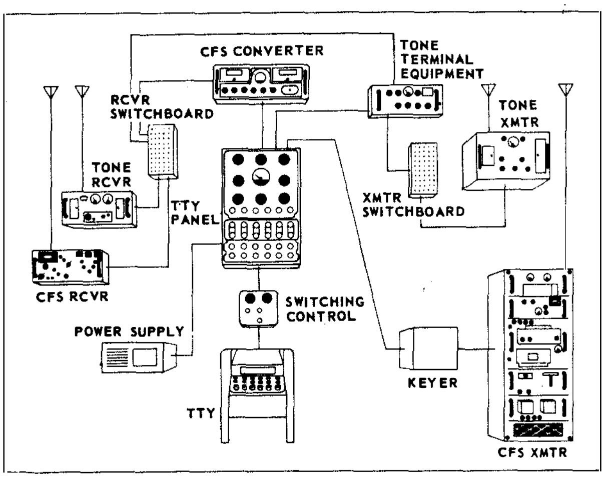
The operating speed of all teletypewriters used with the MUX set must be identical so that both terminals of the system can cycle in synchronism. Normally, 100 wpm channel speed is used, although the units and the teletypewriters can be changed to operate at 60 or 75 wpm.

The AN/UGC-1 is completely transistorized. It and the receiver group, transmitter group, and a common power supply are all housed in a single cabinet only 36 inches high. The AN/UGC-1 offers a choice of three system channel speeds: 60, 75, or 100 wpm per channel, and two, three or four channels of operation, depending on traffic requirements and radio propagation conditions.

A recently developed transistorized telegraph terminal set designed for 100 wpm, single sideband operation is the AN/UCC-1. Multiplexing is accomplished by frequency division. The equipment has the capability of 16 narrowband channels or 8 narrowband channels and 4 narrowband to wideband channels, in the frequency range of 300 to 3300 cps. Spacing between channels is 170 cps.

## RATT SYSTEMS AFLOAT

The various pieces of equipment—teletypewriters, keyers, converters, receivers, and transmitters—are combined into a complete RATT (radioteletype) system. The Navy uses two basic RATT systems aboard ship. One, the tone-modulated system for short-range operation, is similar to the familiar a-m radio. The other, the carrier-frequency shift system for long-range operations, is similar to the standard f-m radio. The two systems are shown in figure 10-55.

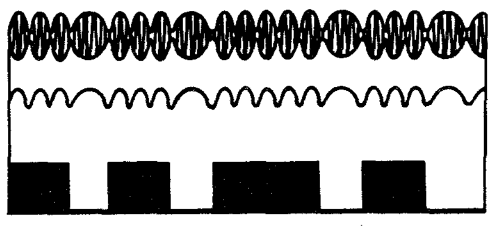



1.225
Figure 10-55. —Basic RATT transmit-receive systems.

The page printer—model 15 or 28—sends out a continuity of d-c on-and-off pulses (timed intervals of current and no-current). These intervals are, of course, mark and space impulses, and various combinations represent the various characters being transmitted.

When two teletypewriters are wire-connected, the exchange of intelligence between them is direct. But when the teletypewriters are not joined by wire, operation is more complex. Direct-current mark and space intervals cannot be sent through the air.

The gap between the machines must be bridged by radio. To bridge the gap, a radio transmitter and receiver are needed. The transmitter produces a radiofrequency carrier wave to carry the mark and space intelligence. A device such as a keyer is needed to change d-c pulses from the teletypewriter into corresponding mark and space modulation for the carrier wave in the transmitter. The radio receiver and a converter are required to change the radiofrequency signal back to d-c pulses. Figure 10-56 shows a modulated carrier wave with audio tone impulses impressed on the radiofrequency carrier wave, with corresponding d-c mark and space signals. Figure 10-57 shows a carrier-frequency shift wave that increases and decreases to denote mark and space d-c impulses. In the operations shown in figures 10-56 and 10-57, the

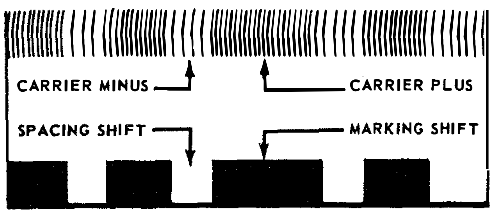


1.226
Figure 10-56. —Modulated carrier wave with corresponding audio tone for mark and space electrical impulses.

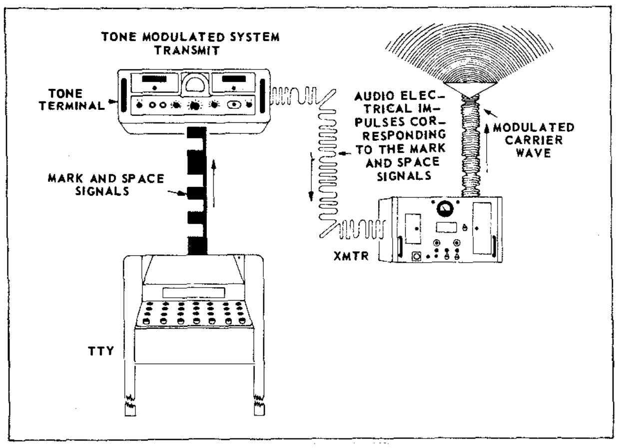
d-c teletypewriter signal that can travel only by wire becomes, through the medium of a tone terminal or keyer unit, either a tone-modulated signal or a carrier-frequency shift signal for radio carrier wave transmission.

SHORT-RANGE SYSTEM

To transmit messages by the short-range system, a page printer, a tone terminal, and a transmitter are used. This printer sends out a d-c signal. The signal is changed to audio tones in the tone terminal. The transmitter impresses the audio tones on the carrier and sends out a tone-modulated carrier wave (fig. 10-58).




1.227
Figure 10-57. —Frequency of carrier wave increases and decreases corresponding to mark and space impulses.




1.228
Figure 10-58. —D-C mark and space impulses converted to audio tones and impressed on carrier wave.

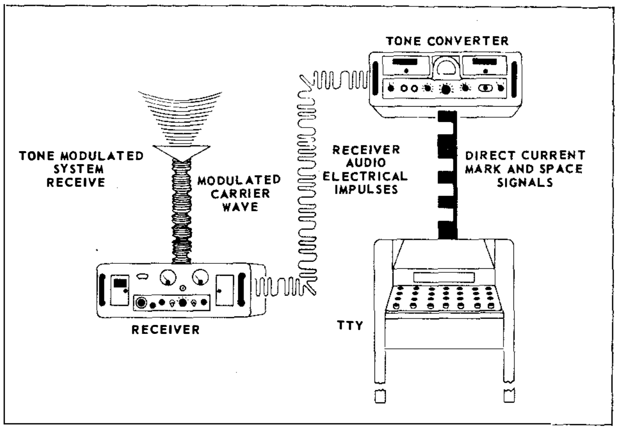
To receive messages with the short-range system, a radio receiver, a tone converter, and a page printer are required. The tone-modulated carrier wave enters the receiver, which extracts the signal intelligence and sends the audio tones to the tone converter. The converter changes the audio tones into d-c mark and space pulses for the page printer (fig. 10-59).

In practice, the same tone terminal is used for the receiving and the sending circuit inasmuch as it contains both a transmit "keyer" unit and a receive "converter" unit.

LONG-RANGE SYSTEM

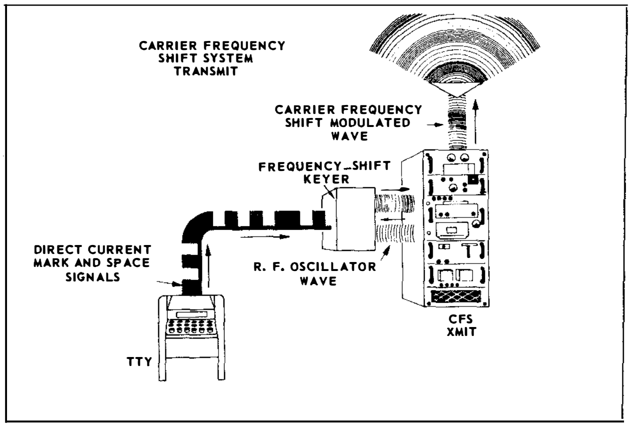
At the transmitting end of the long-range system are a page printer, a transmitter, and a frequency shift keyer unit. The keyer unit is built into newer transmitters, but in some older systems it is a separate piece of equipment. When the page printer is operated, d-c mark and space signals are changed by the keyer unit into frequency shift intervals. These frequency shift intervals are transmitted as carrier-frequency shift signals (fig. 10-60).

On the receiving side of the long-range system are a receiver, a frequency shift converter, and a page printer. When the carrier-frequency shift signal enters the receiver, it is detected and changed into a corresponding frequency shifted audio signal. The audio output of the receiver is fed to the converter, which changes the frequency-shifted audio signal into d-c mark and space signals (fig. 10-61).

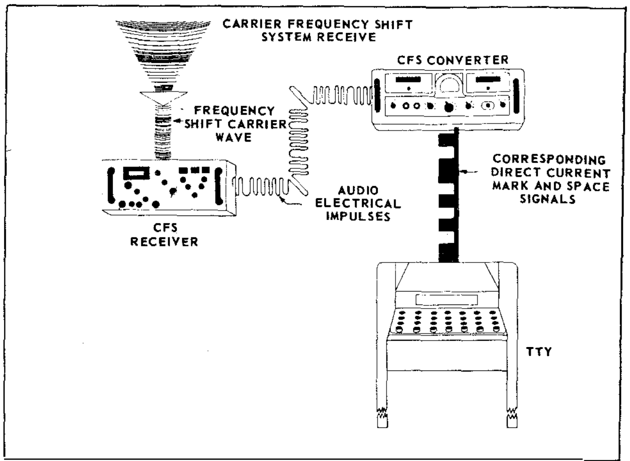



1.229
Figure 10-59. —Receiving operation of tone converter.

In both the tone-modulated system and the carrier-frequency shift system, all teletypewriter signals pass through the teletypewriter panel that controls the looping current in all the circuits. The teletypewriter panel integrates the tone-modulated and the carrier-frequency shift systems. It provides every possible RATT interconnection available on board ship. This operational flexibility gives maximum efficiency with the fewest circuits and the least amount of equipment in the Navy's compact RATT systems afloat.




1.230
Figure 10-60. —D-C mark and space impulses are changed by the keyer unit into frequency shift intervals.




1.231
Figure 10-61. —Conversion of frequency shifter carrier wave into mark and space impulses.

# CHAPTER 11

# TELETYPEWRITER PROCEDURE

Teletype is the primary means of communications now in use by the Navy. As stated in chapter 2, the Naval Communication System is the Navy-operated portion of the DCS. Most of this system uses fully automatic means of relaying message traffic. This automatic equipment is designed so that it will reject messages that are not in accordance with correct message-handling procedures. When proper procedure is used, messages arrive at their destination quickly, with a minimum amount of handling by communication personnel. This chapter and applicable publications should be studied thoroughly to ensure proper use of teletype procedure.

## ROUTING INDICATORS

In order to move relay message traffic efficiently from one point to another, each station in a teletypewriter network is designated by a routing indicator. An indicator is made up of a group of from four to seven letters, according to a specific pattern, to indicate the nation to which the station belongs, its geographic area, and whether it is a major, minor, or tributary station.

### CONSTRUCTION

Routing indicators are distinguished easily from call signs and address groups because the first letter of a routing indicator is always the letter R. Routing indicators are not encrypted for transmission security purposes. The second letter identifies the communication system of each country. Those of the United States and Allied Nations are as follows: A—Australia, B—British Commonwealth (less Canada), C—Canada, U—United States, X—Nato. The third letter indicates the geographical location in which a station is located or from which it is served. The fourth and subsequent letters identify relay and tributary stations.

## PUBLICATIONS

Publications of principal importance to teletype operators are the effective editions of ACP 127 (with United States Supplement), ACP 117 (with Canadian and United States supplements), JANAP 128, and DNC 5. Tape relay procedure is dealt with in ACP 127 and DNC 5. Routing indicators are listed in ACP 117 and supplements thereto. Instructions pertaining to AUTODIN are found in JANAP 128.

Supplements actually are separate publications, issued by individual Allied countries, that amplify (or expand) the basic publications. For example, ACP 127 U. S. SUPP-1 prescribes operating procedures that are peculiar to United States to United States tape relay networks. Listed in ACP 117 CAN-US SUPP-1 (a combined supplement) are routing indicators for Canada, The United States, and Allied countries that have teletypewriter interchange agreements. The ACP 117 US SUPP-1 contains information to be used in routing unclassified (including off-line encrypted) U. S. -originated messages only, to unlisted military and nonmilitary activities, including those requiring commercial refile, both within the United States and overseas, for which routing has not been provided in the current edition of ACP 117 CAN-US SUPP-1.

At larger shore COMMCENs, the routing indicator book would literally be worn out in a short time through constant usage. For that reason, most of the busier message centers ashore transfer routing information from ACP 117 to cardboard strips, which are held in metal frames supported by revolving stands called spindles. Routing spindles are practically indestructible and provide speedier access to current routing information. They also provide more space for entering frequent routing indicator changes than is available on a fixed, printed page.

## MACHINE FUNCTIONS

Machine functions are of the utmost importance in teletype operation. Because some functions do not show up on the printed page copy of the message, one may wonder why it is necessary to use them at all. Remember that teletype messages are relayed in tape form; machine functions play an important part in efficient operation of the tape relay system. An explanation of machine functions and rules for their use are given in the ensuing six topics.

### SHIFT (FIGS) AND UNSHIFT (LTRS)

Teletype machines, owned or leased for use in naval communications, shift from uppercase characters (figures) to lowercase characters (letters) only when the LTRS key is pressed. Many naval messages, however, are delivered to some addressees by commercial teletypewriter exchange service (TWX). The TWX machines shift automatically from uppercase to lowercase characters whenever the SPACE BAR is pressed, in addition to shifting when the LTRS key is pressed. To ensure that this unshift-on-space feature does not result in errors, the following rules must be complied with when transmitting by direct keyboard or punching tape on either a TWX or Navy-owned or leased teletype.

1. Always press the LTRS key to shift from uppercase to lowercase (disregarding the unshift-on-space feature of TWX machines). Example: 35784 (SPACE) (LTRS) TRY MAKE. This procedure has no adverse effect on either a TWX or Navy machine. Failure to follow this procedure would result in the following error:
   a. Transmitted on TWX machine: 35784 TRY MAKE.
   b. As received on Navy machine: 35784 546 . -(3.
2. Always press the FIGS key to shift from lowercase to uppercase, and also after the space before each group of figures or uppercase characters in a series. Example: 35784 (SPACE) (FIGS) 27896... The procedure in step 2 has no adverse effect on either a TWX machine or on a Navy machine. This rule applies whether direct keyboard transmission or tape perforation is used. Failure to follow this practice would result in the following error:
   a. Transmitted on Navy machine: 35784 (SPACE) 27896.
   b. As received on TWX machine: 35784 WUIOY.

### CARRIAGE RETURN (CR)

The carriage return function resets the machine to the left margin of the paper. As a special precaution to make sure that the carriages return on all machines properly, the operator presses the CR key twice at the end of each line. Regardless of typing speed when punching a message tape, the message is transmitted on circuits running at 60, 75, or 100 words per minute. At these high speeds, the carriage does not have enough time to return to the left margin on a single CR function. As a result, the next character prints while the carriage still is moving toward the left. Always remember to press the CR key twice at the end of each line in the message example in this chapter.

### LINE FEED (LF)

The line feed function advances the paper on the page. Note that the normal end-of-line functions include only one LF. At the end of the message, however, eight LF functions are used to provide more space between messages on the printed page.

### BELL SIGNAL

The bell signal attracts the attention of the receiving operator. It precedes the precedence prosign in the routing line (format line 2) in FLASH messages.

On most teletypewriters the bell signal rings when the uppercase S key is pressed. Some equipments, though, particularly those used in the Canadian tape relay network, have the bell on the uppercase J key. Correct procedure, consequently, requires the bell signal to be transmitted as follows: (FIGS) JJJJJSSSSS (LTRS).

### SPACE (SP)

The space function advances the carriage without printing any character on the page. It is used throughout the message for spacing between prosigns, routing indicators, words or groups, and the like.

### BLANK (BL)

Pressing the blank key has no effect on the page copy of a message, but it advances blank tape through the punch block of the teletype perforator. The blank function is required in operating certain cryptosystems, but has no application in teletype procedure. Do not substitute BLs for LTRS functions.

## MESSAGE ALIGNMENT

Message alignment is essential so that the receiving teletypewriter can print a legible page copy of the message. The alignment procedure given here is for guidance when preparing message tapes for transmission. Functions that usually are inserted by the automatic channel numbering unit are discussed in the topic. Machine functions that are a part of message alignment must appear in the specified sequence. Otherwise, the message is rejected at the first automatic relay station along its route.

All messages must be preceded by five spaces, the appropriate security warning prosign (if used), two carriage returns, and one line feed. Transmission must begin with five spaces. Any tape feedout functions preceding the five spaces are not transmitted.

Functions at the end of each line of a message are two carriage returns and one line feed. An exception is when the end of a line is also the end of a page of a long message. Then, end-of-line functions are two carriage returns and four line feeds.

End-of-message functions are two carriage returns, eight line feeds, letter N repeated four times, and 12 letters (functions). (The BL key is not used in lieu of LTRS. Any tape feedout in excess of 12 LTRS is removed before a message is transmitted.)

Separation between groups within any given line of a message is one space, except in the text of tabulated messages (presented later in message examples). Spacing between routing indicators in the routing line is particularly important because routing indicators are sensed by the automatic switching equipment when it is determining message routes.

The lines of a teletype message are limited to 69 characters, including spaces.

## MESSAGE NUMBERING

In addition to the DTG and any message identifying numbers (called cite numbers) in the text, numbers assigned a message for identification purposes are of two types. They are station serial numbers and channel numbers.

### STATION SERIAL NUMBERS

Teletype messages are assigned station serial numbers by the station originating (punching) the messages. Messages are numbered consecutively for a 24-hour period, beginning at ØØØ1Z each day.

Station serial number is a permanent means of message identification. It remains the same regardless of whether the message is destined for one or many addressees. Communication activities that need to refer to a message (to obtain repetitions, for example) cite the station serial number of the message as part of their identifying data. The station serial number also is referenced for in-station accountability of the message.

When a station has more than one outgoing position or transmitting channel, a separate set of serial numbers is used for each channel. In such instances, a channel letter designator is added to the station serial number to identify the channel over which the message is transmitted. The leter appears after the station serial number. Letter A usually is assigned the first channel. The next channel is designated B, the next C, and so on. Station serial number 107B, for example, indicates a message transmitted over channel B of a teletypewriter station.

### CHANNEL NUMBERS

Another name for channel numbers is transmission identification (TI). Both terms are used interchangeably.

To provide a means of keeping a constant check on traffic between stations, a channel number is required in the heading of every message. The channel number ensures that no message is lost or unaccounted for. Each station relaying a message adds its channel number to the head of the message. The station receiving the message checks this channel number against its record of transmissions received from that station. The number of transmissions received and the number in the message heading must agree. Such a check on traffic is known as "protecting the continuity of service." Understand: A message carries the same station serial number all the way, but receives a new channel number at each relaying station.

Equipment that automatically sends transmission identification ahead of each message is the most satisfactory means of performing the identification function. When automatic number equipment is unavailable, transmission identification is prepared in tape form in such a way that a tab containing identification for one transmission can be detached from a roll and be transmitted ahead of each message. As a last resort, transmission identification is incorporated directly into each message as it is being prepared for transmission.

Transmission identification for messages transmitted directly into fully automatic relay stations consists of (1) letter V; (2) start of message indicator ZCZC; (3) three-letter station and channel designators; (4) one figures shift, (5) a channel serial number; and (6) one letters shift. Example: VZCZCABC(FIGS)Ø31 (LTRS).

The preceding example is explained in this manner: Letter V is required to ensure that the first character of intelligence is not lost or garbled. The start of message indicator (abbreviated SOM) activates the automatic switching equipment at the relay station. (The SOM must appear only once in each transmission, introduced directly into an automatic relay station.) Letters ABC are the station (B) and the channel (C) designators of the station making the transmission. The figures shift is operated once to shift the equipment from lowercase to receive the channel serial (Ø31). Then, the letters shift is operated once to bring the equipment back to the lowercase position.

A slightly different form of transmission identification applies in messages transmitted directly into torn tape relay stations. It consists of (1) letters VV: (2) three space functions: (3) the three-letter station and channel designators: (4) a figures shift; (5) a channel serial number; and (6) a letters shift. Example: VV(3 SPACES) ABC(FIGS)Ø31(LTRS).

The explanation of the foregoing example is the same as for the automatic system, except that characters VV(3 SPACES) replace the start of message indicator. This substitution is made because ZCZC serves no purpose unless automatic switching equipment is used.

## MESSAGE FORMAT

Messages transmitted over tape relay circuits must be prepared in the format shown in table 11-1. The 15 format lines are explained briefly in the table, and are amplified in the following paragraphs.

Line 1: Because format line 1 contains the message transmission identification, its construction varies with the type of relay station into which an operator is transmitting. If transmitting into an automatic station, this line must include the start of message indicator(ZCZC). Security prosigns referred to in the Contents column of table 11-1 are not used by the United States. Hence, they are not discussed in this test. (Consult ACP 127 U.S. SUPP-1.) Pilots are explained under a separate topic later in this chapter.

Line 2: Tape preparation usually begins with line 2, the routing line. It consists of the precedence prosign (repeated) and the routing indicators of stations called, that is, stations to which message is routed for final delivery. To avoid misroutes, the routing line must be prepared with special care.

In multiple-call messages, all routing indicators associated with a single relay station are grouped together in the routing line. They are not intermingled indiscriminately. If a called station serves more than one addressee in the message, the station's routing indicator need appear only once in line 2.

When dual precedence is used, only the higher precedence appears in the routing line. If a dual precedence of FLASH and a lower precedence are assigned a multiple-address message, and the message required using more than nine routing indicators in line 2, the originating station makes two separate transmissions. One transmission goes to the action addressees, and the other is sent to the information addressees. Remember: When the FLASH precedence prosign is transmitted in the routing line, it is preceded by the bell signal.

Table 11-1.—Teletype Message Format

| Parts | Components | Elements | Format Line | Contents | Explanation [1] |
|---|---|---|---|---|---|
| HEADING | Procedure | Handling instructions | 1 | Transmission identification.<br>Security warning prosign (when used).<br>Pilot - Pilots contain:<br>Repeated precedence prosign.[2]<br>Routing indicator(s).<br>Prosigns, operating signals and address designations[3] as required. | Always contains transmission identification (which includes the "start of message indicator" when necessary); also contains pilot(s) as required to convey specific message-handling instructions. |
| | | Called station(s) | 2 | Repeated precedence prosign.[2]<br>Routing indicator(s) of station(s) responsible for delivery or refile. | Basic routing line.<br>If message is dual-precedence, only the higher precedence is shown in this line. |
| | | Calling station and filing time | 3 | Prosign DE.<br>Routing indicator(s) of station preparing message for transmission.<br>Station serial number.<br>Filing time. | Filing time is the date and time the message was filed with the communication center. |
| | | Transmission instructions | 4 | Security warning operating signals.<br>Prosign T.<br>Other operating signals.<br>Special operating group(s) (SOGs).<br>Address designator(s).<br>Routing indicator(s). | Indicates specific transmission responsibility not apparent in other components of the message heading. Not to be used unless necessary. Plain language address designators are not permitted in codress messages. |
| | Preamble | Precedence; date-time group; message instructions | 5 | Precedence prosign(s).<br>Date-time group and zone suffix (Z indicating Greenwich mean time). Followed by abbreviated month and year.<br>Operating signal(s). | In dual precedence, both prosigns are shown separated by a space. Operating signals are used only when required to convey message-handling instructions. |
| | Address | Originator | 6 | Prosign FM.<br>Originator's designation. | Message originator is indicated by plain language, routing indicator, address group, or call sign. |
| | | Action addressee(s) | 7 | Prosign TO.<br>Routing indicator(s).<br>Operating signal.<br>Address designation(s). | Action addressees are indicated by plain language, routing indicator(s), address group(s), or call sign(s). In multiple-address messages, when addressees are listed individually, each address designation must be on a separate line and may be preceded either by the operating signal ZEN (meaning delivered by other means) or by the routing indicator of the station responsible for delivery. Such use is mandatory on all joint and combined messages. |
| | | Information addressee(s) | 8 | Prosign INFO.<br>Routing indicator(s).<br>Operating signal(s).<br>Address designator(s). | Same as for line 7, except that line 8 pertains to information addressee(s). |

76.49.1

Table 11-1.–Teletype Message Format – Continued

| Parts | Components | Elements | Format Line | Contents | Explanation [1] |
|---|---|---|---|---|---|
| HEADING Contd | Address - Continued | Exempted addressee(s) | 9 | Prosign XMT.<br>Address designator(s). | Used only when a collective address designation is used in line 7 or 8 and an indication of the addressee(s) exempted from the collective address is required. |
| | Prefix | Accounting information; group count | 10 | Accounting symbol (when required).<br>Group count prosign GR.<br>Group count. | The group count prosign and group count must be used only when the text consists of countable encrypted groups. |
| SEPARATION | | | 11 | Prosign BT. | |
| TEXT | | Classification; internal instructions; thought or idea expressed by originator (in that order) | 12 | | See ACP 121 series. |
| SEPARATION | | | 13 | Prosign BT. | |
| ENDING | Procedure | Confirmation | 14 | | Not used in tape relay operation. |
| | | Correction | 15 | Prosign C.<br>Other prosigns, operating signals, and plain language as required. | |
| | | End-of-message functions | | 2CR, 8LF, 4Ns, 12LTRS | The 4Ns in this sequence are the end-of-message indicator. |

[1] Include only when required for clarity.
[2] If message is dual-precedence, only the higher precedence is shown in this line.
[3] Plain language designators are not permitted in codress messages.

76.49.2

Line 3: Line 3 consists of the prosign DE, routing indicator of station preparing the message for transmission, station serial number, and the date and time a message is received in the communication center for transmission (shown as calendar date separated by slant from hour and minutes expressed in digits followed by zone suffix, e.g., 11/1215Z, or by the Julian date immediately followed by hour and minutes in digits without a zone suffix, e.g., 2241215). The filing time for refile messages is the date and time the message is received by a communication center for refile. It is essential that the prosign DE follow immediately the two carriage returns and one line feed at the end of the routing line (line 2). Automatic relay equipment is designed to stop seeking outgoing channels upon receipt of the letter D at the beginning of format line 3.

Line 4: Line 4 consists of the operating signals ZNR or ZNY, followed; by the appropriate classification characters repeated five times, e.g., ZNR UUUUU, ZNY CCCCC, ZNY SSSSS. The classification character for unclassified EFTO (encrypt for transmission only) is the letter E. When necessary, transmission instructions denoting transmission and/or delivery responsibility are included in line 4. Such instructions are employed only when essential to ensure delivery of the message. They are not used when stations called are automatic guard for addressees, nor when delivery responsibility is indicated in the address portion of a message.

Lines 5 and 6: See table 11-1 for explanation.

Line 7: Line 7 is the action addressee line, and commence with the prosign TO. It contains address designators of commands or activities that are to take action on the message. Action addressees are indicated by plain language, routing indicators, address groups, or call signs.

Delivery responsibility is indicated by preceding each address designation with the routing indicator of the station responsible for delivery to that addressee. An exception to this procedure is when addressees are designated by a collective address designator or an address indicating group. Then, it is unnecessary to precede the designator with routing indicators. When a single station is responsible for delivery to all addressees represented by a collective address designator, however, that station's routing indicator precedes the designator. When delivery to an addressee is accomplished by other means than a particular transmission, the operating signal ZEN is used in place of a routing indicator. A slant sign separates the routing indicator (or ZEN) from the address designator.

Line 8: The explanation of line 8 is the same as line 7, except that line 8 pertains to information addressees.

Line 9: Line 9 is utilized when necessary to exempt one or more addressees from a collective address designator appearing in lines 7 or 8. Line 9 consists of prosign XMT and designator(s) of commands or activities exempted from the collective address designator.

Line 10: In tape relay procedure, line 10 (group count) is included only when the text of a message consists of encrypted groups. An accounting symbol is used to indicate financial responsibility only when the message requires commercial refile. (Complete instructions concerning accounting symbols are contained in ACP 127 U. S. SUPP-1.)

Line 11: Prosign BT appears in line 11. It separates the text from the message heading.

Line 12: Line 12 is the text of a message. The first word of all plain language test messages must be either the abbreviation UNCLAS, the word CLEAR, or the security classification of the message. The abbreviation UNCLAS indicates that the message is unclassified, and that the originator has authorized its transmission over nonapproved circuits. The abbreviation UNCLAS and the word CLEAR are sent as one word, but a space is transmitted between each letter of the security classification of a classified message. For example, SECRET is sent as S E C R E T .

Line 13: Prosign BT appears in line 13. It separates the text from message ending.

Line 14: Line 14 is not used in tape relay procedure.

Line 15: Occasionally, an error in the text of a message is undetected until the message is nearly completed. Instead of cancelling the entire transmission (or destroying the tape) and starting the message again, the error is corrected in line 15. Correction consists of prosign C, followed by the correct version of the error. End-of-message functions are a part of line 15. They follow any necessary corrections, and consist of two carriage returns, eight line feeds, letter N repeated four times, and 12 letters functions. End-of-message functions must be in the exact order indicated.

## MESSAGE EXAMPLES

Message examples shown in the remainder of this chapter are for illustrative purposes only. They do not necessarily reflect actual routing indicator, call sign, or address group assignments. Format of examples, however, gives the proper sequence of message elements and line functions used. End-of-line and end-of-message functions are in parentheses. Messages are prepared as they would appear when reproduced on a page printer set for single line feed.

### PLAINDRESS MESSAGE

A plaindress message carries originator and addressee designators in the message heading. Message text may be plain language on encrypted. A group count is not required for plain language, but an encrypted message always carries a numerical group count.

#### Single-Address Message

Following is a plaindress version of a single-address message.

| Format line | | |
|---|---|---|
| | (5 SPACES 2CR LF) | |
| 2 | PP RUHPC | (2CR LF) |
| 3 | DE RUHPB Ø85 244Ø841 | (2CR LF) |
| 4 | ZNR UUUUU | (2CR LF) |
| 5 | P Ø1Ø837Z SEP 67 | (2CR LF) |
| 6 | FM CINCPACFLT | (2CR LF) |
| 7 | TO RUHPC/USS RENSHAW | (2CR LF) |
| 11 | BT | (2CR LF) |
| 12 | UNCLAS | (2CR LF) |
| | 1. THIS PLAINDRESS | (2CR LF) |
| | SINGLE-ADDRESS MSG IS | (2CR LF) |
| | PREPARED IN FORMAT | (2CR LF) |
| | PRESCRIBED FOR INTRA- | (2CR LF) |
| | NAVY MSGS ADDRESSED | (2CR LF) |
| | TO SINGLE ADDEES. | (2CR LF) |
| | 2. TRANSMISSION IN- | (2CR LF) |
| | STRUCTIONS ARE UN- | (2CR LF) |
| | NECESSARY BECAUSE | (2CR LF) |
| | DELIVERY RESPONSI- | (2CR LF) |
| | BILITY IS INDICATED IN | (2CR LF) |
| | ADDRESS OF MSG. | (2CR LF) |
| | 3. NOTE UTILIZATION | (2CR LF) |
| | OF LINE 15 TO CORRECT | (2CR LF) |
| | AN ASSUMED ERROR | (2CR LF) |
| 13 | BT | (2CR LF) |
| 15 | C WA PLAINDRESS | (2CR LF) |
| | SINGLE-ADDRESS | (2CR 8LF) |
| | NNNN | (12LTRS) |

#### Multiple-Address Message

A multiple-address message in intra-Navy form appears in the next example. Plain language address designators are employed because all the addressees are a part of the tape relay network.

| Format line | | |
|---|---|---|
| | (5 SPACES 2CR LF) | |
| 2 | RR RUHPB RUHPC RUATA | (2CR LF) |
| | RUWSPG | (2CR LF) |
| 3 | DE RUECW 115A 273150̸5 | (2CR LF) |
| 4 | ZNR UUUUU | (2CR LF) |
| 5 | R 3Ø1455Z SEP 67 | (2CR LF) |
| 6 | FM CNO | (2CR LF) |
| 7 | TO RUHPB/CINCPACFLT | (2CR LF) |
| 8 | INFO RUHPC/ | (2CR LF) |
| | COMHAWSEAFRON | (2CR LF) |
| | RUATA/COMFAIRWESTPAC | (2CR LF) |
| | RUWSPG/ | (2CR LF) |
| | COMWESTSEAFRON | (2CR LF) |
| 11 | BT | (2CR LF) |
| 12 | UNCLAS | (2CR LF) |
| | 1. INCLUSION OF CALL | (2CR LF) |
| | SIGNS/ADDRESS GROUPS | (2CR LF) |
| | IN ADDRESS UNNECES- | (2CR LF) |
| | SARY. | (2CR LF) |
| 13 | BT | (2CR 8LF) |
| 15 | NNNN | (12LTRS) |

A message received via CW, R/T, or manual RATT must be prepared in tape relay format before it can be introduced into the tape relay network. This preparation is made by the station that introduces the message into the network. (It is called the refile station.)

Assume that a refile station receives an unclassified message via radiotelegraph. Before tape preparation, the station must (1) insert routing indicators in format lines 2, 7, and 8; and (2) convert the heading to authorized plain language address designators.

The following example typifies a message prepared in tape relay format after it is received by radiotelegraph.

| Format line | | |
|---|---|---|
| | (5 SPACES 2CR LF) | |
| 2 | PP RUCKCF RUCKHC | (2CR LF) |
| | RUEGNE | (2CR LF) |
| 3 | DE RUECC Ø55 2521542 | (2CR LF) |
| 4 | ZNR UUUUU | (2CR LF) |

| Format line | | |
|---|---|---|
| 5 | P R Ø91428Z SEP 67 | (2CR LF) |
| 6 | FM USS TUCKER | (2CR LF) |
| 7 | TO RUCKCF/COMDESRON | (2CR LF) |
| | ONE TWO | (2CR LF) |
| 8 | INFO ZEN/COMDESDIV | (2CR LF) |
| | ONE TWO ONE | (2CR LF) |
| | RUCKHC/CINCLANTFLT | (2CR LF) |
| | RUEGNE/COMCRUDESLANT | (2CR LF) |
| | RUCKCF/CTF 14Ø | (2CR LF) |
| 11 | BT | (2CR LF) |
| 12 | UNCLAS | (2CR LF) |
| | 1. PLAIN LANGUAGE | (2CR LF) |
| | TEXT. | (2CR LF) |
| | 2. NOTE USE OF ZEN TO | (2CR LF) |
| | INDICATE MSG DLVD BY | (2CR LF) |
| | OTHER MEANS TO | (2CR LF) |
| | COMDESDIV 121. | (2CR LF) |
| | 3. NOTE USE OF DUAL | (2CR LF) |
| | PRECEDENCE. | (2CR LF) |
| | A. ONLY HIGHER | (2CR LF) |
| | PRECEDENCE APPEARS | (2CR LF) |
| | IN ROUTING LINE. BOTH | (2CR LF) |
| | APPEAR IN LINE 5. | (2CR LF) |
| 13 | BT | (2CR 8LF) |
| 15 | NNNN | (12LTRS) |

As indicated in the preceding example, RUCKCF has delivery responsibility for two addressees via fleet broadcast. If the message is transmitted on RATT broadcast, routing indicators and call signs normally are not removed. But if the message is sent on CW broadcast, routing indicators and call signs must be removed by RUCKCF. In other words, only plain language address designators appear in the heading. They are separated from each other by the separative sign.

## JOINT AND COMBINED FORM

Messages originated by or addressed to activities served by Army or Air Force tape relay networks must be in joint form. If addressees are served by teletypewriter systems belonging to other countries, the message format is called the combined form. These forms differ slightly from the intra-Navy form, however.

In the intra-Navy message form, routing indicators are used in the address of both single- and multiple-address messages to denote delivery responsibility. In the joint and combined forms, routing indicators are used for this purpose only in multiple-address messages. The address must consist of either all plain language designators or all call signs and address groups.

## ABBREVIATED PLAINDRESS MESSAGES

Operational requirements for speed of message handling may sometimes require abbreviation of plaindress message headings. Any or all of the following elements may be omitted from the message heading: precedence, date, date-time group, and group count.

Most plaindress messages originated within the teletype system omit the group count (format line 10). In this instance, absence of the group count does not, in itself, place the messages in abbreviated plaindress form. (This exception applies to the definition of the abbreviated plaindress form.) Only in encrypted messages are numerical group counts required for messages originated within the system.

Abbreviated plaindress form is employed widely in radiotelephone, radiotelegraph, and manual teletypewriter procedures. It is used rarely, if ever, in tape relay procedure. An abbreviated plaindress message is included in the explanation of manual teletypewriter procedures later in this chapter.

## CODRESS MESSAGES

A codress message is an encrypted message that has in the encrypted text the designations of the originator and addressees (and any internal passing instructions). Accordingly, the address components (format lines 6, 7, 8, and 9) are omitted. Codress is a valuable sesurity device, because it conceals the identity of units and prevents an enemy from making inferences from originator-addressee patterns.

Transmission instructions are required in the heading of codress messages when the station (or stations) called in line 2 is to deliver or refile the message without decrypting it. If the station is to decrypt the message, as well as refile it, the station's routing indicator must appear after prosign T in line 4. An example of a codress message follows.

| Format line | | |
|---|---|---|
| | (5 SPACES 2CR LF) | |
| 2 | OO RUCKCR RUECK | (2CR LF) |
| 3 | DE RUTPC Ø42C 2551Ø4Ø | (2CR LF) |
| 4 | ZNR UUUUU | (2CR LF) |
| | RUECK T RUECK XYPD | (2CR LF) |
| 5 | O 121Ø37Z SEP 67 | (2CR LF) |
| 10 | GR97 | (2CR LF) |
| 11 | BT | (2CR LF) |
| 12 | (Ninety-seven encrypted | (2CR LF) |
| | groups typed five characters | (2CR LF) |
| | per group and ten groups to | (2CR LF) |
| | the line.) | (2CR LF) |
| 13 | BT | (2CR 8LF) |
| 15 | NNNN | (12LTRS) |

## ROUTINE LINE SEGREGATION

The automatic relay system uses a method known as routing line segregation for routing multiple-call tapes (messages having two or more routing indicators in the routing line). This method means that routing indicators in the routing line are segregated or distributed in accordance with the desired transmission channel in the switching process. Under this method, only the routing indicators applicable to a particular transmission appear in the routing line. Messages received at a station that has further relay responsibility contain only the routing indicators for which that station has relay responsibility.

Routing line segregation does not affect tape preparation at the originating station; it is accomplished at relay stations. At the automatic relay stations, relay equipment segregates routing indicators automatically according to the required transmission path.

In order to make the semiautomatic relay system compatible with the fully automatic system, relay stations that are not connected directly to the automatic system must also perform routing line segregation on all relayed messages. To perform the routing line segregation, semiautomatic relay stations require an operator using special routing segregation equipment. Refer again to table 11-1 to understand routing line segregation process in the following message example.

Format lines 2 and 3 of a message as prepared by originating station RUQAC and forwarded to RUQA relay Asmara:

PP RUFRC RUCKC RUWSC RUMFC
DE RUQAC Ø27 2641234
(Etc.)

Station RUQA relay must make two transmissions of this message, one to RUTP, Port Lyautey, and another to RUMF, Philippines.
As relayed to RUTP:

VZCZCQAB137
PP RUFRC RUCKC RUWSC
DE RUQAC Ø27 2641234
(Etc.)

As relayed to RUMF:

VZCZCQAB137
PP RUMFC
DE RUQAC Ø27 2641234
(Etc.)

The next example is how the message is processed by RUTP. Two transmissions are required, one to RUFR, Naples, and the other to RUEC, Washington, for relay to RUCKC and RUWSC. The routing line is altered for the two transmissions as follows:
Transmission to RUFR:

VZCZCTPA296QAB137
PP RUFRC
DE RUQAC Ø27 2641234
(Etc.)

Transmission to RUEC:

VZCZCTPC678QAB137
PP RUCKC RUWSC
DE RUQAC Ø27 2641234
(Etc.)

Station RUEC is responsible for two transmissions, one to RUCK, Norfolk, the other to RUWS, San Francisco. Each transmission is reduced to a single call in the basic routing line.
As relayed to RUCK:

VZCZCECB311TPC678
PP RUCKC
DE RUQAC Ø27 2641234
(Etc.)

As relayed to RUWS:

VZCZCECD935TPC678
PP RUWSC
DE RUQAC Ø27 2641234
(Etc.)

From the preceding examples, it can be seen that routing indicators are dropped from the routing line when they have served their purpose. This procedure results in decreased transmission time for onward relay of the message. The message arrives at each terminal station with only that station's routing indicator in the routing line.

## PUNCTUATION

Message drafters try to word their messages clearly without using punctuation. Occasionally, though, punctuation is essential for clarity. In such instances, punctuation marks (or symbols) are used in preference to spelling out the desired punctuation.

All punctuation marks and symbols on U. S. military teletypewriter keyboards are authorized for use in U. S. networks. Only those marks and symbols listed in table 11-2, however, may be used in messages that have other routing indicators besides the United States in format line 2.

**Table 11-2.—Punctuation Used in Allied Messages**

| Punctuation | Abbreviation | Symbol |
|---|---|---|
| Period | PD | . |
| Hyphen | --- | - |
| Parentheses | PAREN | ( ) |
| Slant sign | SLANT | / |
| Colon | CLN | : |
| Comma | CMM | , |
| Question mark | QUES | ? |

## TABULATED MESSAGES

Ability to handle information in tabulated form is one of the many advantages of teletypewriter equipment. If a message is received for transmission in tabulated form, it normally should be transmitted in that form. In some instances column headings require more space than data in a column. When this inequality happens, use more than one line for headings. (Compare the form of headings in examples of incorrect and correct methods.) Keep columns as close as possible to the left margin, to reduce total transmission time.

In the first example, each dot represents the transmission of a space, which requires as much circuit time as transmitting a character. In the second example (the correct way), the same information is transmitted at a considerable saving of circuit time.

1. Example of incorrect method:

```
STOCK REPORT AND REQUIREMENTS

   CAT QUANTITY
ITEM NO   ON HAND  ARTICLE    REQUIRED
1...268423...1ØØ...CYL RINGS.........3ØØ
2... 93846... 39...MUFFLERS........  5Ø
3...624364... 28...MAGNETOS........  2Ø
4... 34256...3ØØ...WRIST PINS........3ØØ
5... 19432...14Ø...VALVES...........5ØØ
6... 43264... 42...CARBURETORS.....  5Ø
```

2. Example of correct method:

```
STOCK REPORT AND REQUIREMENTS
            QNTY
ITEM      ON HAND
  CAT NO         ARTICLE      RQRD
1 268423  1ØØ  CYL RINGS      3ØØ
2  93846   39  MUFFLERS        5Ø
3 624364   28  MAGNETOS        2Ø
4  34256  3ØØ  WRIST PINS     3ØØ
5  19432  14Ø  VALVES         5ØØ
6  43264   42  CARBURETORS     5Ø
```

## MULTIPLE-PAGE MESSAGES

To facilitate reproduction of incoming messages by distribution centers, all messages exceeding a total of 20 lines of heading and text, beginning with format line 5, are divided into pages for transmission.

1. Each page consists of not more than 20 lines.
2. The first page must begin with format line 5 of the message heading and continue for a total of 20 lines, including succeeding lines of the heading.
3. Second and succeeding pages must be identified by the page number, the routing indicator of the station of origin, and the station serial number. When message text is transmitted in plain language, the security classification or the abbreviation UNCLAS

must also be included as part of the page identification of second and succeeding pages. Page identification must appear on a separate line, and is not included in the line count as in step 2.

4. Machine functions used between pages are 2CR and 4LF.

5. The number of pages of message text in any transmission must not exceed five; a page consisting of part heading and part text does not count as a textual page. Messages that exceed five pages of message test are divided in transmission sections.

In the following example of the proper way to page a message, note that necessary corrections, where needed, appear at the end of the particular page. The rules regarding paging apply only to the narrative-type messages submitted to the message center in page copy form. Paging rules do not apply to statistical and meteorological (weather) messages in which paging information would disrupt processing by the user of the information, e. g., as when transmitting data from a series of punched cards. Such messages, however, are divided into transmission sections if they exceed 100 lines of text.

| | |
|---|---|
| (5 SPACES 2CR 1LF) | |
| RR RUWSPG RUHPS | (2CR 1LF) |
| DE RUECW Ø43B 2511123 | (2CR 1LF) |
| ZNR UUUUU | (2CR 1LF) |
| R Ø8Ø951Z SEP 67 | (2CR 1LF) |
| FM CNO | (2CR 1LF) |
| TO RUWSPG/COMWESTSEAFRON | (2CR 1LF) |
| RUHPB/CINCPACFLT | (2CR 1LF) |
| BT | (2CR 1LF) |
| UNCLAS | (2CR 1LF) |
| (14 lines of text) | (2CR 4LF) |
| PAGE 2 RUECW 43B UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 4LF) |
| PAGE 3 RUECW 43B UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 4LF) |
| PAGE 4 RUECW 43B UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 1LF) |
| C LINE 6 WA LANDING POINT | (2CR 4LF) |
| PAGE 5 RUECW 43B UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 1LF) |
| C LINE 14 WB THAT UNLIKELY | (2CR 4LF) |
| PAGE 6 RUECW 43B UNCLAS | (2CR 1LF) |
| (Remainder of text not to exceed | (2CR 1LF) |
| 20 lines) | (2CR 1LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

## LONG MESSAGES

Messages that exceed five textual pages are long messages. They must be transmitted in sections. This procedure prevents prolonged circuit tieups that could result in delaying more important traffic.

At a convenient point within the limits of five pages, the text of a long message is separated into sections. Normally, separation is at the end of a sentence or a cryptopart. (Long encrypted messages have cryptoparts.) Each section is numbered and the section number is inserted on the same line as the abbreviation UNCLAS or appropriate security classification. When a message is divided into two sections, the first section is identified as SECTION 1 of 2, and the second as FINAL SECTION OF 2. In long encrypted messages, when a transmission section commences with a new cryptopart, identification of the cryptopart follows designation of the transmission section. Transmission sections of a long message have the same heading, except that station serial numbers change with sections. Each section bears the same date-time group and filing time. A group count, if used, applies only to the section it accompanies. Transmission section and page identification are not included in the group count. The cryptopart identification is included. Following are examples of a message handled in two transmission section.

| | |
|---|---|
| (5 SPACES 2CR 1LF) | (2CR 1LF) |
| RR RUHPB RUWSPG RUMGB | (2CR 1LF) |
| DE RUECW 1Ø5A 2612015 | (2CR 1LF) |
| ZNR UUUUU | (2CR 1LF) |
| R 181912Z SEP 67 | (2CR 1LF) |
| FM CNO | (2CR 1LF) |
| TO RUHPB/CINCPACFLT | (2CR 1LF) |
| INFO RUWSPG/ | (2CR 1LF) |
| COMWESTSEAFRON | (2CR 1LF) |
| RUMGB/COMNAVMARIANAS | (2CR 1LF) |
| BT | (2CR 1LF) |
| UNCLAS SECTION 1 OF 2 | (2CR 1LF) |
| (13 lines of text) | (2CR 4LF) |
| PAGE 2 RUECW 1Ø5A UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 4LF) |
| PAGE 3 RUECW 1Ø5A UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 4LF) |
| PAGE 4 RUECW 1Ø5A UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 4LF) |
| PAGE 5 RUECW 1Ø5A UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 4LF) |

| | |
|---|---|
| PAGE 6 RUECW 1Ø5A UNCLAS | (2CR 1LF) |
| (20 lines of text) | (2CR 1LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |
| (5 SPACES 2CR 1LF) | |
| RR RUHPB RUWSPG RUMGB | (2CR 1LF) |
| DE RUECW 1Ø6A 2612015 | (2CR 1LF) |
| ZNR UUUUU | (2CR 1LF) |
| R 181912Z SEP 67 | (2CR 1LF) |
| FM CNO | (2CR 1LF) |
| TO RUHPB/CINCPACFLT | (2CR 1LF) |
| INFO RUWSPG/ | (2CR 1LF) |
| COMWESTSEAFRON | (2CR 1LF) |
| RUMGB/COMNAVMARIANAS | (2CR 1LF) |
| BT | (2CR 1LF) |
| UNCLAS FINAL SECTION OF 2 | (2CR 1LF) |
| (PAGED AS NECESSARY) | (2CR 1LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

## CORRECTING ERRORS

Even the best operators sometimes make mistakes. There are definite procedures for correcting mistakes, depending on whether they occur in tape preparation or while transmitting direct from a keyboard.

You learned in chapter 10 how to erase or letter out errors in tape by backspacing and striking the LTRS key as many times as necessary to obliterate the error. This method is used to correct errors in tape preparation, except when they occur in format lines 1, 2, 3, and 4. Errors in the first four format lines cannot be corrected. The operator must discard the tape with the error in it and prepare a new one. The main reason for this rule is that even one extra LTRS function in any of the first four format lines results in rejection of the tape at the first automatic relay station.

Another special rule applies to correcting errors in the security classification of a plain language message. When such errors occur, backspace and obliterate the entire classification. Then, start anew with the first letter of classification.

When transmitting from the keyboard, the operator cannot correct mistakes that occur in the message heading nor in the security classification when it is the first word of the text. Cancel the transmission, send 2CR, 1LF, 1LTRS, and prosigns E E E E E E E E AR, followed by sending station's routing indicator and the usual end-of-message functions. In teletype procedure the error prosign is exactly 8 Es—no more, no less—with a space between each E.

To correct a mistake in the text of a message (other than one in the security classification), send 1 LTRS, 8 Es, repeat the last word sent correctly, and continue with the correct version of the text. For example, assume that in transmitting IN ACCORDANCE WITH PREVIOUS INSTRUCTIONS a mistake is made in the word "previous." Correct it as follows: IN ACCORDANCE WITH PREVX E E E E E E E E WITH PREVIOUS INSTRUCTIONS. The error prosign is transmitted immediately after the error occurs. Transmission resumes with the last word or group sent correctly.

If the text is transmitted before discovery of an error in it, make the correction on the line after prosign BT. Use of prosign C for this purpose was shown in earlier message examples. Errors in a multiple-page message, which were not corrected by 8 Es or the lettering-out method, are corrected at the bottom of each page by means of prosign C. If an error is not noticed before starting another page, the error is corrected at the end of the last page.

## HIGH-PRECEDENCE TAPES

Messages of FLASH precedence are given special handling. When tape is prepared at the originating station, the repeated precedence prosign in line 2 is preceded by the bell signal so that succeeding stations have audible warning that a high-precedence message is coming in. Example:

(FIGS)JJJJJSSSSS(LTRS)ZZ RUHPB RUWSC
DE RUATC Ø58A 244231Ø
ZNR UUUUU
Z Ø12312Z SEP 67
(Etc.)

Notice that the precedence prosign appears in lines 2 and 5, just as in any other message, but the bell signal is used only in line 2.

In semiautomatic relay stations, high-precedence tapes receive hand-to-hand processing. The receiving operator immediately notifies the supervisor when a high-precedence tape is being received. The supervisor sees that the tape is taken immediately to the proper outgoing circuits and sent out. A receipt must be transmitted to the station from which the message was received. A receipt is obtained from every station to which the message is relayed.

Equipment in automatic relay stations is designed to "recognize" IMMEDIATE as well as FLASH messages. Upon receipt of repeated prosigns ZZ or OO at the beginning of the routine line, the director component of the switching equipment seeks an immediate connection with the proper outgoing circuits instead of waiting for the four Ns at the end of the message. As a further aid to high-speed relay of high-precedence messages, the busiest circuits usually are provided with an additional receiving unit for use exclusively with high-precedence messages.

The system of station-to-station receipts used by semiautomatic relay stations for FLASH messages is not practical in the fully automatic system because messages enter and leave the relay station unseen and untouched by human operators. For this reason, receipts for FLASH messages are handled in one of the following three ways.

1. Messages originated and addressed entirely within the automatic relay network require a receipt from addressee to originator.
2. Messages originated by a station within the automatic network and addressed to stations outside the automatic network require a receipt from the station transferring the message from the automatic network (called gateway refile station) to the originator. All messages transmitted outside the automatic network must be receipted for, station-to-station.
3. Messages originated outside the automatic network and destined for addressees within the automatic network are receipted for station-to-station from originator to the gateway refile station. No receipt is required of such messages after entry into the automatic relay network, unless an acknowledgment was requested.

## MISSENT AND MISROUTED MESSAGES

Occasionally an operator receives a message that was delivered through error. Whenever this mistake happens, remember that every COMMCEN is responsible for delivering every message received, even though it was transmitted through error. Messages transmitted through error are classed in two groups: missent and misrouted.

A missent message has the correct routing indicator, but the relay station transmitted it over the wrong circuit. The message may have carried Asmara's indicator RUQA, for example, but was transmitted over the RUFR circuit to Naples.

Misrouted messages bear the wrong indicators, either through error when assigned by the punching station, from mechanical trouble in the system, or from the tape-cutter's typing mistake.

Should two copies of a multiple-address message be received, and the second is not marked SUSPECTED DUPLICATE, assume that one of the other addressees did not receive his copy. Notify the relay station from which duplicate message was received, explaining the situation. The relay station then checks its monitor rolls to make sure that all addressees received a copy of the message in question.

The procedure for forwarding a misrouted message is treated in detail in the discussion of reroute pilot tapes.

## PILOT TAPES

A pilot indicates that, for some reason, a particular message requires special handling over relay circuits. The pilot is considered to be format line 1 of the message. The four types of pilots are—

| Pilot | Abbreviation | Associated operating signal |
|---|---|---|
| 1. Subject to correction. | SUBCOR | ZDG |
| 2. Corrected copy. | CORCY | ZEL |
| 3. Suspected duplicate transmission. | SUSDUPE | ZFD |
| 4. Rerouted message. | - - - - | ZOV |

### SUBCOR PILOT

When a relay operator finds a garbled or mutilated tape of PRIORITY or lower precedence, the tape usually is not relayed until a good copy is available. If waiting for a good copy would delay the message unreasonably, or if the message is of higher precedence than PRIORITY, it is forwarded immediately, subject to correction. The station releasing a message subject to correction is responsible for seeing that a good tape is transmitted as a correct copy as soon as possible.

In the following example, a message from the Far East, addressed to Washington, is received garbled at the primary relay station in Honolulu, and is forwarded SUBCOR.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| OO RUECN | (2CR LF) |
| ZNR UUUUU ZIG RUHP | (2CR LF) |
| VV(3 SPACES)MGA19ØVV | (2CR LF) |
| (3SPACES)ATA1Ø5 | (2CR LF) |
| OO RUECN | (2CR LF) |
| DE RUATH Ø93 26119Ø1 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| O 18191ØZ SEP 67 | (2CR LF) |
| FM COMNAVFORJAPAN | (2CR LF) |
| TO RUECN/DIRNAVSECGRU | (2CR LF) |
| BT | (2CR LF) |
| (Text garbled but still useful.) (Etc.) | (Etc.) |

CORCY PILOT

When a relay station forwards a SUBCOR message, as in the foregoing example, it is that station's responsibility to obtain a good tape and forward it to the station to which the SUBCOR was sent. The next example shows the pilot used by RUHP in forwarding the corrected copy of the preceding message.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| OO RUECN | (2CR LF) |
| ZNR UUUUU ZEL RUHP | (2CR LF) |
| VV (3 SPACES)MGA19ØVV | (2CR LF) |
| (3 SPACES)ATA1Ø5 | (2CR LF) |
| OO RUECN | (2CR LF) |
| DE RUATH Ø93 26119Ø1 | (2CR LF) |
| ....Etc.... | (Etc.) |

SUSDUPE PILOT

When a station has no conclusive evidence that a tape was transmitted, but suspects that it was, the message is forwarded as a suspected duplicate. In such instances, the station called is responsible for preventing duplicate deliveries to the addressee. Example:

| | |
|---|---|
| (TI) (5SPACES 2CR LF) | |
| PP RULAGB | (2CR LF) |
| ZFD RULA | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| PP RULAT RULAC RULAGB | (2CR LF) |
| DE RUECH Ø48A 2541158 | (2CR LF) |
| P 111213Z SEP 67 | (2CR LF) |
| (Etc.) | (Etc.) |

REROUTE PILOT

As learned in the previous section, a misrouted message bears an incorrect routing indicator. Because a misroute is handled differently, do not confuse this type of message with a missent message, which bears the correct routing indicator but inadvertently is sent to the wrong station. The misrouted message must be forwarded with a pilot, whereas the missent message is forwarded without alteration.

The station detecting a misroute is responsible for taking corrective routing action. (In some instances the station detecting a misroute is a relay station; in others, the tributary station to which the message was misrouted.) Corrective routing action consists of preparing a pilot containing the message precedence (repeated), the correct routing indicator of the station to effect delivery, the operating signal ZNR or ZNY, appropriate classification character repeated five times, operating signal ZOV, the routing indicator of the station preparing the pilot, and, if required, transmission instructions. Transmission instructions are used only in multiple-addressed messages, and then only when absolutely necessary to effect delivery of the message.

In the following example, assume that relay station RUHP receives a message for further relay, and discovers a misroute in it. An operator at RUHP prepares a reroute pilot tape, prefixes it to the original tape (as received), and relays the message to the correct station.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUHPF | (2CR LF) |
| ZNR UUUUU ZOV RUHP | (2CR LF) |
| VV(3 SPACES)UATØ98 | (2CR LF) |
| RR RUHPB RUHPE | (2CR LF) |
| DE RUATA Ø43 251Ø759 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| R Ø8Ø923Z SEP 67 | (2CR LF) |
| FM NAS ATSUGI | (2CR LF) |
| TO RUHPB/CINCPACFLT | (2CR LF) |
| INFO RUHPE/COMBARPAC | (2CR LF) |
| BT | (2CR LF) |
| (Etc.) | (Etc.) |

After rerouting the message, RUHP transmits a service message to RUATA (station originating the misrouted message), pointing out the incorrect routing and indicating corrective action taken. This procedure is an important part of the reroute process. It brings the routing error to the attention of the station at fault, and helps prevent further misroutes.

## TWX SYSTEM

The teletypewriter exchange service (TWX) is a commercial teletypewriter system owned and operated by various telephone companies. Its services are available to anyone on much the same basis as is the telephone. Any businessman may have TWX installed in his office. Charges are made as for phone service--so much for the use of the equipment and so much for each call, based on time and distance. The TWX serves outlying stations that do not send or receive enough traffic to warrant the cost of circuits and equipment that would make them a part of the regular Navy communication system.

A message to an activity served by TWX is forwarded over DCS circuits to the station nearest its destination and there it is refiled into the TWX network. This method results in considerable savings because the long-haul portion of such traffic is then handled over DCS-leased lines, and the only extra cost is for the short-distance transmission from the filing station.

## TELEX SYSTEM

Dialing, calling, and establishment of circuit connections between designated refile stations and customers served by Western Union are accomplished by TELEX in accordance with operating instructions contained in the directory furnished by the Western Union Company.

## COMMERCIAL MESSAGES

Official messages to commercial activities are sent over DCS circuits to the DCS commercial refile station nearest the addressee. If the message center is near enough, delivery may be made by telephone or by other appropriate means. Otherwise, it must be given to a commercial communication company for final delivery.

Here are two messages addressed to commercial activities. The first message has two commercial addressees; the second has one naval addressee and one commercial addressee. Note that the form is the same for both messages.

Example 1:

```
VZCZCCDA 198 (5 SPACES 2CR LF)
RR RUEGCU                         (2CR LF)
DE RUECD Ø43A 2591Ø15             (2CR LF)
ZNR UUUUU                         (2CR LF)
R 261235Z SEP 67 ZEX              (2CR LF)
FM CNO                            (2CR LF)
TO RUEGCU/TELETYPE CORP           (2CR LF)
41ØØ FULLERTON                    (2CR LF)
AVE CHGO                          (2CR LF)
RUEGCU/COLLINS RADIO CO           (2CR LF)
CEDAR RAPIDS IOWA                 (2CR LF)
BT                                (2CR LF)
UNCLAS                            (2CR LF)
THIS IS AN EXAMPLE OF A           (2CR LF)
MULTIPLE ADDRESS MSG              (2CR LF)
FOR COMMERCIAL ADDEES             (2CR LF)
ONLY, ROUTED TO                   (2CR LF)
AUTHORIZED REFILE POINT           (2CR LF)
NEAREST ADDEES                    (2CR LF)
BT                                (2CR 8LF)
NNNN                              (12LTRS)
```

Example 2:

```
VZCZCCDB 312 (5 SPACES 2CR LF)
RR RUCKDY RUWPLC                  (2CR LF)
DE RUECD 296B 26Ø1759             (2CR LF)
ZNR UUUUU                         (2CR LF)
R 272331Z SEP 67                  (2CR LF)
FM CNO                            (2CR LF)
TO RUCKDY/NAVSHIPYD NORVA         (2CR LF)
RUWPLC/CONSOLIDATED               (2CR LF)
VULTEE ACFT                       (2CR LF)
CORP POMONA                       (2CR LF)
BT                                (2CR LF)
UNCLAS                            (2CR LF)
THIS IS AN EXAMPLE OF A           (2CR LF)
MULTIPLE ADDRESS MSG              (2CR LF)
FOR A NAVAL AND A                 (2CR LF)
COMMERCIAL ADDEE, ROUTED          (2CR LF)
BY TELETYPE FOR                   (2CR LF)
DELIVERY TO                       (2CR LF)
NAVAL ADDEE AND TO NEAREST        (2CR LF)
POINT OF COMMERCIAL               (2CR LF)
REFILE FOR DELIVERY TO            (2CR LF)
COMMERCIAL ADDEE                  (2CR LF)
BT                                (2CR 8LF)
NNNN                              (12LTRS)
```

## CLASS E NTX MESSAGES

Class E messages originated by ships were discussed in chapter 6. The class E privilege also is extended to personnel at all overseas naval stations served by naval communications. Such messages are handled as plaindress, single-address messages to points of refile in the continental United States. Although many shore stations on both coasts are authorized to refile class E messages from ships at sea, those originating at overseas shore stations are refiled at the circuit entry points at Washington and San Francisco. Following is an example of a class E message in teletype form.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUECC | (2CR LF) |
| DE RULAC 125A 247Ø913 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| R 141227Z SEP 67 | (2CR LF) |
| FM NAVCOMMSTA SAN JUAN | (2CR LF) |
| TO RUECC/NAVCOMMSTA | (2CR LF) |
| WASHDC | (2CR LF) |
| BT | (2CR LF) |
| MSG CK18 COMLE JOHN D | (2CR LF) |
| NICHOLAS 33Ø8 SENATOR AVE | (2CR LF) |
| SE DISTRICT HEIGHTS MD | (2CR LF) |
| JOYCE AND KIDS ARRIVING | (2CR LF) |
| IDLEWILD 123Ø AM OCT 15 | (2CR LF) |
| PAA FLT 2Ø6 MEET IF | (2CR LF) |
| POSSIBLE MARK VECELLIO | (2CR LF) |
| NAVCOMMSTA SAN JUAN | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

## READDRESSING TELETYPE MESSAGES

The procedure for readdressing teletype messages is the same as for readdressing radiotelegraph messages. That is, all procedure lines preceding line 5 (preamble) of the original preamble. The supplementary heading is separated from the remaining portion of the original heading by a line feed function.

Assume that on receipt of the following message, COMFIVE wishes to readdress it for INFO to NTC Bainbridge, Md.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| PP RUECW RUCKC RUWSPG | (2CR LF) |
| DE RUHPB 123C 258Ø821 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| P 15Ø911Z SEP 67 | (2CR LF) |
| FM CINCPACFLT | (2CR LF) |
| TO RUECW/CNO | (2CR LF) |
| RUWSPG/COMWESTSEAFRON | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| (Plain language text.) | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

The next example is the message as readdressed. Notice that COMFIVE changed the precedence in the supplementary heading. Selection of the precedence and the decision whether the message is to be readdressed for action or information are responsibilities of the readdressing activity. The original message is unchanged past line 4.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUECTAJ | (2CR LF) |
| DE RUCKC Ø34 2581334 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| R 151452Z SEP 67 | (2CR LF) |
| FM COMFIVE | (2CR LF) |
| INFO RUECTAJ/NTC BAIN | (2CR LF) |
| P 15Ø911Z SEP 67 | (2CR LF) |
| FM CINCPACFLT | (2CR LF) |
| TO RUECW/CNO | (2CR LF) |
| RUCKC/COMFIVE | (2CR LF) |
| RUWSPG/COMWESTSEAFRON | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| (Plain language text.) | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

## SERVICE MESSAGES

Service messages are brief messages between communication personnel used to expedite message handling. Usually, service messages concern transmissions originated at, addressed to, or refiled by a station, although they may pertain to any phase of traffic handling, communication facilities, or circuit condition.

Plain language service messages are prepared in abbreviated plaindress format. The degree of abbreviation depends on whether service messages must be related. If two stations are directly connected, service messages consist of only format lines 1, 2, 3 (less station serial number), 4, and 12. Service messages requiring relay contain all format lines except lines 5, 6, and 10. Lines 7 and 8 are used only when necessary to show action and information addressees, at which time addressees are designated by routing indicators. Service messages requiring commercial refile must show the complete address.

The text of all service messages begins with the security classification or the abbreviation UNCLAS. The abbreviation SVC follows, and, in turn, may be followed by a reference number. When reference numbers are used, they are assigned consecutively on a monthly basis, commencing with the first and ending on the last calendar day of each month. This numbering method provides an additional means of referring to a particular service message.

Following is an example of an abbreviated service message between directly connected relay stations, requesting retransmission of a garbled tape.

(TI) (5 SPACES 2CR LF)

| | |
|---|---|
| RR RUEP | (2CR LF) |
| DE RUCA 2451421 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| UNCLAS SVC EUC128 RPT | (2CR LF) |
| EUC128 ZES2 | (2CR 8LF) |
| NNNN | (12LTRS) |

A normal, single-address service message between tributary stations in the continental United States (CONUS) is shown in the next example. (In the CONUS, a tributary station receiving a garbled message requests retransmission (rerun) from the station originating the message. Outside the CONUS, a tributary station receiving a garbled message from a relay station requests retransmission from the relay station.)

(TI) (5 SPACES 2CR LF)

| | |
|---|---|
| RR RUEPDA | (2CR LF) |
| DE RUEPPD Ø29 26ØØ643 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS SVC RUEPDA 15A | (2CR LF) |
| 26ØØ5Ø5 Ø7Ø445Z | (2CR LF) |
| ZES2 | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

## TEST TAPES

Standard test tapes are utilized for testing circuit operation. The test tapes themselves must be letter perfect to prevent misleading the receiving operator at the distant station. Operators should prepare test tapes ahead of time and keep them available near the operating position for use when needed. Accurate reception of the tests indicates that the circuit and the equipment at both terminals are operating satisfactorily.

Test tapes are transmitted on a circuit or channel that has just been opened, but before transmission of traffic. In the following examples, a channel is opened between RUEPW and RUEPWN.

(TI) (5 SPACES 2CR LF)

| | |
|---|---|
| RR RUEPW | (2CR LF) |
| DE RUEPWN | (2CR LF) |
| ZNR | (2CR LF) |
| TEST THE QUICK BROWN FOX | (2CR LF) |
| JUMPS OVER THE LAZY DOG | (2CR LF) |
| 123456789Ø RYRYRYRYRYRYRYRYRY | (2CR LF) |
| INT ZBZ K | (2CR 8LF) |
| NNNN | (12LTRS) |

When the operator at RUEPW determines that the test message is satisfactory, he transmits:

(TI) (5 SPACES 2CR LF)

| | |
|---|---|
| RR RUEPWN | (2CR LF) |
| DE RUEPW 2511245 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| ZBZ5 K | (2CR 8LF) |
| NNNN | (12LTRS) |

After a circuit or channel is opened for traffic, it becomes necessary, sometimes, to interrupt traffic and send a test because of poor readability. In such instances, the test tape is constructed as follows:

(Sufficient LTRS to permit splicing tape into a continuous loop.)
(5 SPACES 2CR LF)
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
123456789Ø TEST DE RUHPC (2CR)
THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
123456789Ø TEST DE RUHPC (2CR LF)
RYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRYRY

RYRYRYRYRYRYRYRYRYRYRYRYRY (2CR LF)
(Sufficient LTRS to permit splicing tape into a continuous loop.)

## ENSURING CONTINUITY OF TRAFFIC

Except for FLASH messages, station-to-station receipts are not employed in the tape relay system. Responsibility for continuity of received messages rests with the station receiving the traffic. A receiving station ensures that a tape is received under each channel number and that numbers are not duplicated or omitted.

When no transmission is received over a circuit or channel for a period of 30 minutes (this interval may be increased to 60 minutes at the discretion of the relay station on channels to its tributaries), the receiving station originates a service message (called a channel check) to the transmitting station. A channel check is assigned a precedence of IMMEDIATE, and is in the following form:

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| OO RUHPB | (2CR LF) |
| DE RUHPC 2461605 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| UNCLAS SVC ZID PBA113 | (2CR 8LF) |
| NNNN | (12LTRS) |

(The channel number after operating signal ZID indicates the channel number of the last message received from RUHPB on that channel.)

Station RUHPB checks the channel number of the last message transmitted to RUHPC on the channel indicated, and, if it agrees with the number in the channel check, RUHPB transmits:

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| OO RUHPC | (2CR LF) |
| DE RUHPB 2461607 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| UNCLAS SVC ZIC PBA113 | (2CR 8LF) |
| NNNN | (12LTRS) |

If the message reported as last received does not correspond to that sent last, RUHPB takes whatever action is necessary to establish contact with RUHPC, and retransmits the missing message(s).

At tributary stations, if no traffic is received for a period of 30 minutes (or 60 minutes if so directed), the tributary originates and transmits a channel check addressed to its own station. The following example is such a channel check.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| OO RUHPB | (2CR LF) |
| DE RUHPB | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| UNCLAS SVC CHANNEL CHECK | |
| RYRYRYRY | (2CR LF) |
| ABCDEFGHIJKLMNOPQRSTUVWXYZ | |
| 1234567890 | (2CR 8LF) |
| NNNN | (12LTRS) |

The preceding message, routed to its own station, indicates to the tributary a satisfactory circuit condition if it is received promptly from the relay station and the channel number agrees with the received message log. If it is not returned over the receive channel within a reasonable length of time, circuit trouble should be suspected, and the condition of the circuit should be investigated by maintenance personnel.

## CHANGING CHANNEL NUMBER SEQUENCE

Channel number sequences are changed daily as near 0001Z as practicable. Because of having many circuits on which numbers must be changed, relay stations usually commence resetting their outgoing channel numbers to 001 at approximately 2330Z daily.

Upon receipt of channel number 001 from the relay station, tributary stations reset their numbers to 001. Then they originate a service message to the relay station, stating the last number received for that day and listing any messages awaiting rerun. This service message is sent under channel number 001 for the new day.

When only U.S. network stations are involved, the following deviations from the rules set forth in ACP 127 are applied in the situations indicated. Procedures of ACP 127 apply in all other instances.

Major relay stations must, on the transmit side of each circuit or channel—

1. Start a new sequence daily; or
2. Use a continuing sequence 001 through 1000.

Minor relay and tributary stations follow the numbering system used by their connected relay stations.

In the following example, station RUECD sends the final number comparison for the old day and informs RUEC that retransmission of a message still is pending.

(TI) (5 SPACES 2CR LF)
RR RUEC (2CR LF)
DE RUECD 255ØØØ2 (2CR LF)
ZNR UUUUU (2CR LF)
UNCLAS SVC ZID ECA164
AWAITING ZDK ECA137 (2CR 8LF)
NNNN (12LTRS)

The same procedure is observed on circuits between relay stations, except that on multichannel circuits one service message usually suffices for reporting all circuits. Example:

(TI) (5 SPACES 2CR LF)
RR RUEC (2CR LF)
DE RUWS 255ØØØ2 (2CR LF)
ZNR UUUUU (2CR LF)
UNCLAS SVC ZID ECA558 ECB62Ø
ECC459 ECD7ØØ (2CR 8LF)
NNNN (12LTRS)

When a station changes transmission identification numbers under the 1000 number sequence, the transmission of number 1000 (represented by 000) indicates the end of the current series. Receipt of a message with channel number 001 indicates that a new series has been instituted. No further notification is required. At the receiving station, traffic records pertaining to the previous series must not be considered complete until every number in the series is accounted for.

## TRACER PROCEEDINGS

Naval communications prides itself on reliability, but no communication system is absolutely perfect. Some provision must be instituted for tracing messages that are lost or meet unreasonable delay. Tracers answer three questions: Was the message actually lost? Who lost it? Why was it lost?

Tracers are sent to protect the dependability of communications — not to serve as a basis for disciplinary action. They warn the station at fault that its internal message-handling procedures may need reexamination.

Tracing a message entails no more than checking from station to station to find where the failure occured. The proceedings leading to transmission of a service message tracer differ, however, depending upon whether the message in question is a nondelivery, a suspected nondelivery, or an excessively delayed delivery. Detailed procedures for each of these circumstances are prescribed in the effective edition of ACP 127.

For purposes of this discussion of tracer proceedings, assume that a known (not suspected) nondelivery occurs. In such instances, tracer proceedings start with the originator of the message, either on his own initiative or at the request of the addressee who did not receive the message.

The first step the originator takes is either to cancel or retransmit the original message to the addressee not receiving it. If the message is retransmitted, the operating signal ZFG is transmitted immediately after the DTG in the original message heading. (Operating signal ZFG means "This message is an exact duplicate of a message previously transmitted.")

After retransmitting the message, a service message tracer is drafted and sent to the first relay station concerned with the original message. The relay station, after assuring that the message was not mishandled at the station, forwards the tracer to the next relay station for action, and to the originating station for action, and to the originating station for information. This procedure continues on a station-to-station basis until the cause for the lost message is determined and reported to the originating station.

To illustrate a message being traced from originator to addressee, assume that a message originated by RUEAHQ was lost en route to the addressee at RUFPBW. After retransmitting the original message to RUFPBW as an exact duplicate, RUEAHQ originates and transmits the following tracer to the service desk of the first relay station handling the original message.

(TI) (5 SPACES 2CR LF)
RR RUEASU (2CR LF)
DE RUEAHQ Ø25A 26815ØØ (2CR LF)
ZNR UUUUU (2CR LF)
UNCLAS SVC RUEAHQ 1Ø4C
267Ø8ØØ 24Ø75ØZ (2CR LF)
ZDE2 RUFPBW/HQ USAFE ZDQ
RUEA HQB115 (2CR LF)
24Ø9ØØZ (2CR 8LF)
NNNN (12LTRS)

(The meaning of the operating signals used in the text of the tracer are: ZDE2--Message___ undelivered. Advise disposition. ZDQ--Message___was relayed to___by___at___.)

On receipt of the tracer, RUEASU checks its handling of the original message and finds that the message was forwarded to RUFP. Tracer action continues with RUEASU sending the following message to RUFPSU (service desk of relay station RUFP) and RUEAHQ.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUFPSU RUEAHQ | (2CR LF) |
| DE RUEASU Ø75A 2681625 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| TO RUFPSU | (2CR LF) |
| INFO RUEAHQ | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS SVC RUEAHQ 1Ø4C | |
| 267Ø8ØØ 24Ø75ØZ | (2CR LF) |
| ZDE2 RUFPBW/HQ USAFE ZDQ | |
| RUFP JNB185 | (2CR LF) |
| 24Ø955Z | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

On receipt of the foregoing tracer, RUFPSU checks its station monitors and finds that the questioned message was sent to RUFPBW for delivery to the addressee. Accordingly, RUFPSU sends this tracer:

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUFPBW RUEAHQ | (2CR LF) |
| DE RUFPSU 1Ø9A 26817Ø5 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| TO RUFPBW | (2CR LF) |
| INFO RUEAHQ | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS SVC RUEAHQ 1Ø4C | |
| 267Ø8ØØ 24Ø75ØZ | (2CR LF) |
| ZDE2 RUFPBW/HQ USAFE ZDQ | |
| RUFPBW BWA234 | (2CR LF) |
| 241ØØØZ | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

As seen in the preceding examples, the original message was traced from the originating station to the station serving the addressee. After a thorough search of its files and records, RUFPBW discovers that the original transmission of the questioned message was received garbled and was filed without a good copy being obtained. That station must accept responsibility for the nondelivery. It does so in the following report to the originator of the message.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUEAHQ RUFPSU | (2CR LF) |
| DE RUFPBW 223B 2681915 | (2CR LF) |
| ZNR UUUUU | (2CR LF) |
| TO RUEAHQ | (2CR LF) |
| INFO RUFPSU | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS SVC ZUI RUEAHQ 1Ø4C | |
| 267Ø8ØØ | (2CR LF) |
| 24Ø75ØZ ZDE2 RUFPBW/HQ | |
| USAFE RECEIVED | (2CR LF) |
| ZBK2. THISTA FAILED TO | |
| INITIATE ZDK | (2CR LF) |
| REQUEST. CORRECTIVE ACTION | |
| TAKEN | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

## MANUAL TELETYPE PROCEDURE

Manual teletype procedure is used on teletype circuits that are not part of the tape relay network — on ship-ship and ship-shore RATT circuits, for example. The procedure, contained in the effective edition of ACP 126, presents little difficulty for an operator versed in radiotelegraph procedure. The two procedures are closely related, and the message formats are essentially the same. Because of this similarity, the message formate for manual teletype message is not given here.

The rules in manual teletype procedure concerning calling and answering, repetitions, corrections, use of ending prosigns, and the like, are the same as in radiotelegraph procedure.

## MANUAL TELETYPE MESSAGES

In the ensuing message examples, similarities of the manual teletype procedure are seen in both radiotelegraph and tape relay procedures. As in all message examples throughout this text, format lines not needed for the message are omitted. End-of-line and end-of-message machine functions are indicated in parentheses. (As necessary, refer to the format in table 5-3, chapter 5, to understand the examples.)

Here is a plaindress, single-address message originated by USS Epperson and addressed to USS Renshaw. The originator and the addressee are in direct communication, and the call serves as the address. A preliminary call is made before transmitting the message.

```
(5 SPACES 2CR LF)
NWBJ DE NTGT K                       (2CR LF)
(5 SPACES 2CR LF)
NTGT DE NWBJ K                       (2CR 8LF)
(5 SPACES 2CR LF)
NWBJ DE NTGT                         (2CR LF)
R 272113Z SEP 67                     (2CR LF)
GR3Ø                                 (2CR LF)
BT                                   (2CR LF)
UNCLAS                               (2CR LF)
1. EXCEPT FOR ABSENCE OF             (2CR LF)
SEPARATIVE SIGNS IN HEADING,         (2CR LF)
FORMAT OF MSG IS IDENTICAL           (2CR LF)
TO RADIOTELEGRAPH                    (2CR LF)
2. NOTICE THAT END-OF-               (2CR LF)
MESSAGE FUNCTION ARE BT              (2CR LF)
THE SAME AS IN TAPE RELAY            (2CR LF)
PROCEDURE                            (2CR LF)
BT                                   (2CR 8LF)
K                                    (12LTRS)
NNNN
```

The next example is of a plaindress, multiple-address message. The originator is not in direct communication with the addressees, and sends the message to NAVCOMMSTA Guam for relay. Assume that communications are established by an exchange of calls (as in the preceding example).

```
(5 SPACES 2CR LF)
NPN DE NWBJ                          (2CR LF)
T                                    (2CR LF)
P Ø51921Z SEP 67                     (2CR LF)
FM USS RENSHAW                       (2CR LF)
TO COMDESDIV TWO FIVE TWO            (2CR LF)
INFO COMDESRON TWO FIVE              (2CR LF)
COMDESFLOT FIVE                      (2CR LF)
GR29                                 (2CR LF)
BT                                   (2CR LF)
UNCLAS                               (2CR LF)
1. MOBILE UNITS TRANSMIT-            (2CR LF)
TING UNCLAS MSGS TO SHORE            (2CR LF)
STATIONS VIA RATT MUST USE           (2CR LF)
PLAIN LANGUAGE DESIGNATORS           (2CR LF)
IN ADDRESS OF SUCH                   (2CR LF)
MSGS                                 (2CR LF)
BT                                   (2CR LF)
K                                    (2CR 8LF)
NNNN                                 (12LTRS)
```

The following example is of an abbreviated plaindress message, with the call serving as the address.

```
(5 SPACES 2CR LF)
NLNB DE NREB                         (2CR LF)
P                                    (2CR LF)
BT                                   (2CR LF)
UNCLAS                               (2CR LF)
1. THE DATE AND GROUP                (2CR LF)
COUNT ARE OMITTED FROM               (2CR LF)
THIS MSG. OTHER ELEMENTS             (2CR LF)
THAT COULD BE OMITTED AT             (2CR LF)
THE DISCRETION OF THE ORIG           (2CR LF)
ARE PRECEDENCE AND TIME              (2CR LF)
GROUP IN MSG ENDING                  (2CR LF)
BT                                   (2CR LF)
1421Z                                (2CR LF)
K                                    (2CR 8LF)
NNNN                                 (12LTRS)
```

A radioteletypewriter message prepared in codress form is shown in the next example. The called station, NAVCOMMSTA Honolulu, must decrypt and deliver the message to certain local activities named in the encrypted text. The originator uses an indefinite call.

```
(5 SPACES 2CR LF)
NPM DE NA                            (2CR LF)
R 2718Ø5Z SEP 67                     (2CR LF)
GR46                                 (2CR LF)
BT                                   (2CR LF)
ENCRYPTED GROUPS                     (2CR LF)
BT                                   (2CR LF)
C 12-XYTOP                           (2CR LF)
K                                    (2CR 8LF)
NNNN                                 (12LTRS)
```

## TOUCH TELETYPEWRITING TEST

Before a Radioman can be recommended to take the fleet servicewide examination for advancement to either RM3 or RM2, he must demonstrate ability as a teletypist by satisfactorily passing a performance test in touch teletypewriting. This performance test is not a part of the competitive examination. It is administered by the local examining board at least once each quarter, or four times a year. Radiomen cannot compete in the servicewide examinations without first passing the performance test and meeting all the other requirements listed in the front of this Navy Training Course.

The teletypewriting test for advancement to RM3 consists of three messages, totaling approximately 600 characters, which must be transmitted in 9 minutes. For RM2, four messages, totaling 750 characters, must be sent in 9 minutes. Some of the message texts are plain language, others are composed of five-character groups of random mixed numerals. The headings contain about 30 percent and the texts about 70 percent of the total number of characters. Only in the event a teletypewriter is unavailable will the examining board let a person use a telegraphic typewriter for the typing test.

Time limits for the test include servicing each message by endorsing the time of transmission, circuit used, and operator's sign. Servicing should not require much time, but be sure to include time for servicing in practice runs.

Transmission of the touch teletypewriting test must be by direct keyboard method; examinees are not permitted to cut a tape. A total of five errors (uncorrected or omitted characters) is permitted in the official test. If an error is corrected properly and according to the correct procedure, it does not count as an error. Thus, there is no limit to the number of corrected errors. But correcting errors takes time, and, on an examination, if one must stop to correct too many errors, he may disqualify himself by failing to finish within time limits.

Immediately before the official test, Radiomen will be given a practice test consisting of messages that are different from the official test, though similar in number, length, and general content. The results of the practice test do not affect the score of the official test, but if a man tries his best on the practice test, it will help him overcome nervousness, and he will be better able to adjust his typing speed within the time limits on the official test.

Be sure to practice teletypewriting in preparation for the performance test. Strive to improve both accuracy and speed. Remember that a man may not be able to do his normal best typing on the day of the test. The examining board may hold the test in surroundings unfamiliar to persons taking the test. Besides, most persons are victims of nervousness on examination day. It is well, therefore, to have sufficient speed and accuracy to provide a little "margin" for overcoming nervousness in unfamiliar surroundings.

# CHAPTER 12

# ADMINISTRATION

Maintaining accurate records and observing good message-handling procedures contribute to an efficient communication organization. In this chapter Radiomen will learn about some of these records and how they are used. Bear in mind, however, that different stations may handle certain procedures in different ways. There is no "one" way to log a message, for example; nor is there only "one" message blank form. For the most part this chapter discusses those practices and procedures that have become fairly well standardized.

## MESSAGE FILES

Every message handled by a ship or station is placed in one or more files. Some files are maintained by all ships and stations, but others are optional and are maintained only to fill the need of a particular ship or station. Table 12-1 summarizes the types of message files maintained by all ships and stations.

• Keep accurate files: The importance of well-kept files and of cooperation by the various watch sections to keep them that way cannot be stressed too much nor too often. Radiomen should be able to locate any message in 1 or 2 minutes. Inaccurate files aboard ship mean delays in processing traffic, some of which may be operational in nature and of high precedence. Large shore stations file thousands of messages monthly. Hence, it is easy to see that a misfiled message often means a lost message.

### COMMUNICATION CENTER AND CRYPTOCENTER FILES

The communication center file contains a copy of every message addressed to or originated by the command. It does not matter whether the messages were sent plain or encrypted, or by radio, visual, mail, or other means. All are filed together in DTG order. Classified messages are filed in either of two ways: in encrypted form, or by dummy or filler. A dummy or filler is a form showing only the heading of the message. The communication center file may be subdivided into incoming and outgoing sections.

Plain language translations of classified messages are stowed in the cryptocenter file. Top Secret messages are stowed separately. Messages of other classifications usually are filed together.

If the file location of a needed message is unknown, check the communication center file. If the message is unclassified, it will be found there. If the message is classified, there will be an encrypted or dummy version, indicating that the message is in the cryptocenter file.

Messages in the communication center and cryptocenter files bear the signatures or initials of the drafter, releasing officer, communication watch officer, operator, persons to whom the message was routed, and such other information as may be required by the local command.

• Combined files: All the files listed in table 12-1, except the general message files and broadcast files, may be combined for convenience of stowage, filing, and referencing. Combining these files eliminates the need for filler or dummy sheets in the communication center file referring to the cryptocenter file. Separate stowage, however, must be provided for Top Secret messages and (in most instances) special category messages.)

When any or all of these files are combined, stowage and accounting requirements must conform to regulations for the highest classification of messages held in the files. All classified files must be afforded stowage and accountability in accordance with the current edition of OpNavInst 5520.1.

Table 12-1.—Summary of Message Files

| File | Contents | Disposition |
| --- | --- | --- |
| Communication Center | A copy of every message addressed to or originated by the command. Filed chronologically by DTG. Classified messages are filed by encrypted version, or by filler or dummy. | Messages incident to distress or disaster: destroy when 3 years old.<br>Messages involved in any claim or complaint: destroy when 2 years old, or when complaint or claim is settled, if earlier.<br>Messages of historical or continuing interest: retain.<br>All other messages: destroy when 1 year old. |
| Cryptocenter | The edited plain language version of each classified message addressed to or originated by the command. Filed by DTG. This file may be subdivided as necessary, in order to comply with stowage requirements for classified matter. In effect, the cryptocenter file is the classified version of the communication center file. | Same as communication center files. |
| Radio Station | Radio circuit copy of each message received, addressed to, transmitted, or relayed by radio. Filed in DTG order. | Destroy when 1 month old. |
| Visual Station | Copy of each message received, addressed to, transmitted, or relayed by visual means. | Destroy when 1 month old. |
| General Message | A copy of each general message addressed to the command, segregated by type (ALNAVs, ALCOMs, NAVOPs, etc). Filed according to serial numbers. | Destroy when canceled or superseded. (Copy must be retained for communication center file.) |
| Broadcast | Messages received by broadcast method. | Destroy when 1 month old. |

76.51

## STATION FILES

The radio station file contains copies of messages handled by the command via radio. It includes a copy of each nontactical message received, transmitted, or relayed by the radio facilities of the ship or station. The copies must bear the operators' servicing endorsements. They are filed in chronological order by DTG, and the file may be combined with the communication center file.

The visual station file is a chronological record of all nontactical traffic handled by the command by visual means. It is identical in purpose and description to the radio station file. Radiomen do not maintain the visual station file—it is kept by Signalmen.

## GENERAL MESSAGE FILE

The general message file is a record of all general messages addressed to the command. Normally, the file is subdivided by type of general message, and each type is filed in serial number order. (Types of general messages are discussed in chapter 5.)

General message files are given the security classification of the highest classified message contained in the files. For convenience of access and stowage, the files may be segregated by security classification, with appropriate cross-references, and the classified portion filed in the cryptocenter or other secure space.

## BROADCAST FILE

Ships copying broadcasts are required to have complete broadcast files. Messages actually addressed to the ship are written up on message books for local delivery, and after processing, copies are placed in the communication center and radio station files. As messages are received on the broadcast, they are filed in serial number order in the broadcast file. The broadcast file usually is maintained on a monthly basis because the serial numbers run consecutively and start with number 1 the first day of each month.

When a ship moves from one broadcast area to another, it shifts the broadcast guard accordingly. As a result, more than one broadcast may be guarded during the month. A notation is made in the file showing the station from which each broadcast was received, and the inclusive serial numbers of messages from each station.

## DISPOSAL OF FILES

Stowage space often is a problem, both ashore and afloat. The larger shore communication centers solve the problem of stowage space for message files by reproducing the files on microfilm. Aboard ship, stowage space for message files nearly always is inadequate. Except for messages pertaining to distress and those of legal or historical interest, the communication center and cryptocenter files are destroyed after 1 year, as indicated in table 12-1. About the first of July, for example, the files for June of the previous year are destroyed. Methods of destruction, such as burning and pulping, are described in chapter 3. The radio station file is destroyed after 1 month.

General messages must be retained until they are canceled or superseded. Certain general messages (ALNAV, ALNAVSTA, ALSTACON, ALSTAOUT, NAVACT, and NAVOP) are incorporated into the Navy Directives System and are canceled by a superseding message, by a cancellation date indicated in the message text, or automatically after 90 days. Other general messages are incorporated into Registered Publication Memoranda (RPM) and Communications Security Publication Memoranda (CSPM) and are considered canceled when thus published. General messages not incorporated into RPM, CSPM, or the Navy Directives System, and which remain effective at the end of the year, are listed as effective in the first general message of that series for the new calendar year.

## COMMUNICATION LOGS

A communication log is a continuous record of everything that happens on a communication net. Four kinds of communication logs are kept by operators: radiotelegraph, teletypewriter, radiotelephone, and visual. Only the first three concern Radiomen; the visual log is the responsibility of Signalmen.

It is never permissible to erase an entry in any communication log. A necessary change must be made by drawing a single line or by typing slant signs through the original entry and indicating the changed version next to the original entry. Any operator who makes a change must initial it. A log should be kept as neat as possible. It is essential that it be complete and accurate.

### RADIOTELEGRAPH LOGS

As learned in chapter 6, three of the four types of radio watches—guard, cover, and copy—require complete logs. A complete radiotelegraph log must show the following information:

1. All transmissions heard, regardless of origin or completeness, whether addressed to the receiving station or not.
2. Times of opening and closing the station.
3. Causes of delay on the net or circuit.
4. Adjustments and changes of frequency.
5. Any unusual happenings, such as procedure and security violations.
6. Occasions of harmful interference.

If the message is addressed to, or is to be relayed by, the receiving station, it must be written in full on a message blank. A good operator always types directly onto the message blank as the transmission is received. After typing the TOR, he removes the message blank from the typewriter and enters sufficient details in the log to identify the message. Normally, he logs the complete heading, then inserts the notation "See files." If it is unnecessary to write the transmission on a message blank, it must be written out fully in the log.

When opening a net or when starting a new day's log, the operator writes or types his name in the log. He signs the log when he is relieved or when he secures the net. This procedure is repeated at every change of the watch.

An entry must be made in the radiotelegraph log at least every 5 minutes. If the net is quiet, the operator merely logs "No signals." If the operator is too busy to log an entry every 5 minutes, he may enter the essential data later, indicating inclusive times. Figure 12-1 shows how a radiotelegraph log should appear.

Radiotelegraph logs are destroyed after 6 months, except when they relate to distress

**RADIO LOG**
**OPNAV FORM 2810-1 (Rev. 11-58)** Recorder from FPSO Cog. "I" Stock

| ACTIVITY | OPERATOR | CREW | CIRCUIT | FREQUENCY |
|---|---|---|---|---|
| USS ENTERPRISE | W.E. SELLERS RM2 | 3 | 27 | 3319 KC |

| TIME | TRANSMISSION |
|---|---|
| 1245 | NO SIGNALS |
| 125Ø | W.E. SELLERS, RM2 OFF TO M.L. HAMILTON, RM3. RCVR CHECKED WITH FREQ METER. NO TRAFFIC ON HAND. W E. Sellers |
| 1254 | NFFN NHDY NNQN DE NIQM K |
| | NIQM DE NFFN K |
| | NIQM DE NHDY K |
| | NIQM DE NNQN K |
| | NFFN NHDY NNQN DE NIQM - R - 131229Z - FM YONA - TO NFFN NNQN - INFC NHDY GR18 BT (SEE FILES) |
| 1258 | NIQM DE NFFN R AR |
| | NIQM DE NHDY R AR |
| | NNQN DE NIQM INT R K |
| | DE NNQN AS |
| | DE NNQN IMI WA SUBMIT K |
| | DE NIQM WA SUBMIT - EARLPRADATE K |
| 13ØØ | NIQM DE NNQN R AR |
| 13Ø5 | NO SIGNALS |
| 131Ø | NO SIGNALS |
| 1313 | NNQN DE NHDY K |
| | NHDY DE NNQN K |
| | NNQN DE NHDY - T - OJWN - P - 13130Ø8Z - FM NHDY - TO OJWN - INFO NBUV NGTA GR44 BT<br>36155 INDIA MIKE NOVEMBER ALFA JULIETT OYIBM<br>OJCVH USGRI HXRON YIGVL QOOGY STTHU TGKNV<br>HUCHN NEIKE WQYYO QPEAX HXICJ AYPMZ JACIM<br>LEZSO CVDAE SXBLW ETSVC PQBHC UBTBN GYFHJ<br>PBVDF IAKMB VAPDI XCIRU SVJXN SNLVI JNIUL<br>KNCMF BAWXH KFWJR UZPDE RQYNV OEUCI FHADL<br>XKCEW 36155 BT K |
| 1319 | NHDY DE NNQN INT 22 - LEZSO K |
| | NNQN DE NHDY C K |
| 132Ø | NHDY DE NNQN R AR |
| 1325 | NO SIGNALS |
| 133Ø | NO SIGNALS |
| 1335 | NO SIGNALS |
| 134Ø | NO SIGNALS |
| 1342 | T T T T T T T T T T (AA TUNING XMTR) |
| 1347 | NO SIGNALS |
| 1348 | NFFN DE NNQN K |
| | NNQN DE NFFN K |
| | NFFN DE NNQN - O - 131347Z GR 14 BT<br>UNCLAS CARQUAL PLAN CHANGED AS FOLLOWS. 1Ø A/C OVERHEAD 131445Z. 7 A/C OVERHEAD 13153ØZ<br>BT K |
| 135Ø | NNQN DE NFFN R AR |
| 1355 | NO SIGNALS |

| DATE | PAGE NO. |
|---|---|
| 13 NOV 67 | 7 |

(OVER)

36.16

Figure 12-1.—Radiotelegraph log.

or disaster. Then, they must be kept for 3 years. If the logs are of historical or continuing interest, they must be retained indefinitely.

## RADIOTELETYPE LOGS

The radioteletype log may consist either of page copy or perforated tape. Page copy may be wound on a continuous roll, or it can be cut into pages for insertion into a more accessible file. Perforated tape is wound on a reel. The reel type of log is inconvenient for reference, however, because of the necessity for unwinding and rewinding the reel each time it is necessary to search for a transmission.

Some stations are equipped with automatic timeclocks, which stamp the time on perforated tape and page copies of messages. At Stations not equipped with automatic timeclocks, the operator must enter the time on incoming tapes or page copy at least once every 30 minutes.

The disposal schedule for radioteletype logs is the same as for radiotelegraph logs for all stations except tape relay stations. Relay stations are authorized to destroy monitor tapes or page copies of incoming messages after 24 hours. Relay monitor reels or page copies of outgoing messages are retained for 30 days.

## RADIOTELEPHONE LOGS

Aboard ship it is likely that men in certain other ratings do more radiotelephone operating than do Radiomen. Radarmen in CIC, for example, control most of the shipboard radiotelephone circuits. Operation of the radiotelephone is also one of the qualifications for Signalmen and Quartermasters. The reason is that some radiotelephone circuits are controlled from the bridge. In addition to Radarmen, Signalmen, and Quartermasters, the OOD and the commanding officer send and receive messages by radiotelephone.

Radiotelephone circuits manned on the bridge and in CIC, such as the maneuvering, task force command, and combat information nets, are tactical circuits. Complete logs are required on these circuits. For various reasons, the logs differ from those kept by Radiomen in that entries are recorded, by pencil, in ledger-type logbooks. Logs maintained by Radiomen are typewritten on the standard Radio Log (OpNav Form 2810-1) shown in figure 12-2.

Radiotelephone logs must meet the same general requirements as radiotelegraph logs. Often, however, messages are dictated at a rapid pace, and shortcuts are necessary if a complete log is to be maintained. Time can be saved by logging equivalent prosigns for the prowords. Thus, EXECUTE TO FOLLOW can be copied as IX, BREAK as BT, and so on. Don't spell out numbers; record them as figures. Use commonly understood abbreviations. Such shortcuts are acceptable so long as the log meets one simple test: It must be understandable.

Retention and disposal requirements of radiotelephone logs are the same as for radiotelegraph logs.

## MESSAGE BLANKS

Commands vary widely in message-handling procedures and systems of internal routing. Each activity has individual requirements concerning what should be shown on message forms. At most shore communication centers, message blanks are used only for outgoing messages; incoming messages are run off on plain paper on duplicating machines.

Message blanks actually are message "books," each book consisting of a cover and a standard number of flimsies, with sheets of carbon paper inserted. The original (cover) is initialed or signed by recipients of flimsies of the message. After distribution is completed the original is retained in the communication center file.

Figure 12-3 shows two typical message forms. The larger of the two, marked UNCLASSIFIED at the bottom, also is available preprinted with security classifications Confidential, Secret, and Top Secret. The short message blank is the one used most frequently aboard ship. It can be used for both incoming and outgoing messages of any classification. The following discussion concerns the short form.

The upper spaces of the naval message blank are for the security classification, the name of the drafter (for outgoing messages only), precedence, date-time group, and message number (for internal logging). These blocks are followed by spaces for the originator and addressees. About half of the form is left clear for typing the text. Across the bottom are spaces for the releasing officer's signature (for outgoing messages), time of receipt (if message is incoming), time of delivery

**RADIO LOG**
**OPNAV FORM 2810-1 (Rev. 11-58)** Recorder from FPSO Cog. "I" Stock

| ACTIVITY | OPERATOR | CREW | CIRCUIT | FREQUENCY |
|---|---|---|---|---|
| USS LONG BEACH | J.V. PRESTIL, RM3 | 1 | 18 | 2272 KC |

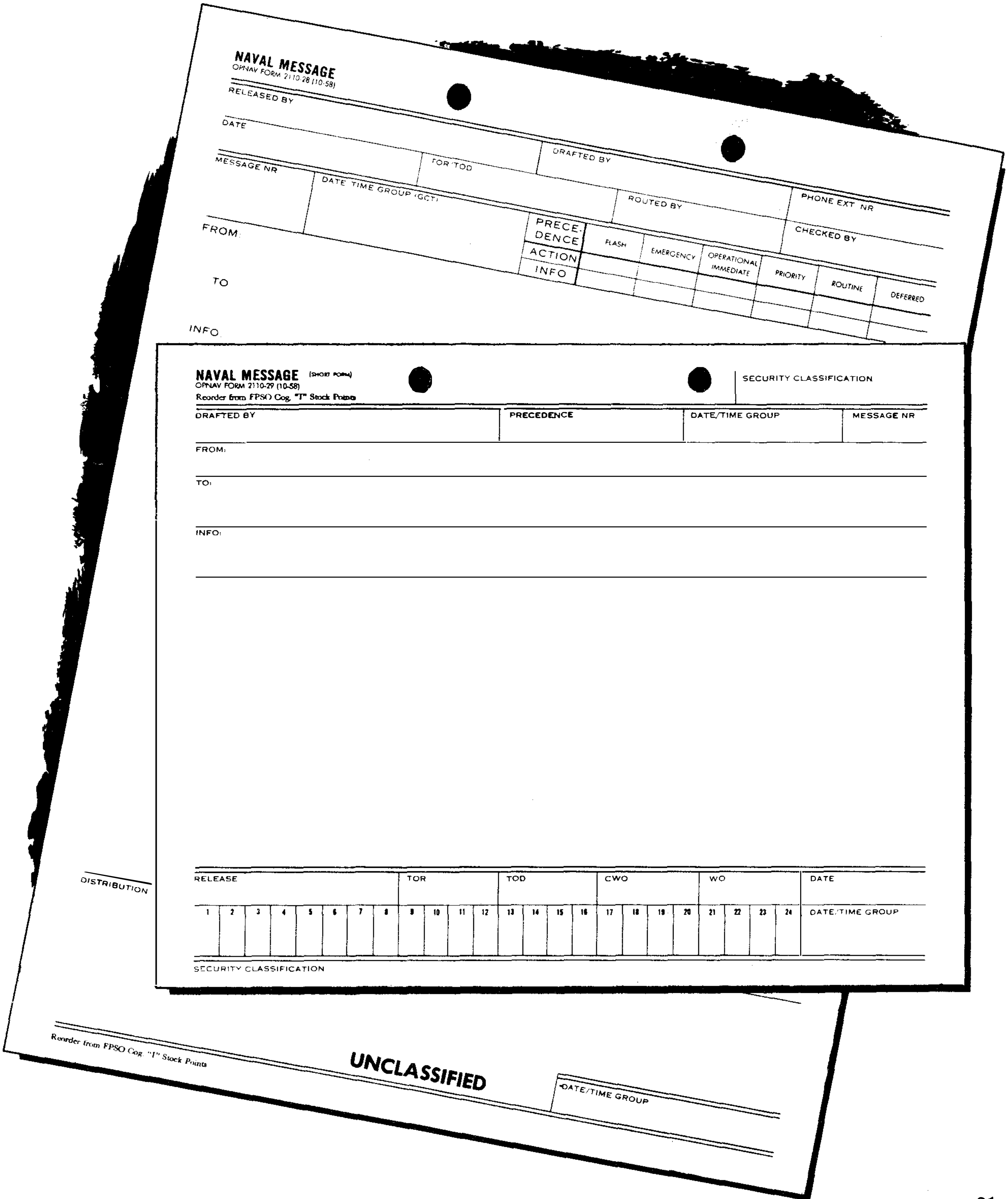
| TIME | TRANSMISSION | |
|---|---|---|
| 15ØØ | SET WATCH--ASSUMED NET CONTROL | |
| | SHOEBLACK THIS IS GIRLCRAZY | THIS IS A DIRECTED NET OF WHAT PRECEDENCE AND FOR WHOM ARE YOUR MESSAGES OVER |
| | THIS IS HAYSTACK | NO TRAFFIC OVER |
| | THIS IS SNOWCAP | 1 P FOR YOU OVER |
| | THIS IS WESTWIND | 1 R FOR HAYSTACK OVER |
| | SUNSHINE SUNSHINE THIS IS GIRLCRAZY GIRLCRAZY OVER | |
| | THIS IS SUNSHINE | NO TRAFFIC OVER |
| 15Ø2 | SHOEBLACK THIS IS GIRLCRAZY | ROGER SNOWCAP SEND YOUR MSG OVER |
| | GIRLCRAZY THIS IS SNOWCAP | MSG FOLLOWS P TIME Ø71455Z FM SNOWCAP TO GIRLCRAZY INFO BEECHNUT GROUPS 15 BT (SEE FILES) |
| 15Ø6 | THIS IS GIRLCRAZY | ROGER OUT |
| | WESTWIND THIS IS GIRLCRAZY | SEND YOUR MSG OUT |
| | HAYSTACK THIS IS WESTWIND | R TIME Ø71452Z GROUPS 5 BT REPORT SHACKLE IDPQ RNZT UNSHACKLE BT OVER |
| 15Ø8 | THIS IS HAYSTACK | ROGER OUT |
| 1513 | NO SIGNALS | |
| 1518 | NO SIGNALS | |
| 1523 | NO SIGNALS | |
| 1528 | NO SIGNALS | |
| 153Ø | J.V. PRESTIL, RM3 OFF TO W. A. SCRUGGS, RMSN--ONE ROUTINE ON HAND FOR SNOWCAP. J. V. Prestil | |
| 1531 | SNOWCAP THIS IS GIRLCRAZY | R TIME Ø7153ØZ FM GIRLCRAZY TO SNOWCAP GROUPS 18 BT (SEE FILES) |
| | THIS IS SNOWCAP | SAY AGAIN WA AT OVER |
| | THIS IS GIRLCRAZY | I SAY AGAIN WA AT 183ØZ OVER |
| 1534 | THIS IS SNOWCAP | ROGER OUT |
| 1539 | NO SIGNALS | |
| 1544 | NO SIGNALS | |
| 1549 | NO SIGNALS | |
| 1551 | GIRLCRAZY THIS IS SNOWCAP | OVER |
| | THIS IS GIRLCRAZY | OVER |
| | GIRLCRAZY THIS IS SNOWCAP | BT UNCLAS YOUR Ø7153ØZ AFFIRMATIVE BT TIME 155ØZ OVER |
| 1552 | THIS IS GIRLCRAZY | ROGER OUT |
| 1557 | NO SIGNALS | |
| 16Ø2 | NO SIGNALS | |
| 16Ø7 | NO SIGNALS | |
| 1612 | NO SIGNALS | |
| 1617 | NO SIGNALS | |

| DATE | PAGE NO. |
|---|---|
| 7 DEC 67 | 1 |

(OVER)

31.47

Figure 12-2. —Radiotelephone log.




31.47

Figure 12-3. —Two typical message blank forms.

(if outgoing), followed by a block for the CWO's initials and another block for initialing by the watch officer or internal router. The day, month, and year are typed in the date block and the DTG is repeated in the lower right corner. This location of the DTG is a time-saver when filing messages or when looking for a particular message in the files. Space for an additional marking of the security classification is provided at the bottom of the message blank.

Numbered blocks across the bottom are utilized for internal routing (distribution) of the message. The commanding officer and executive officer always receive blocks 1 and 2; the rest are assigned according to the needs of the command. Following is a typical shipboard assignment of the numbered blocks; notice that assignment is made by functional title instead of by name: (1) commanding officer, (2) executive officer, (3) operations officer, (4) communication officer, (5) CIC officer, (6) navigator, (7) weapons officer, (8) engineer officer, (9) meteorological officer, (10) supply officer, (11) disbursing officer, (12) medical officer, (13) dental officer, (14) first lieutenant, (15) damage control assistant, (16) chaplain, (17) custodian (RPS or TPL), (18) electronics officer, (19) main propulsion assistant, (20) fire control officer, (21) postal officer, (22) ship's secretary, (23) command duty officer, (24) OOD.

### INCOMING MESSAGES

All CW, RATT, and FAX traffic addressed to a ship is processed through the message center. Except for tactical signals that must be executed within a few minutes, handling of visual and radiotelephone messages is similar. Typically, an incoming message is processed according to the following steps.

1. On arrival of the message in the message center, the CWO or one of his assistants translates the call signs and address groups in the heading. The CWO checks the message, logs it, signifies action and information officers, and gives it to the communication clerk, who makes a smooth original and the requisite number of copies. The original and all copies then are passed back to the CWO.
2. The CWO checks the message again and gives it to the messenger, retaining at least one copy until completion of delivery.
3. The messenger delivers the traffic to the action officer, then to the information officers. They receipt by initialing the original of the copies typed by the communication clerk. The captain, executive officer, and communication officer receive copies of all messages, and for this reason often maintain file boards on which their copies are placed. On large ships the orderlies of the captain and executive officer sign for the messages and make delivery to these officers.
4. After distributing all copies and obtaining initials, the messenger returns the completely initialed original to the message center. There the CWO checks it for completeness of delivery. This master copy becomes a permanent part of the communication center file. The circuit copy is placed in the radio station file.

## INTERNAL ROUTING AFLOAT

Although the captain has overall responsibility for taking any action required by a message, he seldom is indicated as the action officer. Customarily, a message is routed for action to the department head who has direct responsibility for the subject matter of the message. The captain (or executive officer), receiving a copy of all messages, then ensures that the action officer takes the required action.

A message is routed for information to officers who have an indirect interest in its subject matter.

Call signs and address groups in the heading of a message do not indicate who aboard is to receive the message either for action or for information. The CWO must read the text and decide who is principally responsible and who is officially interested. Some incoming messages are borderline cases; that is, more than one department must take some kind of action. The CWO must decide upon the one action officer, keeping in mind that the officer with the greater interest in the subject matter is routed action.

It is important that the proper number of copies of a message be made. An underrouted message may result in delay and the inconvenience of making additional copies. The other extreme—preparing a copy for everyone who might have even a remote interest in the message—is just as bad; it would take too much time and often circulate classified information too widely.

An example of internal routing afloat may be helpful. Such an example is given in table 12-2, in which "A" stands for action, and "I" for information. Refer also to the incoming message shown in figure 12-4.

Final responsibility for routing rests with the CWO, even though an enlisted assistant performs the work. Some CWOs do the routing themselves, using a Radioman mainly for clerical assistance. Others delegate the work of routing, but check its accuracy before delivery is made. At small stations, both ashore

Table 12-2.—Example of Internal Routing Afloat

| Block | Assigned To | Routing | Explanation |
|---|---|---|---|
| 1 | Commanding Officer | I | Receives all messages. Responsible for everything that goes on in his command and, therefore, necessarily must be informed of everything. |
| 2 | Executive Officer | I | Receives all messages. In charge of administering the ship, hence must also be informed of everything. |
| 3 | Operations Officer | A | Acts in matters relating to the ability of the ship to carry out her assigned mission. |
| 4 | Communication Officer | I | Receives all messages, for two reasons: to check for errors, and to be informed if questions arise. |
| 6 | Navigator | I | Plots storms and gales; must determine bearing and distance of ship from gale; plots diversionary route, if necessary. |
| 7 | Weapons Officer | I | Must see that exposed ordnance equipment is covered properly. |
| 8 | Engineer Officer | I | Responsible for damage control and ship's stability. Must ballast as necessary and be prepared to strike topside weights below; must take precautions against water damage to engine-room power panels; must see that shaft alleys, workshops, and storerooms are ready for heavy weather. |
| 9 | Meteorological Officer | I | Receives all messages concerning weather. Must advise command in matters relating to his speciality: anticipated storm track, probable state of sea, etc. |
| 10 | Supply Officer | I | Must see that galley, messhalls, storerooms, and other spaces assigned his division are rigged for heavy weather; may have to revise his menus to provide food that can be served when the seas are high. |
| 12 | Medical Officer | I | Must see that bedridden patients are subjected to a minimum of discomfort caused by roll and pitch of the ship, and that the sick bay, medical store-rooms, and other spaces are secured from heavy weather damage. |
| 14 | First Lieutenant | I | Must see that ground tackle is secured, if not required; that rafts, boats, and other gear on the weather decks are secure from damage. |
| 24 | OOD | I | Responsible for safety of the ship during period of his watch. (A message routed "OOD" is seen by all OODs.) |

76.54

**NAVAL MESSAGE** (SHORT FORM)
OPNAV FORM 2110-29 (10-58)
Reorder from FPSO Cog. "I" Stock Points

SECURITY CLASSIFICATION
UNCLASSIFIED

| DRAFTED BY | PRECEDENCE | DATE/TIME GROUP | MESSAGE NR. |
|---|---|---|---|
| | IMMEDIATE | 11Ø4Ø3Z | 31 |

FROM:
FLEAWEACEN WASHDC

TO:
ALL SHIPS COPYING THIS BROADCAST

INFO:
COMEASTSEAFRON / FLEWEAFAC NORVA / FLT HURRICANE FCSTFAC MIAMI

UNCLAS

11Ø4ØØZ GALE WARNING. BETWEEN FORTY TWO AND FORTY FIVE NORTH FROM THIRTY FIVE WEST TO EUROPEAN COAST. WIND WESTERLY TWENTY FIVE TO THIRTY FIVE KNOTS

WR NR3365 WU/JN

| RELEASE | TOR | TOD | CWO | WO | DATE |
|---|---|---|---|---|---|
| | 11/Ø417Z | | | | 11 OCT 67 |

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | DATE/TIME GROUP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| I | I | A | I | | I | I | I | I | I | | I | | I | | | | | | | | | | I | 11Ø4Ø3Z |

SECURITY CLASSIFICATION
UNCLASSIFIED

Figure 12-4. —Incoming message. 76.51

and afloat, it is not unusual for a Radioman First or Chief to act as CWO and to assume responsibility not only for routing but also for supervising the watch.

## INTERNAL ROUTING ASHORE

The principles of internal routing are practically the same everywhere, but routing at a shore station often presents difficulties because of traffic volume and the number and diversity of activities the station may serve. For some activities, the station may not route all all, but only make delivery in accordance with address groups. Actual routing to action and information officers in such an instance is a function of the addressee. For other activities the station makes internal routing; but the messages for action and information usually go to offices, divisions, or sections—not to individuals.

In addition to the action/information internal routing commonly used everywhere, another routing symbol, cognizance (abbreviated COG), is in use at many of the large shore Message centers. It is used instead of action routing on messages addressed to the Command for information. The purpose of routing for COG is simply to prevent routing for action when the message is not addressed to the command for action. The office that has primary cogninizance over the subject matter contained in the message is routed COG. It is responsible for taking any action that may be required within the command, including checking to see that the CWO's routing for information includes distribution of copies to other activities that might need the information.

Many stations, especially larger ones, maintain a routing file based on subject matter of messages. The file consists of cards showing the activities interested in each subject for action and for information.

Messengers from each activity make several trips daily to the communication center to pick up their activity's incoming traffic and to deliver outgoing messages for transmittal. Delivery to some activities may be made by direct teletype drop instead of by messenger.

## OUTGOING MESSAGES

Typically, an outgoing message is processed according to these steps:

1. After determining that a message is necessary, the drafter prepares it, assigns appropriate classification and precedence, and sends it to the releasing officer.
2. The releasing officer checks the message for content, precedence, classification, brevity, and clarity, making any changes he sees fit. If he thinks the message unnecessary, or that it can go by slower means, he returns it to the drafter. If he approves the message, or approves it with changes, he signs it and sends it to the message center.
3. As soon as the message arrives in the message center, the time of file (TOF) is stamped or penciled on it. Many ships and stations also assign the DTG at this time. The CWO then logs the message in the outgoing message log, which contains the same general type of information as the incoming message log. The CWO determines that all addressees hold copies of any referenced messages listed in the message being processed, or that the references are marked with the abbreviation NOTAL, which the originator uses to indicate that the referenced messages were "not to, nor needed by, all addressees." The CWO also must ascertain that the classification of the message is in accord with the requirements for unclassified references to classified messages. Primarily, these checks are the responsibility of the message drafter, but they are doublechecked by the CWO or one of his assistants.
4. The originator's draft is given to the communication clerk, who makes file and routing copies. On some ships, the originator indicates internal routing for an outgoing message. On others, the CWO performs this duty and routes an outgoing message just as he would an incoming message.
5. If the message is classified, an on-line facilities are not available, the CWO prepares it for encryption and sends it into the cryptocenter. The encrypted version is passed back to the CWO, who drafts a heading, places it on the encrypted copy, and sends it to the watch supervisor in the radio room for transmission. If the message is unclassified, it is unnecessary, of course, to route it through the cryptocenter.
6. In the radio room the message is placed on the air. The time of delivery, accepting station, frequency, and operator's sign are noted on the face of the form, and the message is returned temporarily to the message center for completion of the CWO's outgoing message log.
7. The originator's draft goes into the rough file. The original encrypted copy, if any, goes to the radio supervisor for the radio station file. A filler, dummy, or encrypted copy goes into the communication center file. A plain language copy goes in the proper section of the cryptocenter file. If the message is plain language, a copy goes in the radio station files, as before, and another in the communication center file.

### RELEASING SIGNATURE

Before accepting any outgoing message for transmission, be certain that it is released properly. The signature of the releasing officer appears on the face of the message. Aboard ship the authority to release messages is vested in the commanding officer, but for sake of convenience the authority often is delegated. Following is a typical large ship releasing arrangement.

1. Captain and executive officer—may release any message.
2. Meteorological officer—may release routine weather reports.
3. Navigator—may release routine position reports.
4. OOD—may release visual and radiotelephone messages concerning operations.
5. Communication officer—may release service and class E (personal) messages.

Shore stations maintain a signature file of releasing officers. This file is used in much the same way as a bank's signature file of depositors. Each local command or activity served by the station submits a signature card for every officer authorized to release messages. Besides signatures, the cards also carry information regarding any limitations on the officer's releasing authority. An officer may, for example, be authorized to release messages to shore activities, but not those addressed to forces afloat. When an outgoing message is received over the counter, the releasing officer's signature is compared with that on his card. If he is authorized to release messages of that type and classification, the message is accepted.

## REFERENCES

Many messages refer directly to a previous incoming or outgoing message. It saves bother for everyone if half a dozen officers do not need to telephone the message center to have previous references taken from the files and read to them. Accordingly, if there is a refference in an incoming message, look up the referenced message and show identifying extracts across the face of the routed copies. The same procedure applies to outgoing messages. It is unnecessary to copy the reference in its entirety, but quote enough so that action and information officers get the gist of it. There are two additional reasons why Radiomen must check references in outgoing messages. First, checking references assures accuracy. Second, it is a security measure; unclassified replies to certain types of classified messages are forbidden.

## TRAFFIC CHECKER

The traffic checker is a station's final safeguard against error. Every message handled by the station passes through his hands for a last thorough check before going into the files. (See table 12-3.)

Shore stations often have from one to four men checking traffic full time. Usually there is some specialization to meet local needs—one or two men, for instance, may check only encrypted traffic, wheras the other check plain language traffic. A good checker will do his best to stay "up" with the traffic load. That way he can catch errors before the messages leave the station, thus saving service messages and corrected copies.

A traffic checker must know the station's message-handling procedures inside out. He must be acquainted with in-station memoranda and directives, official publications, and (aboard ship) the communication organization book. He must have a well-rounded knowledge of guard lists, routing indicators, and fleet organization.

Few ships handle enough messages to warrant an assembly line procedure, where one man does nothing but check preceding steps. Messages are checked, of course, but checking ordinarily is done by the CWO and assistants as they go along. The communication officer also checks his personal copy. Many ships hold a daily traffic check before messages handled the previous day go into the files. The checker reads the writeup and circuit copies, noting the heading, text, routing, and so on. If everything is in order, he initials the message to that effect. If he finds an error, he brings it to the attention of the CWO. If the error is serious enough to justify corrected copies, they are made up and delivered at once. Incorrect copies are picked up, or the possessor is advised to destroy them.

The effective edition of DNC 5, U.S. Naval Communication Instructions supports and amplifies NWP 16, Basic Operational Communication Doctrine. The DNC 5 expands and modifies for intra-U.S. Navy and Marine Corps use, information contained in the JANAP and ACP series. Additionally, it contains procedures and instructions not promulgated elsewhere.

## CORRECTIONS TO PUBLICATIONS

Corrections to publications are issued in four ways: errate, change, memorandum, and message. Errate consist of corrections usually in list form and mimeographed, distributed with a publication or change to a publication at the time of its initial distribution. Errata are for the purpose of correcting defects

Table 12-3.–Checklist for Traffic Checkers

1. Examine heading, text, and ending for garbles and omissions.
2. Determine if the message has been handled in accordance with its precedence.
3. Check routing indicators, if any. Check breakdown of call signs and address groups.
4. Check the group count, if any.
5. Check the continuity of the station serial number. See that the number agrees with the number logged.
6. Compare originator's rough draft against hard copy or circuit copy.
7. If the message contains a ZFF, ensure that it has been answered. (ZFF: an operating signal means, in effect, "When did addressee receive message?")
8. Check operator's sign and servicing.
9. Check internal routing for omissions.
10. In shore stations, watch for duplicate messages. If your station receives the same message twice, someone else may have a nondelivery.
11. Watch for excessive in-station delays; compare the time your station received or accepted the message against the time it was delivered or sent.
12. Always be alert for security violations.

76.52

that may affect the status or accountability of a publication, or amending serious errors in the basic text that may lead to misinterpretation.

A change to a publication is itself a serially numbered publication, and may consist of pen-and-ink corrections, cutout corrections, or new pages to amend or add to the contents of a basic publication. Changes are numbered consecutively (change No. 1, No. 2, etc.).

Urgent corrections are of three kinds: Registered Publication Memorandum Corrections (RPMC) for corrections to RPS-distributed publications, Navy Memorandum Corrections (NMC) for Allied Communication Publications (ACPs) distributed and advance changes (ADVCHGs) to tactical publications. Urgent corrections are used when time does not permit the preparation of a serially numbered change. The RPMCs, NMCs, and ADVCHGs are numbered serially, using a system of two numbers separated by a slant sign. The figure before the slant sign indicates the number of the NMC, RPMC, or ADVCHG, and the numbers run consecutively for the life of the basic publication. The figure after the slant sign indicates the change that will confirm the material contained in the NMC, RPMC, or ADVCHG. For example, NMC 2/1 to ACP 113 is the second NMC issued to ACP 113 and will be confirmed by a forthcoming change No. 1.

Message corrections to publications are issued by ALCOM and JAFPUB general messages (or ALCOMLANT, ALCOMPAC when appropriate). Message corrections are used only when it is absolutely necessary to disseminate the correction by rapid means.

One of the jobs of RM2 and RM2 is to help keep communication publications up to date. All communication publications, particularly the call sign, address group, and routing indicator books, frequently undergo necessary changes. The custodian (or technical publications librarian) is responsible for the prompt and accurate entry of all changes and corrections to publications. Usually, he issues the changes and corrections to the leading Radioman for the publications held in communication spaces. The leading Radioman then assigns the work to his men. Aboard some ships and stations, each man is assigned his share of the publications to keep up and is responsible only for those assigned to him. Other activities assign the correcting job to any men available at the time the work needs to be done.

Entering corrections in publications is tedious work. It is a necessary chore, however, and is of such importance that it warrants the most careful attention. Here are some general rules for entering corrections:

1. Read and understand the specific instructions contained in the correction before you begin the actual entry.
2. For pen-and-ink corrections, use green ink or any dark ink except red. Red ink is not visible under the red night lights used aboard ship.
3. Type lengthy pen-and-ink corrections on a separate slip of paper, then paste the paper on the page.
4. When cutouts are provided, use them in preference to pen-and-ink corrections.
5. Cutouts should be cemented flat on the page with rubber cement or mucilage. (Rubber cement or mucilage is more satisfactory than cellophane tape because the tape often sticks pages together or may tear pages if its removal is attempted.) If there is insufficient room on the page to insert cutouts, they may be attached to the inner (binding) edge of the page as flaps.
6. Delete, in ink, all subject matter superseded by a cutout before adding the cutout. This method prevents using the superseded material if the cutout becomes detached.
7. Because a correction entered is one section of a publication often affects another section, such as the index, make certain that the corrections are entered in all applicable sections.
8. After entering pen-and-ink or cutout corrections, note on the margin, opposite the line containing the correction, the identification of the correction, as NMC 1/2, ALCOM 3, etc.
9. Upon completion of the entry of any change affecting page numbers, and before destroying any superseded pages, make a page check of the publication.
10. After entering the correction, fill in the information required by the "Record of Changes" page in the front of the publication. This page provides spaces for the correction number and its date, the entry date, your signature and rate, and the name of your ship or station.

## WATCH SUPERVISION

As you advance in rating you are expected to assume more responsibility and to become more proficient in your field. As Radioman 2 you are required to take charge of a watch, supervise traffic handling, and act as a minor technician for many equipments. Even though at your present duty station you might not be given a watch to supervise, remember that in time of war Radiomen are scattered throughout the enlarged fleet, and it is quite possible for an RM2 to be the only experienced Radioman aboard.

Communication organizations, afloat and ashore, differ widely in internal message-handling procedures. It is difficult to lay down more than a few specific rules for supervisors because of varying problems, purposes, sizes, and locations of individual stations. If you had an opportunity to serve on the watch before taking it over, you probably are reasonably well indoctrinated in the local way of doing things. If not, you will have to depend on your superiors for guidance. In either case, make a study of the organization and regulations of your duty station, and know the contents of departmental and division notices and directives.

Upon the supervisor of any watch falls responsibility for keeping traffic moving and for running a taut watch. You must know your publications and instructions, and have them at hand for ready reference. At sea you should know and understand the cruising disposition of the fleet. You should be familiar with your own radio equipment and, if possible, the equipment of ships in company. That way you can allow for equipment limitations. You should not have to refer to the equipment technical manual for any of the following data on your transmitters, or, as applicable, receivers: model, location, source of power, frequency range, type of emission, rated power output, and effective day and night ranges, summer and winter.

During exercises you must watch your men closely, with an idea to the correction of any shortcomings that may appear. Keep an eye on the strikers; if they show no interest in self-betterment and in making themselves of more value to the Navy, find out why.

Before taking over each watch, obtain all possible information relating to circuit conditions; special orders; cruising disposition; traffic awaiting transmission, receipt, execution, or acknowledgment; frequencies under guard; gear in use; and guardships.

Before relinquishing the watch, assure yourself that all of your men are relieved, and that your operators surrendered to their reliefs logs that are up to the minute and signed. Pass on all information of interest to your relief, and be satisfied that he understands the current communication situation.

The supervisor's desk is so wired that he can cut in on any of the operating positions and monitor the transmissions. Listen in frequently to both radiotelephone and radiotelegraph nets to check for off-frequency operation, incorrect procedure, and unauthorized use of plain language. Correct offending operators. Ensure that traffic flows smoothly. Do not allow letterwriting while on watch, nor the reading of books and magazines (except official publications). See that files are kept orderly, and that out-of-date sections are burned on time.

When you are given an outgoing message, look it over carefully before passing it to an operator for transmission; After the message is sent, note the operator's servicing. Check the address and group count of an incoming message, and take particular care to see whether relay is necessary. As frequently as possible during the watch, examine the logs and records, and make a final check at the end of the watch. Constant checking and rechecking are the best means of preventing mistakes that can embarrass not only you but the entire chain of command.

Traffic usually is filed on the morning after the day it is hendled. After the daily files are complets, a final check should be made for nondeliveries. If at any time a delayed delivery or a nondelivery is discovered, that fact, with the attendant circumstances, should be reported at once to the Radioman in charge, who will inform the CWO or communication officer. Fear of the consequences of a mistake should not be a deterrent to such a report. If an honest mistake was made, punishment seldom is occasioned, and a report and rectification are essential to good communication practice.

The relationship between officers and men of the communication organization must, for the sake of efficiency, be based on mutual confidence and trust. A supervisor can do his part to attain this objective by keeping alert and by conducting his watch in such a manner that the radio officer respects his ability. When mistakes occur, as they do in all offices, the radio officer undoubtedly will recognize that, although the error was avoidable, his supervisor nevertheless is competent. Most mistakes merely require provision for prevention of recurrence.

Constant work, observation, and correction are necessary to make your men efficient and responsible by second nature. It is your prime duty to make them so, and to instill in them the conviction that the success of naval communications depends on them individually.

The remainder of this chapter contains special topics of interest to the supervisor.

## OPORDER COMMUNICATION ANNEX

An operation order (OpOrder) is a directive outlining procedures to be followed for some particular operation, such as an invasion, airstrike, or convoy. That part of the OpOrder of interest to Radiomen is the communication annex, which usually is one of several annexes. The communication annex sets forth instructions that govern radio and visual communications during the operation. Typically, it deals with such topics as—

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. Radio silence.
4. Use of UHF.
5. Radio procedures and circuit discipline.
6. Command circuits.
7. Call signs and address groups
8. Radiotelephone codes and ciphers.
9. Visual communications.
10. Frequency plans for surface ship nets, CIC communications, and for aircraft communications.
11. Movement reports.

Departures from, or modifications of, communication doctrine for a particular operation are described carefully in the annex. Departures from standard doctrine are not made except for good reasons.

The information Radiomen are required to have from the annex is furnished through the chain of command. From the communication officer it passes through the signal and radio officers to the watch officers and the leading PO. The leading PO disseminates the information to the watch sections.

## COMMUNICATION (FREQUENCY) PLAN

The communication annex of an OpOrder contains a table of circuits and frequencies devised to fulfill the communication requirements of the forces participating in the operation. Depending on the size of the operation, the number of circuits required may be quite large. Because of equipment limitations, every ship or command cannot guard all of the circuits simultaneously; nor does every ship or command have the same circuit requirements. For these reasons, the frequency plan in the communication annex designates the circuits each type of ship or command is to guard. It also specifies the circuits each type is to maintain in a ready or standby condition.

The overall frequency plan usually is condensed by the individual ship into a ship's communication plan. This communication plan is the radio supervisor's guide for setting up equipment and circuits and for maintaining communications.

Communication plans vary with individual ships and may appear in many forms. Most communication plans, however, contain at least the following information concerning each circuit:

1. Circuit designation (number);
2. Frequency;
3. Utilization (primary tactical, secondary tactical, and the like);
4. Specific transmitter and receiver used;
5. Remote position(s) to which patched;
6. Net control station.

Other pertinent data, such as scheduled frequency shifts and the time radio checks are to be conducted, may also be included in the communication plan.

## STATUS BOARDS

Status boards usually are large, thick sheets of plexiglass on which the supervisor maintains a record of frequently changing communication data. For instance, the communication plan normally is transferred to a status board. As changes in equipment or circuit status occur, the supervisor records the changes on the status board, and thereby maintains an up-to-the-minute record of the equipment in use, the circuits that are up, and those that are in standby, and so on.

To be of any value, a status board must be accurate. An inaccurate board can cause a lot of confusion, particularly when relieving the watch. To avoid this disarrangement, the supervisor personally makes all changes to a status board.

## FREQUENCY ADHERENCE

One of the supervisor's duties is to be sure that transmitters and receivers are exactly on frequency. Off-frequency operation may result in a ship's transmission not being heard at all. Less extreme cases are also dangerous because they lead to use of excessive power to blast through what the off-frequency station believes to be poor receiving conditions. Information on frequency planning and tolerances is explained in ACP 180.

Newer models of Navy transmitters are capable of greatly improved frequency stability. This feature means that, when correctly set on the desired frequency, they are unlikely to drift off frequency. Ships and shore stations are also provided with a frequency-measuring instrument—the frequency meter—used principally to measure frequencies of transmitters and receivers. It is a calibrated device to which an oscillating circuit may be compared, either to determine its frequency, or to adjust it to a desired frequency. The frequency meter itself is not an ultimate standard of accuracy. It may become unreliable, hence it should be checked weekly against the standard radiofrequency broadcasts of National Bureau of Standards radio station WWV. Transmissions from WWV are explained fully in chapter 14. Provisions of DNC 5 require that frequency meters be checked at least once each week. A log is directed to be kept of the checks conducted.

The frequency of radio receivers on circuits where no (or few) transmissions have been received should be checked with the frequency meter at least once every hour. Crystal-controlled receivers need not be checked this often, inasmuch as there is less likelihood of their drifting in frequency.

Shipboard transmitters used frequently should be checked with the frequency meter at least once each watch. Transmitters used only occasionally should be checked before each use. This requirement is not applicable to crystal-controlled transmitters. Most VHF/UHF transmitters are crystal-controlled, but many shipboard transmitters in the MF/HF range are not.

## CRYSTALS

Among the essential items that often receive too little attention are the crystals used in most shipboard VHF/UHF transmitters. These crystals are small, consequently they easily are lost or misplaced. They cannot take too much abuse, although encased in a protective covering. When not actually in use, the crystals should be removed from the equipment and stowed in their appropriate container—usually a metal box.

Lost or inoperative crystals should be called to the attention of the leading Radioman immediately so that they may be replaced. It is embarrassing, to say the least, to be unable to come up on a required frequency because of a missing or inoperative crystal.

The Naval Ship Systems Command Instruction 09670.58 series, the Shipboard Crystal Allowance List, lists the crystals (by equipment, frequency, and ocean area) that each type of ship is required to have. When this instruction is revised, check it closely to make certain that all crystals allocated your ship are aboard.

## TRAINING AND STUDY

As a supervisor of a watch, it is your responsibility to train your men to become more proficient in their duties. During a normal watch, you are presented with an untold number of opportunities for on-the-job training. Conditions permitting, each shift in frequency or change in equipment can be utilized to train one or more of your men. Many outgoing messages can be used in a similar manner. Take advantage of these opportunities, because both you and your men benefit from them. You benefit by having a sharper watch section that requires less of your time in doublechecking their work. They benefit by increasing their advancement opportunities.

By the time you advance to the position of a watch supervisor, you should know the value of studying. Encourage your men to study during slack periods. They are not permitted to write letters or read unofficial books or magazines, so why not use this time in bettering themselves? In the ACPs and other publications available, you and your men have at your fingertips all of the doctrinal communication information required for advancement from Seaman to Master Chief Petty Officer. Take advantage of them!

## WATCH SUPERVISOR'S LOG

Usually, ships and commands that handle a large volume of traffic and maintain a large number of circuits require the watch supervisor to keep a log. The supervisor's log is a running record of the happenings during his watch. It contains such data as circuit outages, equipment failures, frequency shifts, off-frequency reports, traffic backlogs, security violations, and unusual circumstances that occur. Entries are made only when warranted. They are not required specific time intervals.

The supervisor's log is particularly useful as background information when turning over the watch to a relieving supervisor.

## PUBLICATION CUSTODY LOG

The watch supervisor is personally accountable for official publications used by his section. In order to provide effective control, ships and shore stations use publication custody logs for recording the watch-to-watch inventory. No standard form for this log is available, so you may see many different log forms. The publication custody log shown in figure 12-5 satisfies the requirements of the fleet training groups. The log lists all publications in use in a particular space. At the change of watch, the supervisor and his relief sight every publication, and the relief signs the log. By doing so, he says, in effect, that the publications are actually present and that he holds himself responsible for them. Always sight every publication for which you sign. If you fail to do so, you leave yourself open to king-size troubles.

## QUESTIONS FOR SUPERVISORS

Following is a list of questions worth asking yourself every time you stand your watch.

1. Does handling of traffic meet Navy requirements for reliability, security, and speed?
2. Are regulations for handling and stowing classified matter observed in the spaces for which you are responsible?

PUBLICATION CUSTODY LOG

WATCH-TO-WATCH PUBLICATION INVENTORY FOR Radio Central

| Day-Month-Year Period of Watch | | 10 Dec 67 0000-0400 | 10 Dec 67 0400-0800 | 10 Dec 67 0800-1200 | 10 Dec 67 1200-1600 | 10 Dec 67 1600-1800 | 10 Dec 67 1800-2000 | 10 Dec 67 2000-0000 | 11 Dec 67 0000-0400 | 11 Dec 67 0400-0800 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Short Title | Reg. Nr. | | | | | | | | | | | | | | | | |
| ACP 100 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 110 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 112 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 113 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 121 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| FXP 3 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| JANAP 119 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| JANAP 195 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| (Full) Signature (in ink) | | RW Leslie | Jack Colbert | Fred Cramer | RW Leslie | Jack Colbert | Fred Cramer | RW Leslie | Jack Colbert | Fred Cramer | | | | | | | |

I certify that I have personally sighted and inventoried each of the above-listed publications and/or materials. By my signature above I acknowledge responsibility for maintaining security precautions and assume custody for all above-listed publications and/or material during my watch or until properly relieved of their custody. I will report immediately to the custodian or other competent authority any discrepancy in the inventory.

76.52

Figure 12-5. —Publication custody log.

3. Are all logs and files kept properly?
4. Does all wastepaper go into the burn bag?
5. Are unauthorized personnel kept out of the communication spaces?
6. Are encrypted call signs broken rapidly and accurately?
7. Do all operators in your watch section understand communication procedures and authentication?
8. Can all your operators tune every transmitter aboard? Can all operators use a frequency meter?

9. Are frequency meters calibrated weekly against radio station WWV?
10. Is all your equipment operative? If not, is it being placed in working order?
11. Are safety precautions and warning posters displayed?
12. In a sudden electrical accident, would every man in your gang know what to do?
13. Do you know what condition of radio silence exists, and under what circumstances and by whose authority it may be broken?
14. Do you know what channels and frequencies are in use for every purpose? What standby frequencies are available? The call signs of ships in the force?

# CHAPTER 13

# SAFETY

When working with radio, or with any electronic equipment, one rule that must be stressed strongly is: SAFETY FIRST. Dangerous voltages energize much of the equipment with which you work. Power supply voltages range up to 40,000 volts, and radiofrequency voltages are even higher.

Special precautions are also necessary because electrical fields, which exist in the vicinity of antennas and antenna leads, may introduce fire and explosion hazards, especially where flammable vapors are present. Additional precautions are needed for personnel working aloft to prevent injuries from falls and stack gases.

Safety precautions outlined in this chapter are not intended to supersede information given in instruction books or in other applicable instructions for installation of electronic equipment. Check these sources before touching the gear. Additional safety information is contained in NavShips Technical Manual, chapters 60-21 through 60-50, and Test Methods and Practices (EIMB), NavShips 097-000-0130 (section 1-15).

If at any time there is doubt about the steps and procedures you should observe while working on electronic equipment, consult the technician or Radioman in charge.

Danger signs and suitable guards are provided to prevent personnel from coming in accidental contact with high voltages. The warning signs shown in figure 13-1 are posted on or near every radio transmitter, transmitting antenna lead-in trunks, and in radar rooms and other electronic spaces throughout the ship. The signs are painted red to make them more conspicuous. Additional signs warn against such hazards as explosive vapors and effects of stack gases aloft. Look for warning signs and obey them. Notify your supervisor if a dangerous condition exists for which no warning sign is posted.

## FUNDAMENTALS OF ELECTRIC SHOCK

One of the greatest safety hazards for Radiomen is electric shock. In order to avoid this hazard, an understanding of its causes and effects is necessary.

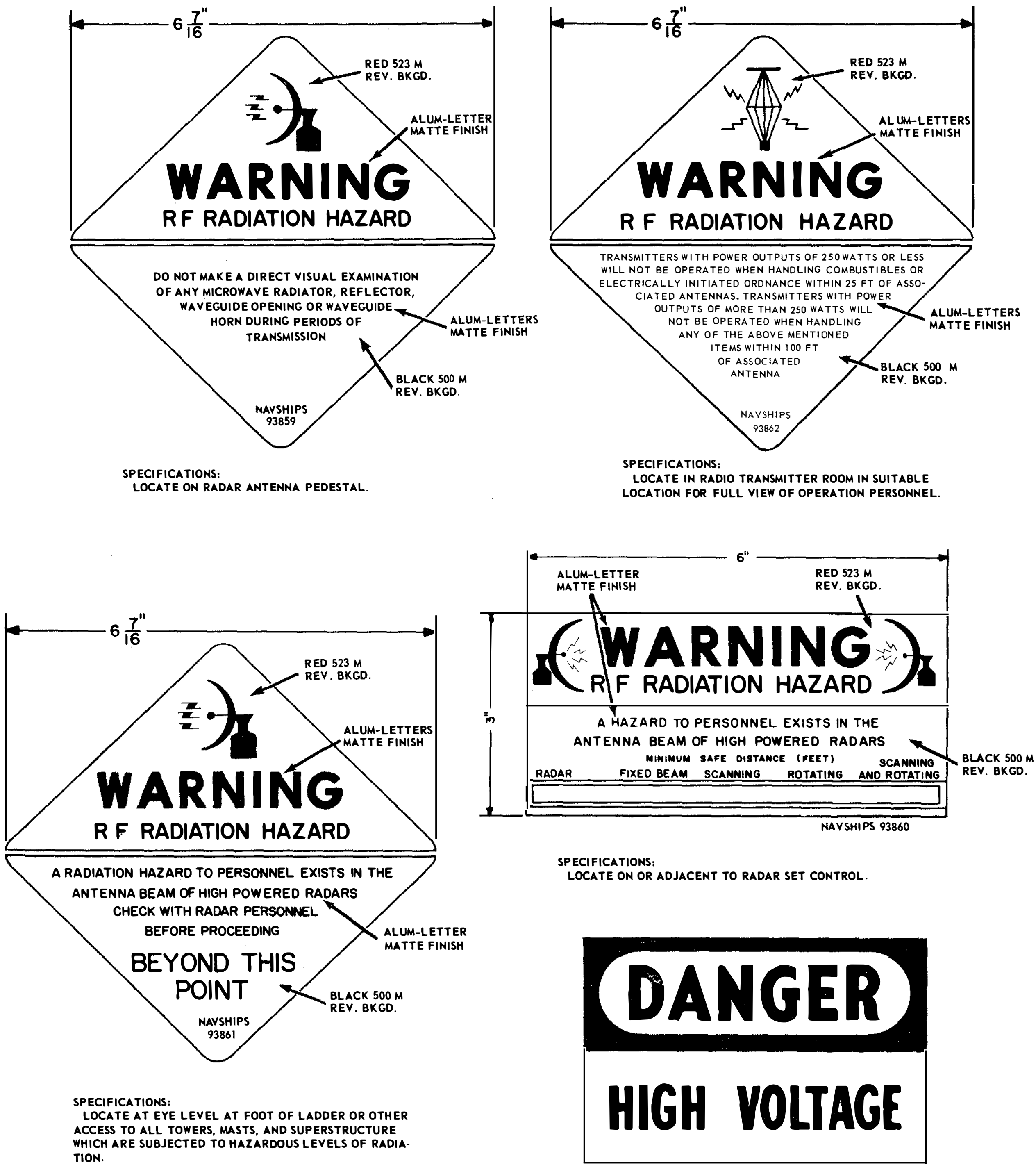
If a 60-cycle alternating current is passed through a man from hand to hand or from head to foot, the effects when current is increased gradually from zero are as follows:

1. At about 1 milliampere (0.001 ampere) the shock can be felt.
2. At about 10 milliamperes (0.10 ampere) the shock is severe enough to paralyze muscles so that the man is unable to release the conductor.
3. At about 100 milliamperes (0.100 ampere) the shock is fatal if it lasts for 1 second or longer.

The resistance of the human body is insufficient to prevent fatal shock from 115-volt or even lower voltage circuits. About 50 percent of shipboard electrocutions are caused by circuits of these types. It is important to remember that current, rather than the quantitative value of the voltage, is the shock factor.

## CONDITIONS FOR SHOCK

Two conditions must be met for current to flow through a man. First, he must form part of a closed circuit; and second, there must be a voltage to cause current to flow through the circuit. If these two conditions exist, and in addition the potential difference between the points of contact is high enough (115 volts is more than high enough), the body resistance is low enough, and the current path goes through some of the man's vital organs, he will be shocked fatally. For this reason a man should see to it that his body does not form part of a closed circuit through which current can flow.




40. 67(76)

Figure 13-1. —Hazard warning signs.

Don't go aboard ship with a casual regard for the deadly potentialities of electric current. Few people would handle electric appliances while in a bathtub, or stand ankle-deep in a flooded basement and fumble for a light switch. What is not so well recognized by many Navymen is that the hull of a ship—which, of course, floats in salt water—is an excellent conductor, and that for all practical purposes the man afloat is "standing in a bathtub" all the time.

SOME NOTES ON HUMAN ERROR

Most accidents are avoidable. So that you can see for yourself how avoidable they are, here are the causes of 22 shipboard electrocutions, all of which were traceable to human error.

| Causes | Deaths |
|---|---|
| 1. Accidentally touched equipment or conductor, which man knew to be energized. | 13 |
| 2. Unauthorized modifications to equipment or use of unauthorized equipment. | 3 |
| 3. Failure to test equipment before working on it to see whether it was energized. | 2 |
| 4. Failure to repair equipment that had given warning of an unsafe condition by one or more nonfatal shocks prior to the fatal shock. | 2 |
| 5. Failure to test equipment for insulation resistance and correctness of ground connection AFTER making repairs, and BEFORE trying gear for operability or putting it to use. | 2 |

Men are also electrocuted ashore. In one instance a man erecting an antenna tied a rock to the end of a bare copper wire and threw it over a 3300-volt powerline. Another died when he climbed a pole on a transmission line to capture a monkey sitting on one of the wires. A third walked out of a warehouse with a companion, saw a wire hanging from a pole, said "There's the wire that was popping yesterday," and, before his companion could stop him, walked up and grabbed the wire to throw it out of the way. These are not fairytales. They are true summaries of reports on the deaths of three men who were either ignorant or contemptuous of the lethal capabilities of electric current.

Intentionally taking a shock from any voltage is always dangerous and is strictly forbidden. When necessary to check a circuit to find whether it is alive, use a test lamp, voltmeter, or other suitable indicating device.

TAGGING SWITCHES

When repairing or overhauling any electronic equipment, make sure the main supply or cutout switches in each circuit from which power could possibly be fed are secured in the OPEN (or SAFETY) position and tagged. Switches should be secured by locking, if possible. The tag should read: "This circuit was ordered open and shall not be closed except by direct order of----" (usually the person making, or in charge of, the repairs). After the work is complete, tags are removed by the same person. If more than one party is working, a tag for each working party is placed on the supply switch. Each party removes only its own tag as it completes its share of the work.

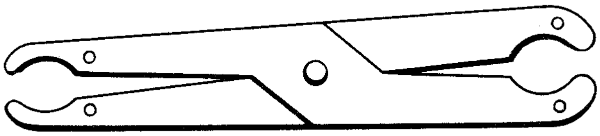
If switch-locking facilities are available, the switch should be locked in the OPEN (safety) position and the key retained by the man doing the work.

When circuits are grounded for protection of personnel engaged in installation or overhaul, such grounds should be located in the vicinity of the working party and should be secured properly to prevent accidental removal. If the grounding point is not near the working party, the tagging procedure just described should be followed, changing the wording on the tags.

FUSES

Fuses should be removed and replaced only after the circuit has been completely deenergized. A blown fuse is replaced with one of the same rated ampere capacity. You are permitted to replace a blown fuse with one of a higher rating only under emergency or battle conditions when continued use of the equipment is more important than consequences of possible damage to equipment. When possible, a circuit should be checked before a fuse is replaced, because a blown fuse usually indicates a circuit fault.

Never change a knife or cartridge-type fuse with your bare hands. Use an approved fuse puller (fig. 13-2). These pullers are made either of laminated bakelite or fiber, and can handle a range of fuses up to 60 amperes. Grasp



1.32A

Figure 13-2. —Fuse puller.

fuse firmly with puller (using end that best fits fuse size) and pull straight out from fuse cabinet.

Plug-type fuse holders are used extensively in modern electronic equipment. The fuses are removed easily and safely by unscrewing the insulated plug.

Unless work is being done on them, fuse boxes, junction boxes, lever-type boxes, and the like are kept closed.

SAFETY PRECAUTIONS

1. Provide ample illumination.
2. Remove metal objects from pockets and Clothing.
3. Insulate worker from ground with dry wood, rubber matting, several layers of sandpaper or dry canvas, or a sheet of phenolic insulating material.
4. Cover metal tools with insulating rubber tape (not friction tape).
5. Work with one hand only.
6. Wear rubber gloves if nature of work permits; if not, a glove should be worn on hand not holding tools.
7. Have men stationed by circuit breakers or switches ready to cut the power in case of emergency.
8. Have a man qualified in first aid standing by during entire period of repairs.
9. Never trust insulating material too far when working with live circuits.

## SWITCHES AND CIRCUIT BREAKERS

As a general rule, use one hand to open and close switches and circuit breakers. Keep the other hand clear so that, if an accident occurs, current will not trace a path up one arm, through your heart, and out the other arm. Touch one switch at a time. Before closing a switch, make sure that–

1. The provisions for tagging, described previously are met.
2. The circuit is ready, and all parts are free.
3. Proper fuses are installed for protection of the circuit.
4. Men near moving parts are notified that the circuit is to be energized.
5. The circuit breaker is closed.

To close a switch with maximum safety, ease it to a position from which the final motion may be completed with a positive and rapid action. To open a switch carrying current, the break should also be positive and rapid. Be sure your hand is dry so that it will not slip off the switch handle and make contact with high voltage. A dry hand also offers better resistance.

All parts of a circuit breaker except the operation handle usually are good conductors of electricity. When working with circuit breakers, remember safety rules in the accompanying list.

SAFETY RULES

(when working with circuit breakers)
1. Use only one hand.
2. Keep hands clear of parts except operating handles.
3. Touch only one breaker handle at a time.
4. Positive and negative breakers with two handles should not be closed simultaneously.
5. Close breaker first; then close switches.
6. Trip circuit breakers before opening switches.
7. Never disable a circuit breaker.
8. Keep the face turned away while closing open-type circuit breakers.
9. Never stand over a circuit breaker that is energized.

## HIGH-FREQUENCY OPERATING HAZARDS

Aside from danger of shock, hazards incident to operating electronic equipment in the high-frequency range may be divided into three categories: (1) radiation hazards to personnel (RADHAZ), (2) hazards of electromagnetic radiation to ordnance (HERO), and (3) hazards associated with volatile liquids (SPARKS).

### RADHAZ

In general, possibility of biological injury from radiation is slight at operating frequencies of most radio communication equipment. But, your duties bring you into close proximity of radar antennas, and here the radiation hazard is very real.

Overexposure to r-f radiation is thermal in nature, and is observed as an increase in overall body temperature or as a temperature rise in certain organs of the body. In short, your body is comprised of skin tissues that form the outer surface, a layer of fat tissue that lies immediately underneath the skin, and a central mass of deeper tissues consisting of muscles, high water content tissues, and bone formations. While working aloft (or in the vicinity of radar transmitting equipment) you may enter a field of electromagnetic radiation. The electromagnetic energy is absorbed in the tissues of your body, thus heat is produced in them. If the organism cannot dissipate this heat energy as fast as it is produced, the internal temperature of the body rises. This increase in temperature results in damage to the body tissue and, if the rise is sufficiently high, in your death. You must remember that electromagnetic radiation is not visible, and its presence must be measured by instruments. Proper warning signs are located at various points to warn you when you are entering an area that may be a radiation hazard.

### HERO

Another danger of r-f radiation is the danger of premature firing of rockets or missiles, or the explosion of their warheads. The hazard to electronic explosive devices (EEDs), such as missiles, rockets, VT fuses, and the like, occurs because of the heat associated with a current passed through the sensitive wires surrounded by a temperature-sensitive explosive. If energy is dissipated in wires, the explosive becomes hot and an explosion can result.

Normally, the circuitry of EEDs is shielded in containers, and if properly shielded, there is little danger of an accident. But, to be safe, there should be no ordnance in any personnel hazard zone or within 25 feet of any radiating antenna.

### SPARKS

Aboard ship, shock hazards and sparks exist on rigging, cables, transmitting and receiving antennas, and other structures that are resonant to a radiated frequency. The position of the radiating antenna in relation to these objects determines the amount of induced voltage. If the induced voltage in an object is large enough, arcs and sparks may be drawn when contact is made or broken by personnel, tools, or other conductive devices. Extreme care must be exercised, consequently, by working personnel during refueling operations, arming aircraft, and handling ammunition or volatile liquids and gases. Additionally, all transmitting equipment should be deenergized. As a safety precaution —if impossible to remove power—a separation must be maintained between the work area and an energized antenna. Separation must be at least 25 feet for transmitters rated at 250 watts or less, and 100 feet for transmitters over 250 watts.

## SOLDERING IRONS

A soldering iron is a fire hazard and a potential source of burns. When soldering cables or wires, keep the iron holder in the open where danger is minimized. Disconnect the iron when leaving work, even for a short period.

When using the iron, keep the ends of wires and cables in such a position that they do not provide a source of injury to the face or eyes. Keep your head away from the iron. Don't flip the iron to dispose of molten solder accumulated on the tip; a drop may strike someone's eye.

## HANDLING CATHODE RAY TUBES

Cathode ray tubes used in communication equipment are not as large as those required for radar and TV. Nevertheless, handling the relatively small cathode ray tubes found in teletype converters and test equipment presents certain hazards. The following safety precautions apply in handling all cathode ray tubes.

- When working with cathode ray tubes, wear safety goggles to protect your eyes from flying glass in event of envelope fracture, which might cause implosion owing to high vacuum within the tube. Recommended goggles provide side and front protection and have clear lenses designed to withstand a fairly rigid impact.
- Be sure that no part of your body is directly exposed to possible glass splinters caused by implosion of the tube. The inside fluorescent coating on some tubes is poisonous if absorbed into the bloodstream. For these reasons, heavy gloves should be worn when handling tubes.

• Remove the tube from its packing box with caution. Take care not to strike or scratch the envelope. Insert the tube into the equipment socket cautiously, using only moderate pressure. Do not jiggle the tube. The neck of the tube is made of thin glass. If the tube should break, particles from the neck may scatter with enough force to cause severe injury.

• These foregoing precautions also apply when removing tube from equipment socket.

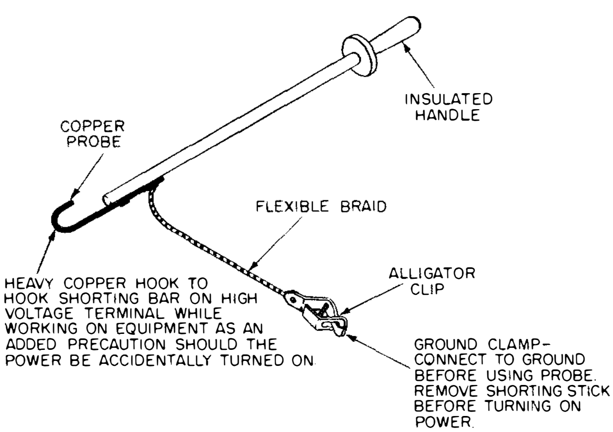
## RUBBER MATTING

Aboard ship a gray, fire retardant, rubber matting with a diamond-shaped surface is cemented to the deck in all electronic spaces. Rubber matting insulates the operator from the steel deck, and the diamond-shaped surface pattern is easy to keep clean and provides safe, nonskid footing. At shore stations, rubber matting is installed around electronic equipment to protect personnel who service or tune the equipment. Usually the matting does not cover the entire deck area.

## SHORTING/GROUNDING BAR

Discharge and ground the circuit components before you work on them. Even when secured, electrical and electronic equipment may retain a charge sufficient to cause a severe shock. Be safe!

The shorting/grounding bar shown in figure 13-3 provides a safe method for grounding deenergized circuits. Connect the flexible lead to a grounded part of the cabinet or chassis by means of the alligator clip. Always make this ground connection first. Then, holding only the insulated handle, touch the copper probe to the circuit or part you want to discharge to ground. Repeat this discharge operation several times.




1.1 (76)

Figure 13-3. —Shorting/grounding bar.

Before touching a capacitor that is connected to deenergized circuit, or one that is disconnected entirely, short-circuit, the terminals with the shorting bar. Repeat this operation several times to make sure the capacitor is fully discharged.

## PAINTING

When you paint radio rooms or use insulating varnish, lacquer, paint thinner, or other volatile liquids in radio space, make sure there is adequate ventilation. Use both exhaust ventilators and power blowers. Blowers should be arranged to ensure rapid removal of explosive, combustible, or toxic vapors. Vapors should be exhausted in such a way that they will not drift into other areas or be sucked into the ship's supply vents.

If paint vapors or fumes are suspected of being explosive, do not allow anyone in the vicinity to use portable electrical equipment of a type that might set off an explosion. Do not permit smoking in the danger area, or allow any type of work that may produce flames or sparks. See that firefighting equipment is handy.

Practice good housekeeping. See that unnecessary objects are picked up and kept out of the way. Any rags, sweepings, and waste that may be contaminated with paint should be placed in a covered metal container or in a bucket of water.

Never eat, drink, or store food in a compartment where painting is in progress. Remove the coffee mess. Keep your hands out of your mouth. Paint is a poison, and ingesting the smallest amount can be serious.

## CLEANING ELECTRONIC EQUIPMENT

Clean electronic equipment helps to assure good performance. Before cleaning, certain precautions are necessary to protect the equipment as well as the operator.

• Turn off the power switches and ground capacitors with the shorting bar.

• A vacuum cleaner with a nonmetallic hose is safe and useful but will not reach all areas where dust accumulates.

• The preferred method for cleaning inside electronic equipment is to use a brush, such as a typewriter cleaning brush, together with the vacuum cleaner to remove dirt as it is loosened by the brush.

• A hand bellows may be used to blow dirt from equipment. Compressed air lines are available aboard ship but are not recommended for cleaning radio equipment because the air pressure may be so strong as to cause damage to delicate electronic parts.

• Do not use steel wool or emery paper for cleaning electronic equipment. Tiny particles of these conducting materials cause troublesome and dangerous short circuits.

Do not use solvents unless absolutely necessary. Some solvents are flammable, others are toxic (poisonous), and still others are both flammable and toxic. Besides these hazards, all solvents are harmful to electronic equipment. They dissolve waxes and compounds used to protect equipment from fungus growth. They soften most types of insulation and cause it to become saturated with the very dirt that the user is trying to remove. The commonly available chlorinated solvents combine chemically with wax and oil to produce enough hydrochloric acid to etch metal surfaces, causing such troubles as erratic operation of switch contacts.

• Flammable solvents such as alcohol must never be used on energized equipment or near any energized equipment from which a spark may be received.

• If solvents must be used for cleaning electronic gear, be sure the area is well ventilated, and use only the smallest possible quantity of solvent to do the job.

• Carbon tetrachloride is no longer authorized by the Navy as a cleaning solvent. Many serious accidents were caused by improper storage and use of carbon tetrachloride, resulting in headaches, dizziness, nausea, loss of consciousness, and even death. Actually, it is four times as poisonous as the deadly carbon monoxide.

• Methyl chloroform is approved for cleaning applications in which carbon tetrachloride previously was used. Even though it is less toxic than carbon tetrachloride, methyl chloroform presents some hazards to personnel. As a result, the following safety precautions must be observed when using methyl chloroform:

1. Use with adequate ventilation.
2. Avoid prolonged or repeated breathing of the vapor.
3. Avoid prolonged or repeated contact with the skin.
4. Do not take internally.

## FIRST AID

It is necessary that you understand first aid to be given for electric shock and burns, and how to revive a person by artificial respiration.

### RESCUE FROM ELECTRICAL CONTACT

Frequently, it is necessary to rescue a victim before you can begin first aid treatment. Rescuing a person who has received an electrical shock is likely to be difficult and dangerous. Extreme caution must be exercised to avoid being electrocuted yourself. Speed is important, of course, but a few moments to evaluate the situation may make the difference between life and death—for you as well as for the person you are trying to rescue.

If the victim still is in contact with the conductor, the first procedure is to stop current flow through his body. You can shut off power by opening switches or circuit breakers, or by cutting the conductor with a wooden-handle ax or hatchet or with insulated pliers. To lift or pull the man away from the conductor, if circumstances are such that power cannot be shut off quickly, use some dry material such as line, cloth, canvas, rubber, or wood. DON'T TOUCH THE MAN. DON'T USE METAL OR MOIST MATERIALS. A neckerchief or belt can be used to pull a person off an electrical circuit. The belt buckle must be removed first, however. When you are trying to break an electrical contact, stand on any dry, nonconducting material to prevent the current from reaching ground through your body.

### ARTIFICIAL RESPIRATION

A victim of electrical shock who has stopped breathing is not necessarily dead, but he is in immediate and critical danger. The method by which a person can be saved after breathing stops is called artificial respiration. The same methods of artificial respiration used for victims of electrical shock can be used for drowning or gas asphyxiation cases.

The purpose of artificial respiration is to force air out of the lungs and into the lungs, in rhythmic alteration, until natural breathing is restored. Artificial respiration should be given only when natural breathing ceases. It must not be given to any person who is breathing naturally on his own. Do not assume that a person's breathing has stopped merely because he is unconscious, or because he has been rescued from contact with an electrical circuit. Remember: Do not give artificial respiration to a person who is breathing naturally.

If possible, send for a medical officer or a Hospitalman; but don't go yourself if you are alone with the victim. Speed in beginning artificial respiration is essential in any instance in which breathing has stopped. Every moment's delay cuts down the victim's chance of survival. Do not take time to move the victim to a more comfortable location, unless he is in such a dangerous position that he must be moved in order to save his life.

If another person is present while artificial respiration is being administered, he can be very helpful. Have him remove false teeth, chewing gum, or other matter from the victim's mouth; at the same time he can bring the victim's tongue forward. He also can loosen the clothing around the victim's neck, waist, and chest. If you are alone, you will have to attend to these details yourself before beginning artificial respiration.

Artificial respiration must be continued for at least 4 hours unless natural breathing is restored before that time or a medical officer declares the person dead. Some people have been revived after as much as 8 hours of artificial respiration.

Three methods of artificial respiration are described in this manual. They are the mouth-to-mouth method, the back-pressure arm-lift method, and the back-pressure hip-lift method.

In addition to the foregoing procedures, there are several other methods of artificial respiration. If you have had training in first aid, it is possible that you learned one of the older methods, but they no longer are considered the most effective way. It is now your responsibility to learn the new techniques.

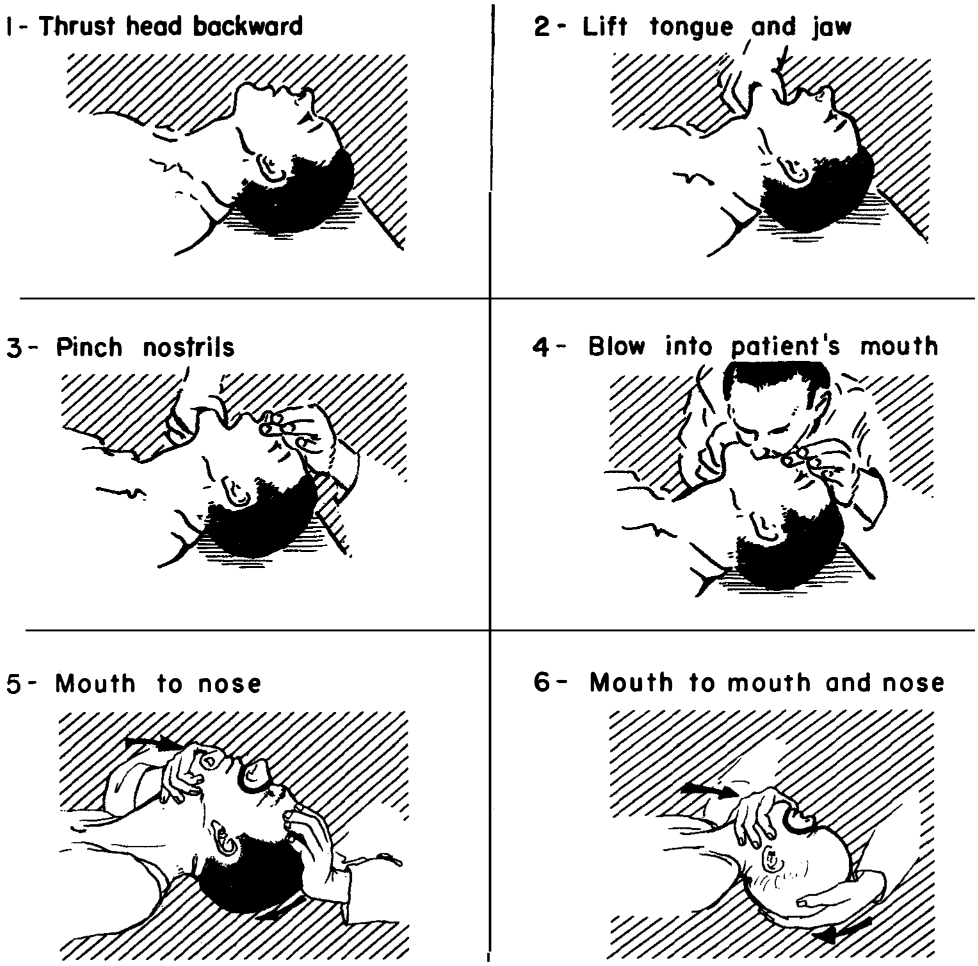
### Mouth-to-Mouth Resuscitation

Mouth-to-mouth resuscitation, shown in figure 13-4, is recommended by the National Academy of Sciences, National Research Council, the American Red Cross, and the Armed Forces as the preferred and most effective way of providing artificial respiration. All other procedures are considered alternate methods for use only when mouth-to-mouth resuscitation is not practicable.

Mouth-to-mouth resuscitation is particularly recommended for use aboard ship in cases of electric shock. Investigations of shipboard electric shock fatalities indicate that, despite the good intentions of rescuers, valuable seconds are sometimes lost in first moving the victim from an awkward, cramped, wet, or isolated location to a roomier, drier place before applying resuscitation measures. Familiarity with this new method enables the man nearest the victim to start revival action readily while sending or yelling for medical help. Commencing artificial respiration can thus be reduced to a matter of a few seconds after freeing the victim from his contact with electricity.

The following six steps are easy to learn. Refer to figure 13-4 as you read them.

1. Place the victim on his back. Loosen collar and belt.
2. Clear his mouth of any foreign matter with your fingers or a cloth wrapped around your fingers.
3. Tilt his head back so his chin is pointing upward. With one hand push his jaw forward into a jutting-out position. Tilting his head and pushing his jaw forward should relieve obstruction of the airway. With the fingers of one hand, pinch victim's nostrils shut to avoid any air leakage.
4. Take a deep breath. Place your mouth over victim's mouth and breathe into him. Your first blowing effort should determine whether any obstruction exists. Watch his chest rise to make sure his air passage is clear.
5. Remove your mouth, turn your head to one side, and listen for the return rush of air that indicates air exchange. Repeat the blowing effort about 12 times per minute.
6. If you are not getting air exchange, recheck victim's head and jaw position. If you still do not get air exchange, turn the victim quickly on his side and administer several blows between his shoulder blades in an effort to dislodge foreign matter. Again clean his mouth with your fingers.




4.224

Figure 13-4. —Mouth-to-mouth method of resuscitation.

Don't worry about germs when a life is at stake. Those who do not wish to come into direct contact with the victim may hold a cloth or handkerchief over victim's mouth or nose and breathe through it. The cloth does not greatly affect the exchange of air.

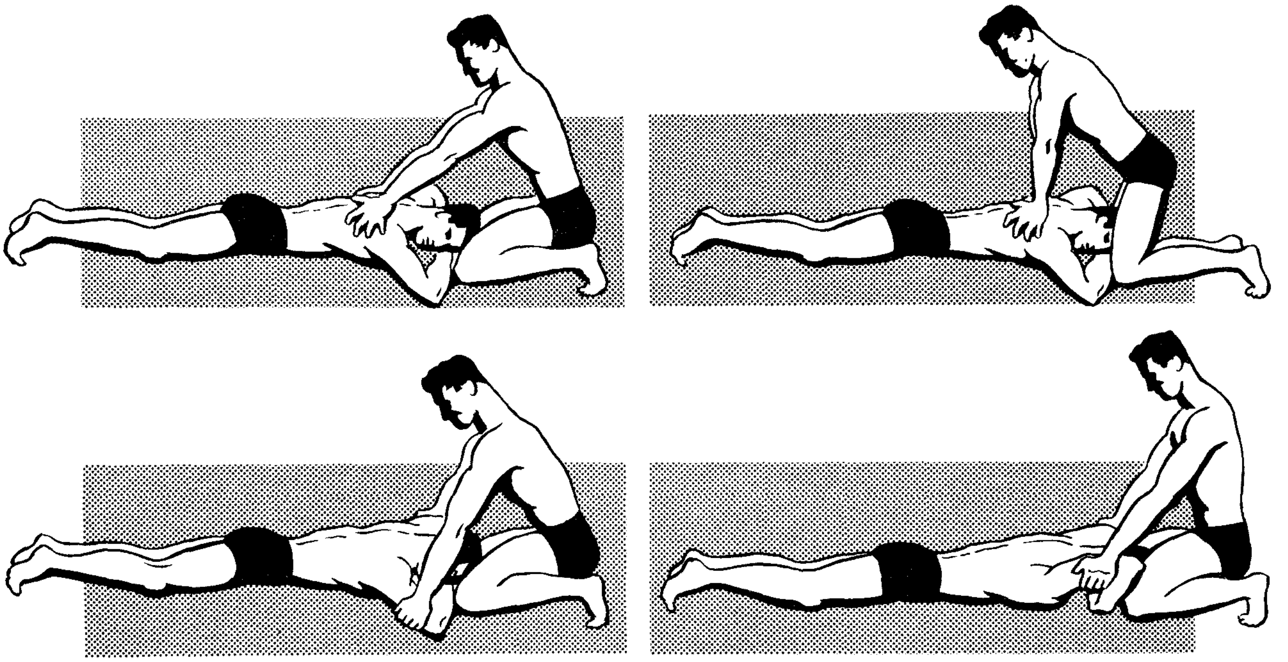
The Navy has available a plastic resuscitation tube, which is a part of every first air kit. Use of the plastic tube makes it easier to keep the victim's tongue from blocking the air passage, and avoids necessity for direct oral contact between rescuer and victim.

Medical research has established conclusively that the mouth-to-mouth respiration technique is superior to all others in reviving a person whose breathing has stopped for any reason. The method is adaptable to a victim of any age. Everyone should be familiar with it.

Back-Pressure Arm-Lift Method

The back-pressure arm-lift method of artificial respiration is illustrated in figure 13-5. This procedure requires the following steps:

1. Place victim so that he is lying face down. If he is on a sloping surface, position him so that his head is slightly lower than his feet. Bend both his elbows and place one hand on the other, as shown in figure 13-5. Rest victim's head on his hands, with his face turned to one side.



4.225

Figure 13-5. —Back-pressure arm-lift method of resuscitation.

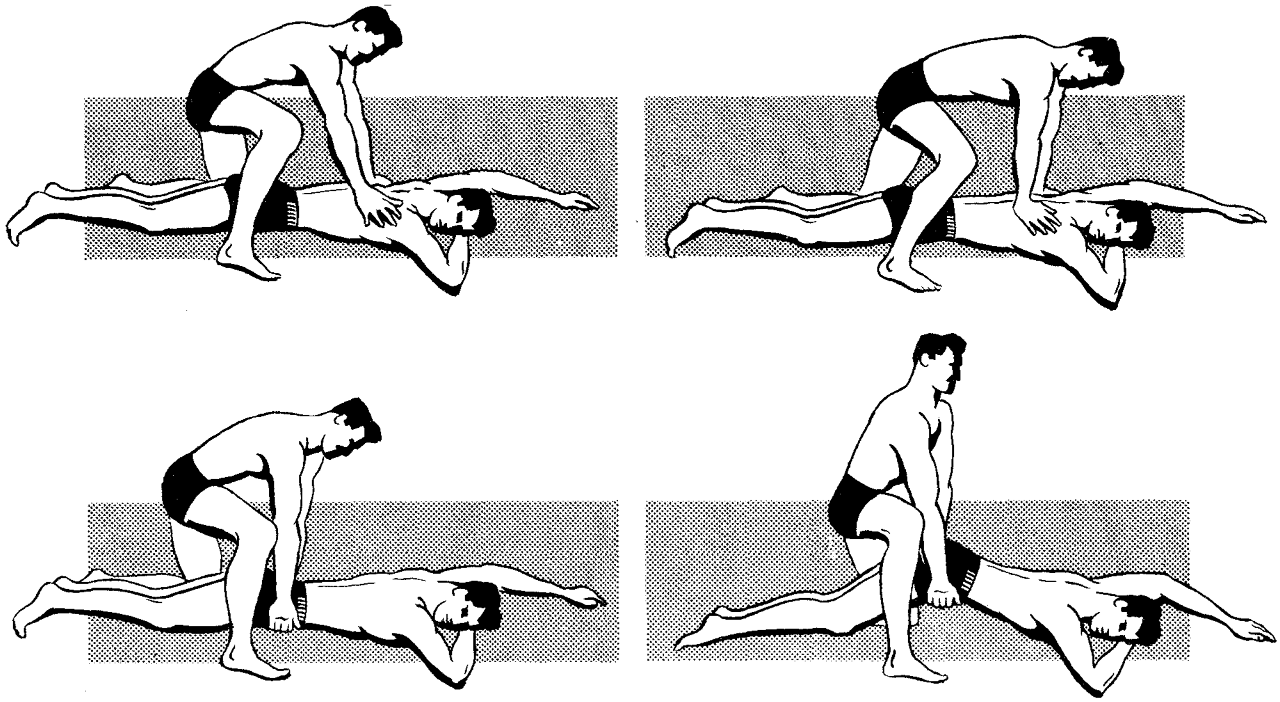
2. Kneel on one knee, facing victim. (You can use either knee.) Place your knee close to his head. Put your other foot near his elbow. You may find it more comfortable to kneel on both knees; if you do, have one knee on each side of the victim's head. Next, place your hands on the middle of his back, just below his shoulder blades, in such a position that your fingers are spread downward and outward, with thumb tips just about touching.
3. With your arms held straight, rock forward slowly so that the weight of your body is gradually brought to bear on victim. This action compresses his chest and forces air out of the lungs. Do not exert sudden pressure, and do not put your hands too high on his back or on his shoulder blades.
4. Release pressure quickly by peeling your hands from victim's back.
5. Now rock backward, and allow your hands to come to rest on victim's arms just above his elbows. As you swing backward, lift victim's arms upward. The arm lift pulls on the victim's chest muscles, arches his back, releases the weight on his chest, and causes his chest to expand and fill with air. Finally, lower the victim's arms. Now you have finished one full cycle.

Repeat the cycle approximately 12 times per minute (5 seconds per cycle). Follow this rhythm: Rock forward and press, rock backward and lift. The pressing and lifting should take approximately equal periods of time. The release periods should be as short as possible.

Try to maintain a slow, easy rhythm—rocking forward on the back-pressure phase, rocking backward on the arm-lift movement. The rocking motion helps to maintain rhythm. Remember that a smooth rhythm is important in performing artificial respiration, but split-second timing is not essential.

Back-Pressure Hip-Lift Method

The back-pressure hip-lift method of resuscitation is shown in figure 13-6. It is used when necessary to give artificial respiration to a person injured in the upper part of the body—chest, neck, shoulders, or arms. The hip-lift procedure is also useful in situations where lack of space makes it difficult or impossible to use the



4.226

Figure 13-6. —Back-pressure hip-lift method of resuscitation.

arm-lift method. The hip-lift technique has the disadvantage of being somewhat harder on the operator

The back-pressure hip-lift principle requires the following steps:

1. Place victim face down, with one arm bent at the elbow and the other arm extended as in figure 13-6. Rest his head on his hand or forearm, with his face turned so that his nose and mouth are free for breathing. At the same time, bring his tongue forward so that it will not clog the air passage.
2. Kneel on either knee, and straddle the victim at the level of his hips. Place your hands on the middle of his back, just below his shoulder blades. Your fingers should be spread downward and outward, with your thumb tips just about touching. Be careful that your hands are not too high on his back; they should be below his shoulder blades.
3. With your arms held straight, rock forward slowly so that the weight of your body is gradually brought to bear upon the victim. Keep your elbows straight and your arms almost vertical, so that pressure is exerted almost directly downward. Do not exert sudden pressure, nor more pressure than is required to feel a firm resistance.
4. Release pressure quickly by peeling your hands from patient's back.
5. Now rock backward and let your hands come to rest on victim's hips, well below his waist. Slip your fingers underneath his hip bones.
6. Lift victim's hips 4 to 6 inches. Lifting them allows his abdomento sag downward and his diaphragm to descend, causing his chest to expand and fill with air. Lower victim's hips. You now have finished one full cycle.

As in the arm-lift method, the cycle should be performed approximately 12 times per minute. If a relief operator is available, he can come in on one side and take over after one of the lift movements.

### Treatment During Recovery

When a person is regaining his breath, the bluish or pale appearance of his skin may be succeeded by a distinct flush of color. His muscles then may begin to twitch and his fingers to scratch and clutch. Swallowing movements are sometimes the first sign of natural respiration. The first attempt to breathe may be a faint catch of breath, or a sigh. You must be careful not to exert pressure when the victim is trying to get his first breath. If he begins to breathe on his own, adjust your timing to assist him. Do not hinder his efforts to breathe; instead, synchronize your efforts with his.

Keep the patient warm. Do not give any liquids until he is fully conscious. To avoid strain on his heart, the patient should be kept lying down and not allowed to stand or sit immediately after he revives. Do not allow the patient to walk or otherwise exert himself. The slightest exertion at this point might easily cause his death from heart failure. After a temporary recovery of respiration, the patient sometimes stops breathing again. If natural breathing stops, resume artificial respiration at once.

## SHOCK

Some degree of shock follows all injuries. It may be slight and almost unnoticed, lasting only a few moments, or it may be severe enough to cause death. An interruption of breathing, from whatever cause, almost always is followed by severe shock.

### Symptoms

A person suffering from shock feels weak, faint, and cold. His face is usually pale and his skin is cold and clammy. Sweating is likely to be very noticeable. Remember, however, that signs of shock do not always appear at the time of injury. Indeed, in many serious cases, they may not appear until hours later.

The symptoms of a person suffering from shock are, directly or indirectly, the result of the circulation of the blood becoming disturbed. His pulse is weak and rapid. Breathing is likely to be shallow, rapid, and irregular, because poor circulation of blood affects the breathing center in the brain. It is unlikely that you will see all these symptoms of shock in any specific instance. Some of them appear only in late stages of shock when the victim's life is in serious danger. It is imperative that you know the symptoms that indicate the presence of shock, but don't ever wait for symptoms to develop before beginning the treatment for shock.

### Prevention and Treatment

The most helpful deed you can perform for a person revived by artificial respiration is to begin treatment for shock. If shock has not yet developed, the treatment may actually prevent its occurrence. If it has developed, you may be able to keep it from reaching a critical stage. It is imperative, therefore, that you begin treatment for shock at the earliest practicable moment.

Get medical assistance as quickly as possible. Meanwhile, place the patient in a horizontal position, with his head slightly lower than the rest of his body. If impossible to do so, it might still be feasible for you to raise his feet and legs enough to help the blood flow to his brain. Do the best you can, under the circumstances, to get the patient into this position. Never let the patient sit or stand or walk around.

Heat is important in the treatment for shock, to the extent that the patient's body heat must be conserved. Keep the patient warm, but not hot. Apply only enough clothing and blankets to bring his body to normal temperature.

As a general rule, liquids should not be given as a part of first aid treatment for shock. Until recently, first aid books emphasized giving warm fluids (in particular water, tea, and coffee) as a part of the treatment. Now it is believed that administering fluids is not a necessary or even desirable part of first aid treatment. It is true that a person in shock is in need of liquids. But liquids given by mouth are not absorbed–and therefore are ineffective–except in very mild cases of shock. In moderate or deep shock, intravenous administration of fluids is necessary; but this medical procedure cannot, under any circumstances, be performed by a person giving first aid.

One final precaution concerning the use of liquids: Never give alcohol to a person who is in shock or may go into shock. Alcohol increases the blood supply to the surface blood vessels, and diminishes the blood supply to the brain and other vital organs.

## BURNS

Burns and scalds are caused by exposure to intense heat, such as that generated by fire, bomb flash, sunlight, hot solids, hot gases, and hot liquids. Contact with electric current also causes burns, particularly if the skin is dry. (Dry skin offers about 20 times more resistance than moist skin to the passage of electric current. When the skin is dry, therefore, local heating effects (burns) are greater, even though total damage to the body is less than when the skin is wet.)

It should be noted that burns and scalds are essentially the same type of heat injury. When injury is caused by dry heat, it is called a burn; when caused by moist heat, it is called a scald. Treatment is the same in both cases.

• Classification of burns: Burns are classified in several ways—by the extent of the burned surface, by the depth of the burn, and by the cause of the burn. Of these categories, the extent of body surface burned is the principal factor in determining seriousness of the burn, and also plays the greatest role in the casualty's chances for survival.

Shock can be expected in adults with burns of over 15 percent; in small children, with burns of over 10 percent of body surface area. In adults, burns to more than 20 percent of the body endanger life. Usually 30-percent burns are fatal if adequate medical treatment is not received.

The depth of injury to the tissues is spoken of in degrees. First-degree burns are the mildest, producing redness, increased warmth, tenderness, and mild pain. Second-degree burns redden and blister the skin and are characterized by severe pain. Third-degree burns destroy the skin and may destroy muscle tissue and bone in severe cases. Severe pain may be absent because nerve endings have been destroyed. The color may vary from white and lifeless (scalds) to black (charred).

Always remember that the size of a burned area may be far more significant than the depth of a burn. A first-degree or second-degree burn that covers a large area of the body usually is more serious than a small third-degree burn. A first-degree sunburn, for example, can cause death if a large area of the body is burned.

In general the causes of burns are classified as thermal (heat) or chemical, or as resulting from sunburn, electric shock, or radiation. Whatever the cause of the burn, shock always results if the burns are extensive.

Treatment of Burns and Scalds

First aid for all burns consists of the following main items: (1) relieve pain, (2) prevent or treat shock, and (3) prevent infection.

In electric shock, the burn may have to be temporarily ignored while resuscitative measures are carried out. Otherwise the treatment is the same as for heat burns. Also, local treatment is the same as for heat burns. Also, local treatment for chemical burns varies, depending on the causative agent. Chemical burns are discussed more fully later in this chapter.

• Ice water treatment: It is recognized that clean water and ice are not always available, but when they are, ice water (as an emergency measure) provides immediate relief from pain and also seems to lessen the damaging effects of burns. For burns affecting less than 20 percent of the body, immerse the burned part in ice water or, where immersion is not practical, repeatedly apply ice-cold moist towels to the burned area. Treatment should be continued until no pain is felt when the burned area is withdrawn from the water. This treatment may last from 30 minutes to as long as 5 hours. When available, hexachlorophene should be added to the water to destroy bacteria. After the ice water treatment, the regular treatment for burns should follow (discussed later).

• Relief of pain: Simple first-degree burns that do not cover a large body area may require no more than one or two aspirin tablets to relieve discomfort. Severe burns cause extreme pain, which contributes to the severity of shock. A person who has suffered extensive burns may be given not more than 1/4 grain of morphine to relieve the pain. The injection site should be massaged for a few minutes to help circulate the morphine. (CAUTION: The casualty may have other injuries. Do not give morphine to any person who has a head injury, chest injury, or who is in deep shock, even if he is suffering from extensive burns.)

• Treat for shock. Any person who has been seriously burned must be treated for shock immediately. Serious shock always accompanies an extensive burn, and is, in fact, the most dangerous consequence of the injury. Start the treatment for shock before making any attempt to treat the burn itself.

Relieving the casualty's pain is, of course, an important part of the treatment for shock. After easing his suffering, place him in a position so that his head is lower than his feet. Make sure that he is warm enough; do not remove his clothing immediately. Remember that exposure to cold will cause shock to become worse, but do not overheat him.

In burn cases, an exception must be made to the rule of withholding liquids from a patient.

A seriously burned person has an overwhelming need for liquids; and administering liquids in such cases is an indispensable part of treatment for shock caused by burns. Give small amounts of sweetened tea, fruit juice, or sugar water, if the casualty has no internal injuries, is conscious, and is able to swallow.

• Prevention of infection: Second- and third-degree burns are, in effect, open wounds and must be covered to reduce possibility of infection. Every effort must be made to use a sterile covering, but makeshift wrappings such as clean sheets and freshly laundered towels may be used.

Ointments and other medicines must never be put on the burn wound. Using these agents may make later treatment by a physician difficult or impossible.

Do not open any blisters. Do not cough or sneeze near the casualty. If possible, keep a piece of sterile gauze over your mouth and nose while you are working near the burn victim. Contamination by microorganisms from the mouth and nose is a frequent cause of serious (and possibly fatal) burn infections.

• Treatment: If the casualty is to receive medical attention soon, do nothing more than relieve his pain, treat for shock, and cover the burn with a sterile wrapping or clean sheet or towel. Do not attempt treatment of the burn wound itself.

If more than 3 hours may elapse before the services of a physician can be obtained, you should dress the burn. First remove the casualty's clothing from around and over the burned area, preferably by cutting it away. Be especially careful not to cause further injury. If clothing sticks to the burn wound, do not attempt to pull it loose. Merely cut around the part that sticks, and leave it in place. If any material such as wax, metal, dirt, grease, or tar adheres to the burn, do not try to remove it. Do not allow absorbent cotton, powder, adhesive tape, or other substances that might cling to the burn to come in contact with the burn. Never apply iodine or any other antiseptics on a burn.

When you have cleared away as much of the clothing as you can, dress the burn. Apply a single layer of sterile, fine-mesh petrolatum gauze over the burn wound, beginning at the outside of the burn wound and working toward the center in a circular manner. Next place bulky fluffs of gauze over the burn, with a large padded dressing as the outer layer. Wrap gauze strips smoothly and gently around the dressing. The bandage should give light, even pressure and immobilize the injured part. Once the bandage is applied, it should be left alone. Leave it in place until the casualty receives medical care.

• Burns of the eye: Burns of the eye require special attention. If they are true heat burns, caused by exposure to steam, bomb flash, welding arc, or any other source of intense heat, treat them as follows:

1. Put a few drops of clean mineral oil or olive oil into each eye.
2. Cover each eye with a small, thick compress, and fasten the compress in place with a bandage or an eyeshield.
3. Make sure that the casualty does not rub his eyes.
4. Get medical attention for the casualty as soon as possible.

## ELECTRICAL FIRES

Any fire is a potential source of disaster. In electrical fires, the following procedures should be observed.

1. Deenergize circuit for the affected equipment. Every radio transmitter has an EMERGENCY OFF switch that removes all power from equipment. In addition to local power switches on equipment, the power supply to all transmitters and receivers, converters, and teletypes can also be secured at power distribution panels.
2. Spread the alarm. Ashore, call the fire department. Aboard ship, use the phone or intercom–if available, send another person to sound the alarm in accordance with ship's fire bill.
3. Secure ventilation. Turn off blowers; close doors.
4. Report fire to the OOD by telephone or messenger.
5. Attack fire with equipment available in immediate vicinity, such as portable

15-pound $CO_2$ (carbon dioxide) extinguishers.

When extinguishing an electrical fire, remember that quick action is required only to deenergize the circuit. When this action has been taken, STOP! LOOK! THINK! The use of $CO_2$ fire extinguishers directed at the base of the flame is always best for all electrical fires. Because carbon dioxide is a dry, noncorrosive, inert gas, it will not damage electrical equipment. And, because it is a nonconductor of electricity, it can be used safely in fighting fires that otherwise would present the additional hazard of electric shock.

## PORTABLE FIRE EXTINGUISHERS

Some portable 15-pound carbon dioxide fire extinguishers have a squeeze-grip style release valve that is operated by a simple hard squeeze-grip. Others have a release valve operated by a handwheel at the top. Both valves have a locking pin to prevent unintentional discharge of the carbon dioxide. To operate, observe the following steps.

1. Carry fire extinguisher in an upright position, and approach fire as closely as heat permits. (Keep extinguisher erect while using it. Because of its construction, it should not be laid on its side.)
2. Remove locking pin from valve.
3. Grasp nozzle horn by its handle. (It is insulated to protect your hand from extreme cold of discharging carbon dioxide.)
4. Open valve by turning valve wheel to left (or squeeze release lever), thus opening valve and releasing carbon dioxide. At the same time direct the flow toward the base of the fire. Move horn slowly from side to side, and follow flames upward as they recede.
5. Close valve as soon as conditions permit, and continue to open and close it as necessary. The firefighter may shut off handwheel-type valve for brief intervals without appreciable loss of carbon dioxide. But once valve seal is broken, carbon dioxide will leak away in 10 minutes or so. The squeeze-grip type likewise may be turned off while in use, but it will hold contents indefinitely without leakage. In continuous operation, the 15-pound cylinder of either type will expend its contents in about 40 seconds.
6. The discharge should not be stopped too soon. When flame is extinguished, coat entire surface engaged in fire with carbon dioxide snow in order to prevent reflash.

The firefighter must be warned that the very qualities that make carbon dioxide a desirable extinguishing agent also make it dangerous to life if the compartment should become filled with it. Certainly, when it replaces oxygen in the air to the extent that combustion cannot be sustained, breathing cannot be sustained either. Radio rooms do not have $CO_2$ systems for total flooding such as those installed in uninhabited spaces used for gasoline and paint stowage. Consequently, when using 15-pound portable fire extinguishers, the firefighter usually does not have to consider the possibility of harm to personnel. Because carbon dioxide is heavier than air, it does not rise, but remains in a pool close to the deck. The quantity of gas released from one–or several–of these extinguishers is insufficient to reduce below a dangerous minimum the total oxygen content of the air in a compartment.

Anyone using a carbon dioxide extinguisher should be warned that snow blisters the skin and causes painful burns if allowed to remain on the skin.

If all efforts with carbon dioxide fail to put out a fire, fresh water applied with a fog applicator may be used. Because of the fire diffusion of its particles, fog reduces but does not entirely remove danger of electric shock.

In cable fires in which the inner layers of insulation (or insulation covered by armor) support combustion, the only positive method of preventing the fire from running the length of the cable is to cut the cable after it is deenergized, and separate the two ends. This preventive action should be accomplished only with well-insulated tools, such as wooden-handled fire axes or insulated pliers.

## WORKING ALOFT

To work on antennas, you must go aloft. Radarmen, Signalmen, and the deck force also may have work to do on the masts and stacks. Before going aloft, it is necessary to obtain permission from the OOD and CWO. Another requirement is to inform them when work is complete and the men are down.

When radio or radar antennas are energized by transmitters, workmen must not go aloft unless advance tests show positively that no danger exists. A casualty can occur from even a small spark drawn from a charged piece of metal or rigging. Although the spark itself may be harmless, the "surprise" may cause the man to let go his grasp involuntarily. There is also shock hazard if nearby antennas are energized, such as those on stations ashore or aboard a ship moored alongside or across a pier.

Danger also exists that radar or other rotating antennas might cause men working aloft to fall by knocking them from their perch. Motor safety switches controlling the motion of radar antennas must be tagged and locked open before anyone is allowed aloft close to such antennas.

If you work near a stack, draw and wear the recommended oxygen breathing apparatus. Among other toxic substances, stack gas contains carbon monoxide. Carbon monoxide is too unstable to build up to a high concentration in the open, but prolonged exposure to even small quantities is dangerous.

Here is what the CWO requires you to do when he receives word that men are going aloft: (1) Secure all radio transmitters and disconnect and ground the transmitting antennas. (2) Unpatch remote control units at the transmitter transfer panel, and place a "Secure, men aloft" sign on all transmitters. (3) Report accomplishment of these details to the CWO so that he can inform the OOD and men going aloft that all radio transmitters are secured.

Make entries in your radio log to show the time of securing, time of opening up to resume operating, name of OOD granting permission to open up, and the time men came off the mast.

Under no circumstances turn on any transmitter unless informed that the men are off the mast, and then only with permission of the OOD and CWO.

Observe these safety precautions when you are going aloft:

Safety Precautions Working Aloft

1. You must have permission of the CWO and OOD.
2. You must have the assistance of another man along with a ship's Boatswain's Mate qualified in rigging.
3. Wear a safety belt. To be of any benefit, the belt must be fastened securely as soon as you reach the place where you will work. Some men have complained on occasion that a belt is clumsy and interferes with movement. It is true the job may take a few minutes longer, but it is also true that a fall from the vicinity of an antenna is usually fatal.
4. Do not attempt to climb loaded with tools. Keep both hands free for climbing. Tools can be raised to you by your assistant below. Tools should be secured with preventer lines to avoid dropping.
5. Ensure yourself of good footing and grasp at all times.
6. Hold fast.

# CHAPTER 14

# MAINTENANCE

Maintenance includes both measures to reduce or eliminate failures and prolong the useful life of equipment (preventive maintenance) and measures taken to correct damage incurred through long use, accident, or other causes (repair, also called corrective maintenance). Subdivisions of electronics maintenance are defined as follows:

Operational maintenance consists normally of inspection, cleaning, servicing, preservation, lubrication, and adjustment, as required, and may also consist of minor parts replacement not requiring highly technical skill or internal equipment alignment. Operational maintenance on communication-electronic equipment is done by Radiomen.

Technical maintenance usually is limited to maintenance consisting of replacement of unserviceable parts, subassemblies, or assemblies, or assemblies and the alignment, testing, and internal adjustment of equipment. Technical maintenance customarily is done by Electronics Technicians.

Tender/yard maintenance requires a major overhaul or complete rebuilding of parts and assemblies. Maintenance beyond the capacity of ship or station forces is performed by tenders or naval shipyards and industrial managers or by contractors responsible to the maintenance yard.

The electronics material officer, one of the assistants to the operations officer, is responsible for the administration of the electronics maintenance program. The trend in recent years is toward increased maintenance responsibilities for Radiomen and other operational ratings. Although the line is not always clearly drawn between operational and technical maintenance, and there may be certain exceptions, it is intended that operational maintenance be done by the operational ratings and technical maintenance by the technical ratings. Duties of the two ratings are summarized as follows:

- Operational ratings—operational use, manipulation, and operational maintenance of electronic equipment associated with the technical specialties of the rating, and such portions of preventive maintenance as do not require realignment after accomplishment.
- Technical ratings—manipulation, technical and tender/yard maintenance, repair of electronic equipment, and preventive maintenance that requires realignment after accomplishment.

## PREVENTIVE MAINTENANCE

Preventive maintenance is defined as the care and servicing by personnel for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of failures either before they occur or before they develop into major defects.

The Navy Maintenance and Material Management (3-M) System has been implemented in the Navy as an answer to the ever-present problem of maintaining a high degree of operational readiness. Although the 3-M system is designed to improve the degree of readiness, its effectiveness and reliability depend on the individuals concerned. The accuracy with which Radiomen perform their work, together with the neat and complete recording of required data on prescribed forms, is one of the keys to the degree of readiness of a ship and therefore is a reflection of the success or failure of RMs as petty officers.

The two basic elements of the 3-M system are the Planned Maintenance System (PMS) and the Maintenance Data Collection System (MDCS). The Planned Maintenance System (PMS) provides a uniform system of planned preventive maintenance.

The Maintenance Data Collection System (MDCS) provides a means of collecting necessary maintenance and supply data in a form suitable for rapid machine processing. A man-hour accounting system is used aboard repair ships and tenders in conjunction with the Maintenance Data Collection System.

Third or second class petty officers are concerned with both the PMS and certain portions of the MDCS as discussed in this chapter.

## PLANNED MAINTENANCE SYSTEM

Planned maintenance reduces casualties and saves the cost of major repairs. The PMS is designed to define the minimum planned maintenance required, to schedule and control its performance, to describe the methods and tools to be used, and to aid in the prevention and detection of impending casualties.

In establishing minimum planned maintenance requirements for equipment, the NavShips Technical Manual, manufacturers' technical manuals, and applicable drawings are reviewed critically. If planned maintenance requirements are found to be unrealistic or unclear, they are modified or completely revised before they are incorporated into the PMS.

It is possible that the planned maintenance prescribed in the PMS may differ from that prescribed in other documents such as the NavShips Technical Manual. Should some variance become apparent, remember that insofar as preventive maintenance is concerned, the PMS supersedes and takes precedence over existing requirements set forth in various technical publications.

### Planned Maintenance System Manual

A master planned maintenance system manual is tailored to each department of each ship. It contains minimum planned maintenance requirements for each maintainable component installed in that particular ship. Appropriate sections (engineering, electronics, weapons, etc.) of the master manual normally are kept in the office of the department concerned. Respective sections are used mainly by department heads in planning and scheduling all maintenance requirements in their departments.

The departmental PMS manual contains a section for each work group within a department. Each section includes a table of contents and a maintenance index page (MIP) for each system, subsystem, or component. Applicable portions of the PMS manual, on which all RMs must be able to enter corrections, are kept in the working space for the equipment to which they pertain. They serve as a ready reference to the required planned maintenance. Each MIP contains a brief description of maintenance requirements and the frequency with which each maintenance is to be effected.

The frequency code is: D—daily, W—weekly, M—monthly, Q—quarterly, S—semiannually, A—annually, C—overhaul cycle, and R—situation requirement. Frequency codes for daily, weekly, monthly, quarterly, semiannual, and annual planned maintenance actions are self-explanatory. Code C designates certain planned maintenance actions performed in a specified quarter (i. e. once) during the operational cycle between shipyard overhauls. Code R identifies planned maintenance actions that are to be performed before getting underway, after a specified number of hours of operation, or to meet other requirements that arise only during specific situations (before overhaul, for example).

Figure 14-1 shows a maintenance index page taken from a typical PMS manual. Information entered on the MIP includes the system or component, a short description of each maintenance requirement, maintenance frequency code plus a consecutive number starting with numeral 1 for each frequency code assigned, rate(s) recommended to perform the maintenance, average time required to perform the maintenance, and related maintenance requirements. Related maintenance listed represents additional planned maintenance that can be completed before, in conjunction with, or immediately after a scheduled maintenance.

Because shipboard application of the PMS varies slightly from one ship to another, information found on MIPS regarding rates recommended to perform the maintenance and the average time required for the task requires clarification. Actually, the maintenance tasks are performed by personnel available and capable, regardless of the rate listed on the MIP. As listed on the MIP, average time required does not consider time required to assemble necessary tools and materials, to obtain permission to go aloft, nor to clean the area and put away tools upon conclusion of the task. Always remember that no maintenance is complete until all tools and equipment are put away and the area is cleaned.

| System, Subsystem, or Component | Reference Publications |
|---|---|
| R-390A/URR<br>Radio Receiver | NAVSHIPS 93053 |

| Bureau Card Control No. | | | | | Maintenance Requirement | M.R. No. | Rate Req'd. | Man Hours | Related Maintenance |
|---|---|---|---|---|---|---|---|---|---|
| CK | 037CRG2 | A5 | BE78 | M | 1. Test the calibration oscillator.<br>2. Test tuning system and signal strength.<br>3. Test bandwidth and audio response.<br>4. Test limiter action. | M-1 | RM3 | 0.9 | None |
| CK | 037CRG2 | A5 | BE79 | Q | 1. Test IF gain.<br>2. Measure overall receiver gain.<br>3. Test audio gain. | Q-1 | RM3 | 0.9 | S-1 |
| CK | 037CRG2 | A5 | BE80 | S | 1. Measure receiver sensitivity. | S-1 | RM3 | 1.2 | None |
| CK | 037CRG2 | A5 | BE81 | S | 1. Clean and inspect the radio receiver. | S-2 | RMSN | 0.6 | M-1 |
| CK | 037CRG2 | A5 | BE82 | A | 1. Lubricate mechanical tuning system. | A-1 | ETSN | 1.0 | Q-1, S-1 |
| | | | | | These maintenance cards were prepared for this equipment in which the following field changes have been accomplished: 1 through 5<br><br>Of these, the following field changes affect the maintenance actions: 4, 5<br><br>New maintenance requirement cards and maintenance index pages will be made available as future field changes are accomplished that affect the prescribed planned maintenance. | | | | |

MAINTENANCE INDEX PAGE
OPNAV FORM 4700-3 (4-64)

BUREAU PAGE CONTROL NUMBER C-20/2-A5

98.171

Figure 14-1.—Maintenance index page.

## Scheduling Planned Maintenance

For each division or maintenance group, a cycle schedule that provides a visual display of planned maintenance requirements (based on the operational cycle of the ship between shipyard overhauls) is exhibited in the departmental office. Figure 14-2 illustrates a cycle schedule. Information supplied on a cycle schedule for any particular division or maintenance group includes the MIP number from the PMS manual, a listing of all equipment within that particular group for which planned maintenance is required, and the specific quarter in which the semiannual, annual, and overhaul cycle planned maintenance actions are to be performed. A cycle schedule also lists quarterly and situation requirement planned maintenance actions that must be scheduled, as well as monthly planned maintenance requirements.

Cycle schedules are utilized by department heads, in conjunction with their division officers and leading petty officers, to prepare quarterly planned maintenance schedules. A quarterly schedule is displayed in a holder, known as the maintenance control board, adjacent to the cycle schedule to which it pertains. Figure 14-3 illustrates a quarterly schedule. A quarterly schedule gives a visual display of the ship's employment schedule and the planned maintenance to be performed during that particular quarter. A quarterly schedule has 13 columns, one for each week in the quarter, for scheduling maintenance throughout a 3-month period.

At the end of each week, the leading petty officer of a division or maintenance group updates the quarterly schedule by crossing out (with an X) the preventive maintenance performed. If a planned maintenance action is not completed during the week it is scheduled, the leading petty officer circles the action on the quarterly schedule. Uncompleted maintenance is then rescheduled for another week within the same quarter.

At the close of each quarter, a quarterly schedule is removed from its holder and retained on board as a record of the planned maintenance completed. This record may be discarded at the beginning of the second quarter after the next shipyard overhaul.

A quarterly schedule also is used by leading petty officers to arrange a weekly planned maintenance schedule for posting in an appropriate work space. All RMs must be able to prepare a weekly schedule. The weekly schedule of planned maintenance should not be considered as the total of all work for a given week. This schedule covers only scheduled planned maintenance and is in addition to other routine work, upkeep, and corrective maintenance to be accomplished. The weekly schedule provides a list of components in the working area, appropriate page number of the PMS manual, and spaces for the leading PO to use in assigning planned maintenance tasks to specified personnel. Daily and weekly planned maintenance actions are preprinted on the forms, and the other maintenance actions are written in by the leading PO as required. When the leading PO is assured that a maintenance task is completed, he crosses out the maintenance requirement number on the weekly schedule. If for some reason a task cannot be completed on the day scheduled, the leading petty officer circles the maintenance requirement number and reschedules it for another day. Current status of scheduled maintenance is readily available by looking at the weekly schedule.

A sample weekly schedule is shown in figure 14-4. In addition to weekly maintenance actions, the leading PO has assigned to Dow the responsibility of requirement M-1 on Tuesday and to O'Brien the responsibility of M-1 on Wednesday. In the example illustrated, all maintenance scheduled for Monday and Wednesday was completed. Dow was unable, however, to complete his scheduled requirement for Tuesday, so the action is rescheduled for Thursday of that week.

## Maintenance Requirement Card

A maintenance requirement card (MRC), is 5 by 8 inches, on which a planned maintenance task is defined sufficiently to enable assigned personnel to perform the task. (See fig. 14-5.) A master set of MRCs is maintained in the departmental office. Cards applicable to the equipment with which RMs are concerned are maintained in the working space. If a card in the working space becomes lost or mutilated, a new card can be made from the master set and used until a feedback report is sent in and a new card obtained.

A maintenance requirement card is one of the principal components of the PMS with which Radiomen are concerned. Suppose that on a Monday morning you look at the weekly schedule (fig. 14-4) and find that you are assigned the maintenance action identified as M-1. The weekly schedule indicates that this particular

TYPE DD

CLASS

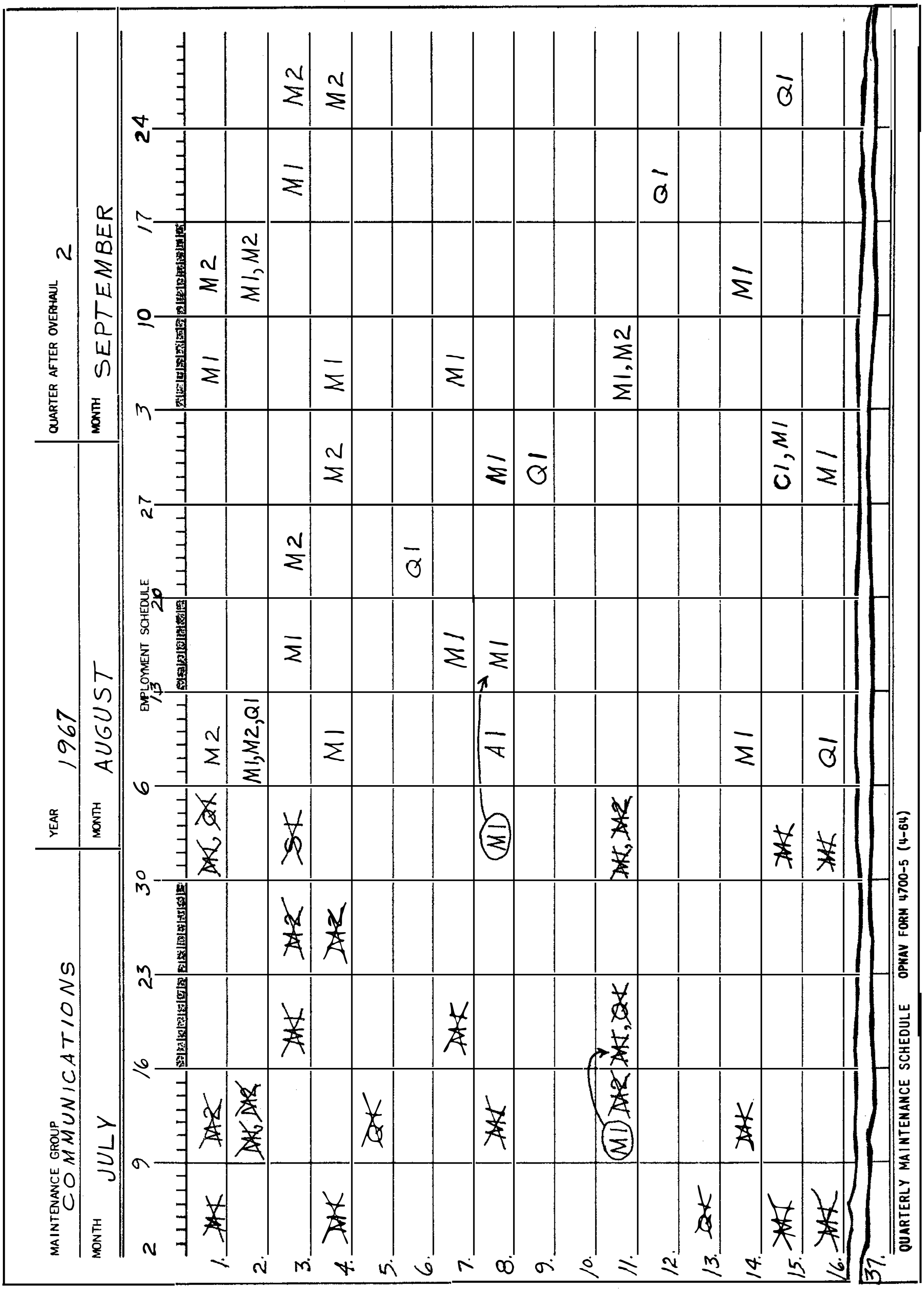
MAINTENANCE GROUP: COMMUNICATIONS

| EQUIP PAGE | COMPONENT | SCHEDULE AS INDICATED — QUARTER AFTER OVERHAUL 1 5 9 | 2 6 10 | 3 7 11 | 4 8 12 | EACH QUARTER |
|---|---|---|---|---|---|---|
| C-1 | AN/URR-35 | | | | | M1, M2, Q1 |
| C-2 | TED-9 | | | | | M1, M2, Q1 |
| C-3 | AM-1365/URT | | S1 | | S1 | M1, M2, |
| C-5 | AN/WRT-2 | A1 | | | | M1, M2 |
| C-6 | AN/CRT-3 | | | | | Q1 |
| C-7 | AN/URC-4 | | | | | Q1 |
| C-8 | AN/SRR-11A | | | | | M1 |
| C-10 | AN/WRT-1 | | A1 | | | M1 |
| C-13 | SCR-536 | S1 | | S1 | | Q1 |
| C-14 | AM-215/U | | | A1 | | |
| C-16 | AN/URT-7C | | | | | M1, M2, Q1 |
| C-17 | CU-692/U | | | | | Q |
| C-18 | CU-691/U | | | | | Q1 |
| C-19 | AN/URA-8A | | | | C1(8) | M1 |
| C-19 | AN/URA-8B | | C1(2) | | | M1, Q1 |
| C-20 | R390/URR | S1 | | S1 | A1 | M1, Q1 |
| C-21 | AN/GRC-27A | | | | | M1, M2, [illegible] |
| C-25 | AN/URC-32 | | A1 | | | M1, Q1, Q2 |
| C-25 | AN/URC-32A | | | A1 | | M1, Q1, Q2 |
| C-26 | AN/SRA-22 | | | | | Q1 |

CYCLE SCHEDULE OPNAV FORM 4700-4 (4-64) 0107-766-4000 C.40996

98.172

Figure 14-2.—Cycle schedule.




98.173

Figure 14-3.—Quarter or subsequent quarter schedule.

GROUP COMMUNICATIONS WORK SCHEDULE FOR WEEK OF 6 AUGUST 1967

| COMPONENT | MAINTENANCE RESPONSIBILITY | PAGE | MONDAY | TUESDAY | WEDNESDAY | THURSDAY | FRIDAY | SAT/SUN | OUTSTANDING REPAIRS AND P.M. CHECKS DUE IN NEXT 4 WEEKS |
|---|---|---|---|---|---|---|---|---|---|
| AN/URR-35 | ABLE | C1 | | | ~~M2~~ | | | | |
| TED-9 | BAKER | C2 | | ~~M1, M2, Q1~~ | | | | | |
| AM-1365/URT | CHARLES | C3 | | | | | | | |
| AN/WRT-2 | DOW | C5 | | (M1) → | | M1 | W1 | | |
| AN/URC-4 | GREENE | C7 | | | | | | | |
| AN/SRR-11A | HAPP | C8 | | | | W1 | | | |
| AN/WRT-1 | INTRYE | C10 | | ~~A1~~ | ~~W1~~ | | W2 | | |
| SCR-536 | JUSTICE | C13 | | | | | | | |
| AM-215/U | KIDD | C14 | | | | | | | |
| AN/URT-7C | LORNE | C16 | | | | | | | |
| CU-692/U | MAYS | C17 | | | | | | | |
| CU-691/U | NAYLOR | C18 | | | | | | | |
| AN/URA-8A | O'BRIEN | C19 | ~~W1~~ | | ~~M1~~ | | | | |
| AN/URA-8B | PETERS | C19 | | | | W1 | | | |
| R390/URR | QUINN | C20 | | ~~Q1~~ | | | | | |
| R390A/URR | RUSK | C20 | | | | | | | |
| AN/GRC-27A | SIMPSON | C21 | ~~W1~~ | | | | | | |
| AN/URC-32 | TODD | C25 | | | ~~W1~~ | | | | |
| AN/URC-32A | USTE | C25 | ~~W1~~ | | | | | | |
| AN/SRA-22 | VICTOR | C26 | | | | | | | |

WEEKLY WORK SCHEDULE OPNAV FORM 4700-6

98.175

Figure 14-4.—Weekly work schedule.

| SYSTEM | COMPONENT | M.R. NUMBER | |
|---|---|---|---|
| Communication & Control | R390A/URR Radio Receiver | C-20 M-1 | |
| | MAINT. SIGNIFICANT NO. | | |
| **SUB-SYSTEM** | **RELATED M.R.** | **RATES** | **M/H** |
| Radio Communication Systems | | RM3 | 0.3 |

**M.R. DESCRIPTION**

1. Check receiver operation.

TOTAL M/H: 0.3

ELAPSED TIME: 0.3

**SAFETY PRECAUTIONS**

**TOOLS, PARTS, MATERIALS, TEST EQUIPMENT**

1. Headphones.

**PROCEDURE**

Preliminary Control Settings:

| | | |
|---|---|---|
| 1. | RF gain | 5 |
| 2. | Function switch | Cal |
| 3. | BFO switch | ON |
| 4. | BFO pitch | 0 |
| 5. | Line gain | 5 |
| 6. | Line meter switch | +10 |
| 7. | Local gain | 5 |
| 8. | Bandwidth | 4 KC |
| 9. | Audio response | WIDE |
| 10. | AGC switch | MED. |
| 11. | Limiter switch | OFF. |

1. Check receiver operation:

a. Connect headphones in receiver phone jack, turn megacycle change knob counter-clockwise until the first two counter digits read "00".

b. Turn kilocycle knob counter-clockwise until the last three digits read "000".

c. Turn ZERO ADJ. completely clockwise.

d. Increase RF GAIN to 10. (Cont.)

**LOCATION**

Page 1 of 2 | CK | 037C | RG2 | A3 | AA05 | M

Procedure Continued

e. While listening in phones and observing carrier level meter, vary kilocycle change knob for zero beat in phones coincident with minimum deflection on line level meter.

f. Turn "ZERO ADJ." maximum counterclockwise.

g. Turn "BFO PITCH" to +2. Beat note will be heard in phones.

h. Turn megacycle change knob clockwise, one position at a time from 00 to 31.

i. Observe carrier level meter while listening for beat note in each position.

j. Carrier level should indicate a minimum of 10 DB and beat note should be clearly audible in phones in each position.

k. Return "MC" change knob counterclockwise until counters are again 00.

l. Turn kilocycle change knob clockwise until last three digits of counter read 000.

m. Counters should read 00+000. This is equivalent to 1 MC.

n. Turn "BFO PITCH" control to "0" and RF gain to 5.

o. Repeat steps 1. c through 1. j.

Page 2 of 2 | CK | 037C | RG2 | A3 | AA05 | M

98.176

Figure 14-5.—Maintenance requirement card (front and back).

maintenance action is listed on page C-20 of the PMS manual. The MRC that describes the task assigned is identified by the number combination C-20 M-1 in the upper-right corner. In preparation for performing the assigned task, MRC number C-20 M-1 (fig. 14-5) is selected from the set of cards in the working space. An MRC identifies each component, gives a brief description of maintenance required, cites safety precautions to be observed, and lists tools, parts, and materials needed to accomplish the task. This information is given to enable personnel to be completely ready to perform all prescribed maintenance before actually working on equipment authorized. The procedure described on the MRC is standardized, and is the best known method of performing that particular task. Any related maintenance requirement included on the MRC should be done at the same time or in conjunction with the assigned task for the purpose of time conservation. Second Class Radiomen must be able to supervise their juniors when they are accomplishing tasks outlined on these MRC cards.

The 16-digit number on the lower right side of the MRC is the bureau card control number, and also appears on the MIP. Each MRC has a bureau card number, which must be referred to in any correspondence concerning the card.

In some ships, two or more divisions may have identical equipment. When this duplication occurs, each division retains separate (but identical) MRC cards for the equipment.

### Feedback Report

A PMS feedback report, OpNav form 4700-7 (fig. 14-6) is designed for reporting any discrepancies or suggested improvements in the PMS as installed aboard ship. This report is to be filled out by the man who discovers a discrepancy or suggests an improvement. It is signed by a designee of the commanding officer, and is mailed via the type commander to an appropriate field office listed on the reverse side of the originator's copy of the form. Atlantic Fleet ships use the Norfolk address; Pacific Fleet ships send reports to the San Diego address.

When submitting a feedback report, be sure it is filled out completely and legibly. Handwritten copies are acceptable, but a ballpoint pen must be used to ensure that all copies are legible. Instructions for preparing a feedback report are listed on the back of the originator's copy as shown in figure 14-6 and are discussed here for clarity.

Individuals submitting reports are required to complete the "TO" line with the appropriate (San Diego or Norfolk) address. In the "FROM" line insert ship's hull number (DDG 11, DD 789, AD 36, etc.) (ship's name may also be included); and in the "VIA" line indicate type commander. Effective date is the day the discrepancy was discovered or the improvement was suggested. The serial number indicates the number of feedback reports sent in by the reporting ship. If a ship previously forwarded 10 feedback reports, for example, her next report is numbered 11.

Blocks concerning the system, subsystem, component, M.R. number, and bureau card control number should be filled in with information from the appropriate MIP and/or MRC. If an MRC or MIP is missing, and the bureau card control number is not available, equipment should be identified by its name and its APL/CID or AN number. The APL/CID number identifying the parts list for the equipment is found in the index to the coordinated shipboard allowance list (COSAL). The "Technical Publications" block in the "Discrepancy" section of the report should include all NavShips and NavElecs publications. If any of these publications are in error, identify them by number, volume, revision, date, change number, page, paragraph, and/or figure.

Before distributing a feedback report (original and four carbon copies), check it for completeness of information. Any discrepancy should be explained clearly; a suggestion for its correction must always be offered.

## MAINTENANCE DATA COLLECTION SYSTEM

The Maintenance Data Collection System is intended to provide a means of recording maintenance actions in substantial detail so that a variety of information may be collected concerning maintenance actions and performance of equipment. In addition to the foregoing information, MDCS furnishes data concerning initial discovery of a malfunction, how equipment malfunctioned, how many man-hours were expended, what equipment was involved, repair parts and materials used, delays incurred, reasons for delay, and the technical specialty or work center that performed the maintenance.

In recording maintenance actions, codes must be used in order to convert information to a language that can be read by automatic data processing machines. Codes are listed in the equipment identification code (EIC) manual, in which

**INSTRUCTIONS ON BACK OF GREEN PAGE**

FROM:

SERIAL #: ______

TO: **BUSHIPS/BUWEPS MAINTENANCE MANAGEMENT FIELD OFFICE**

DATE ______

VIA:

**SUBJECT: PLANNED MAINTENANCE SYSTEM FEEDBACK REPORT**

| SYSTEM | COMPONENT |
|---|---|
| SUB-SYSTEM | M. R. NUMBER |
| | BU. CONTROL NO. |

DESCRIPTION OF DISCREPANCY:

| | | |
|---|---|---|
| ☐ M. R. Description | ☐ Equipment Change | ☐ Typographical |
| ☐ Safety Precautions | ☐ Missing Maintenance Index Page (MIP) | ☐ Technical Publications |
| ☐ Tools, Etc. | ☐ Technical | ☐ Miscellaneous |
| ☐ Missing Maintenance Requirement Card (MRC) | ☐ Procedure | |

SIGNATURE

THIS COPY FOR: **ORIGINATOR** **5**

OPNAV FORM 4700-7 (NEW 10-65)

40.101

Figure 14-6. —PMS feedback report, OpNav form 4700-7.

all RM2's must be able to enter corrections. Third and second class petty officers are required to prepare numerous maintenance forms, using appropriate EICs. These forms are sent to a data processing center where coded information is punched onto cards, which then machine-processed to produce various reports for use in maintenance and material management.

Reports coming from the automatic data processing machines are accurate and useful only if information is entered clearly and correctly on maintenance forms. It is important, therefore, that all codes supplied on the forms be accurate and clearly written. Maintenance Data Collection System Forms.

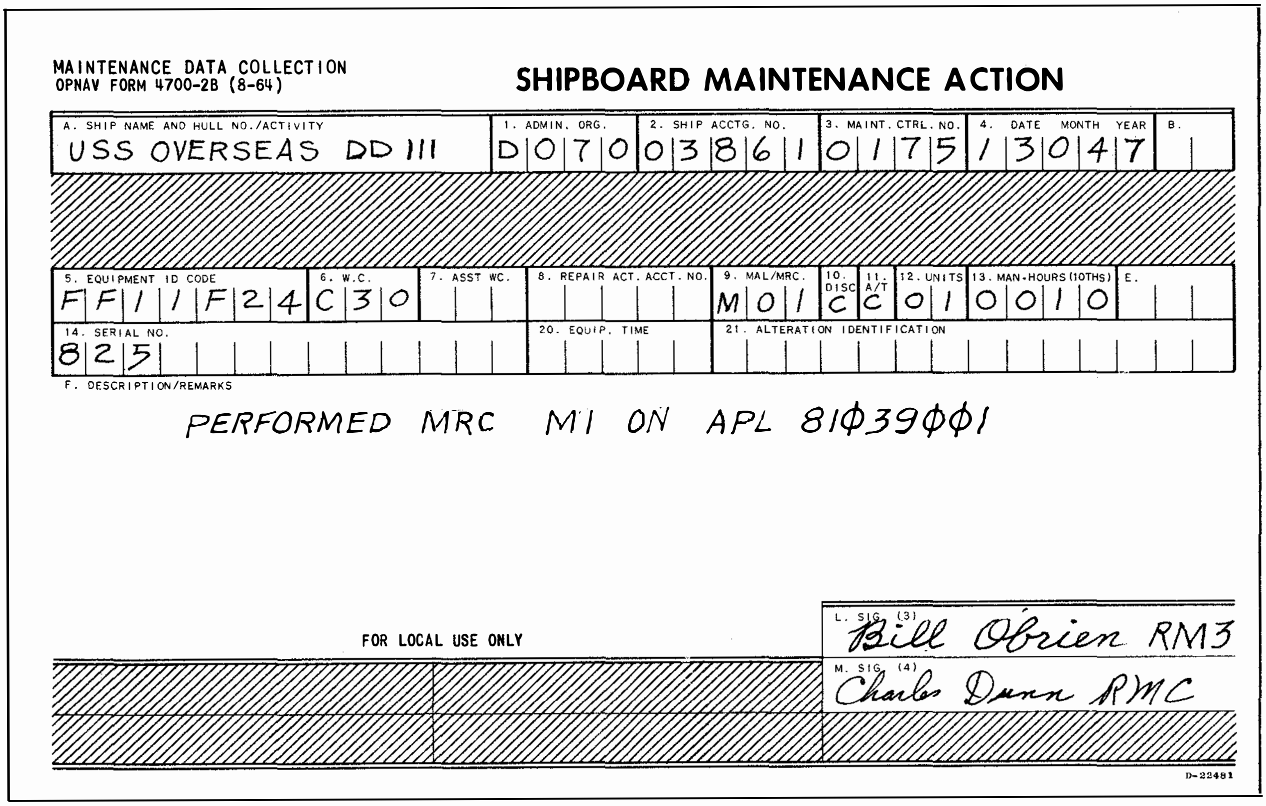
Included in the MDCS forms that require coded entries are OpNav form 4700-2B (Shipboard Maintenance Action), OpNav form 4700-2C (Work Request), and OpNav form 4700-2D (Deferred Action). Detailed descriptions of entries made on these forms appear in the EIC manual and in chapter 3 of the 3-M Manual, OpNav 43P2. Brief accounts of procedures for completing these forms are given here and are illustrated in figures 14-7 through 14-10.

Block A, Ship Name and Hull No. /Activity: Enter name and hull number of ship—for example, USS Overseas (DD 111).

Block 1, Administrative Organization: Record the 4-letter/number code (from section II of EIC manual) to which ship is assigned. (When ship is assigned to DESRON 7, write DO70.)

Block 2, Unit Identification Code: List unit identification for ship or activity for which maintenance was performed. This entry is obtained by referring to Navy Comptroller Manual, Vol. 2, chapter 5.

Block 3, Maintenance Control No: This number is used to relate all documents submitted on a specific job, and is filled in by the maintenance control section of a ship before the documents leave the ship. Numbers are assigned consecutively beginning with 0001 and ending with 0001 and ending with 9999. Upon reaching 9999, start series again at 0001.


MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2B (8-64)

SHIPBOARD MAINTENANCE ACTION

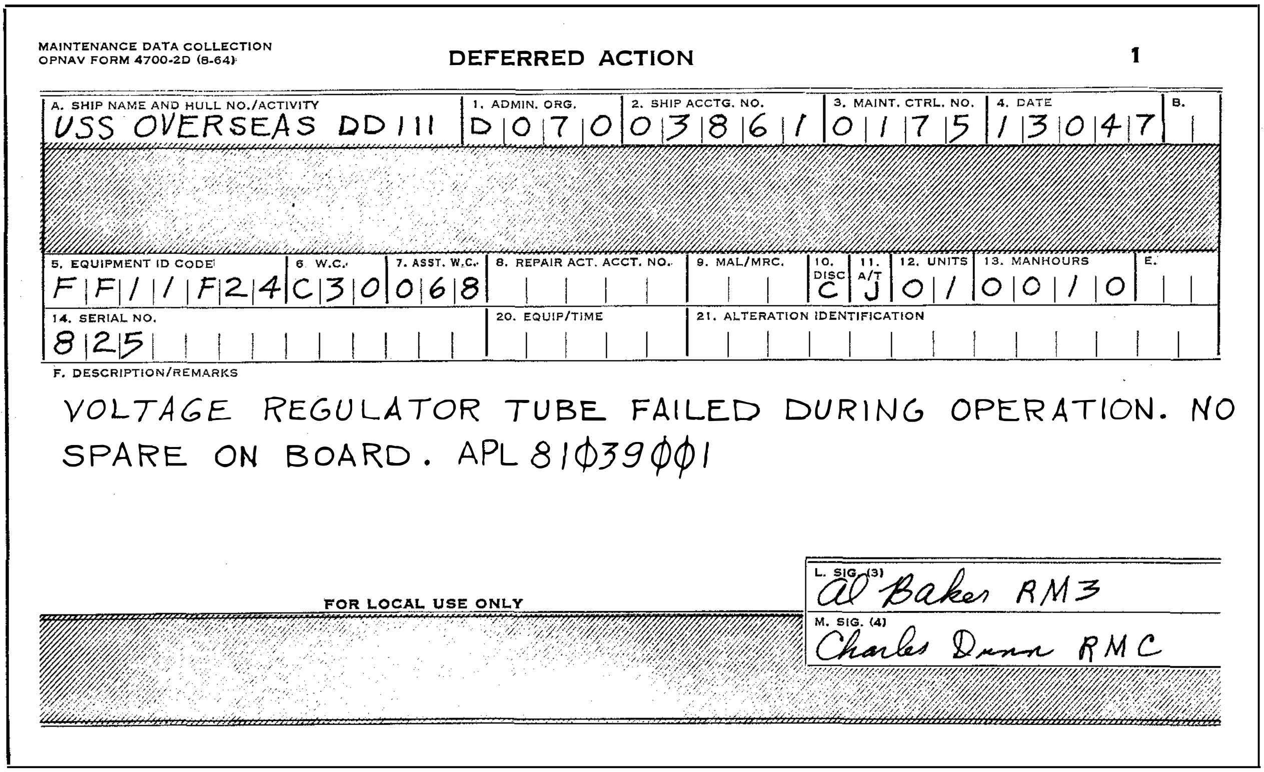
A. SHIP NAME AND HULL NO./ACTIVITY: USS OVERSEAS DD 111
1. ADMIN. ORG.: D070
2. SHIP ACCTG. NO.: 03861
3. MAINT. CTRL. NO.: 0175
4. DATE MONTH YEAR: 13047
B.
5. EQUIPMENT ID CODE: FF11F24
6. W.C.: C30
7. ASST WC.
8. REPAIR ACT. ACCT. NO.
9. MAL/MRC.: M01
10. DISC: C
11. A/T: C
12. UNITS: 01
13. MAN-HOURS (10THS): 0010
E.
14. SERIAL NO.: 825
20. EQUIP. TIME
21. ALTERATION IDENTIFICATION
F. DESCRIPTION/REMARKS: PERFORMED MRC M1 ON APL 81Ø39ØØ1

FOR LOCAL USE ONLY
L. SIG. (3): Bill Obrien RM3
M. SIG. (4): Charles Dunn RMC

D-22481

17.81B

Figure 14-7. —Shipboard maintenance action form.



MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION 1

| A. SHIP NAME AND HULL NO./ACTIVITY | 1. ADMIN. ORG. | 2. SHIP ACCTG. NO. | 3. MAINT. CTRL. NO. | 4. DATE | B. |
| --- | --- | --- | --- | --- | --- |
| USS OVERSEAS DD 111 | D070 | 03861 | 0175 | 13047 | |

| 5. EQUIPMENT ID CODE | 6. W.C. | 7. ASST. W.C. | 8. REPAIR ACT. ACCT. NO. | 9. MAL/MRC. | 10. DISC | 11. A/T | 12. UNITS | 13. MANHOURS | E. |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| FF11F24 | C30 | 068 | | | C | J | 01 | 0010 | |

| 14. SERIAL NO. | 20. EQUIP/TIME | 21. ALTERATION IDENTIFICATION |
| --- | --- | --- |
| 825 | | |

F. DESCRIPTION/REMARKS

VOLTAGE REGULATOR TUBE FAILED DURING OPERATION. NO SPARE ON BOARD. APL 81Ø39ØØ1

FOR LOCAL USE ONLY

L. SIG. (3) Al Baker RM3

M. SIG. (4) Charles Dunn RMC

17.81D

Figure 14-8.—Deferred action form, part 1.

Block 4, Date: Make an entry of the day, month, and year maintenance is accomplished. For a work request, give date the request is submitted.

Block B: Except on the work request, OpNav form 4700-2C, this block remains blank. On the work request, fill in block with a single-letter code, taken from section IX of EIC manual, to identify the type of availability during which the maintenance will be performed.

Block 5, Equipment Identification Code: From section X of EIC manual, supply appropriate 7-letter/number code that identifies the system, subsystem, component, or part, whichever is the lowest designated assembly on which maintenance is requested or performed. Caution must be exercised to ensure that the EIC number correctly identifies the exact item which maintenance is requested or performed.

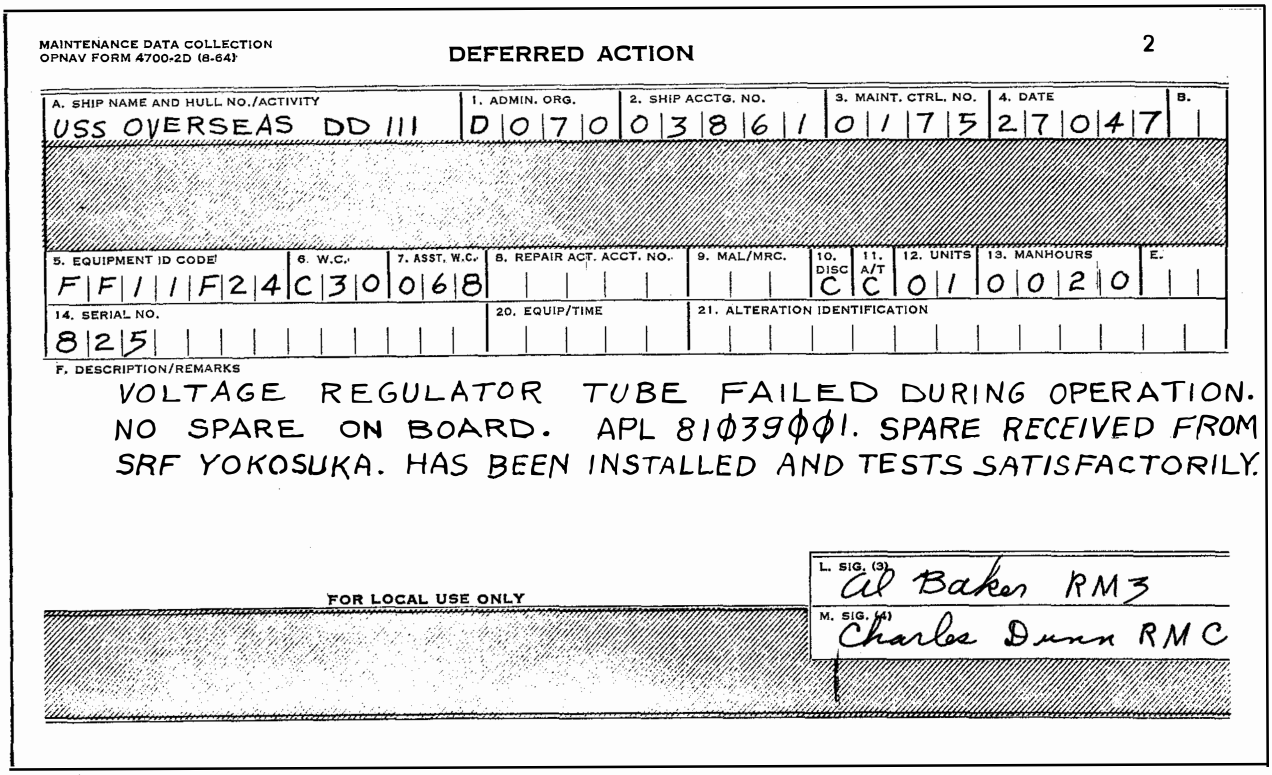
Block 6, Work Center: From section III of EIC manual enter the 3-letter/number code that identifies the department, rating, shop, or group performing maintenance actions on equipment identified in block 5.

Block 7, Assisting Work Center: Leave blank. When information is required in this block it is supplied by a supervisor in accordance with provisions of the EIC manual and chapter 3 of the 3-M Manual.

Block 8, Repair Activity Accounting No.: When the repair activity is known, its accounting number must be recorded. These numbers can be determined by referring to the Navy Comptroller's Manual. Otherwise, this space is filled in by the repair activity designated by the type commander.

Block 9, Malfunction/MRC: If maintenance action is a result of a malfunction, list the 3-digit code, from section IV of EIC manual, which best describes the trouble. (See fig. 14-7.) If the action is a result of planned maintenance (MRC), enter a 3-letter/number combination code to identify the frequency check on equipment. For example, if the situation is a M-1 PMS action, enter M01. For all other actions, enter 000.

Block 10, Discovered: From section V of EIC manual record the appropriate code letter



MAINTENANCE DATA COLLECTION
OPNAV FORM 4700-2D (8-64)

DEFERRED ACTION

2

| A. SHIP NAME AND HULL NO./ACTIVITY | 1. ADMIN. ORG. | 2. SHIP ACCTG. NO. | 3. MAINT. CTRL. NO. | 4. DATE | B. |
|---|---|---|---|---|---|
| USS OVERSEAS DD 111 | D070 | 03861 | 01175 | 27047 | |

| 5. EQUIPMENT ID CODE | 6. W.C. | 7. ASST. W.C. | 8. REPAIR ACT. ACCT. NO. | 9. MAL/MRC. | 10. DISC | 11. A/T | 12. UNITS | 13. MANHOURS | E. |
|---|---|---|---|---|---|---|---|---|---|
| FF11F24 | C30 | 068 | | | C | C | 01 | 0020 | |

| 14. SERIAL NO. | 20. EQUIP/TIME | 21. ALTERATION IDENTIFICATION |
|---|---|---|
| 825 | | |

F. DESCRIPTION/REMARKS

VOLTAGE REGULATOR TUBE FAILED DURING OPERATION. NO SPARE ON BOARD. APL 810390Ø1. SPARE RECEIVED FROM SRF YOKOSUKA. HAS BEEN INSTALLED AND TESTS SATISFACTORILY.

FOR LOCAL USE ONLY

L. SIG. (3) Al Baker RM3

M. SIG. (4) Charles Dunn RMC

17.81D

Figure 14-9. —Deferred action form, part 2.

that identifies when the maintenance requirement was discovered.

Block 11, Action Taken: From section VI of EIC manual enter the code that best describes the maintenance action taken. "Not repairable this ship" (NRTS) codes are used only by repair activities.

Block 12, Units: Show number of identical items, identified in block 5, on which the same maintenance action was attempted, performed, or requested. If equivalent alterations or significant maintenance actions are accomplished on identical equipment bearing different serial numbers, each equipment should be reported on a separate document.

Block 12, Man-hours: On completion of a maintenance action, list total man-hours (to the nearest tenth) expended by all shipboard personnel. If task was completed in 1-1/2 hours, for example, enter "0015." Enter 0 in any space not used.

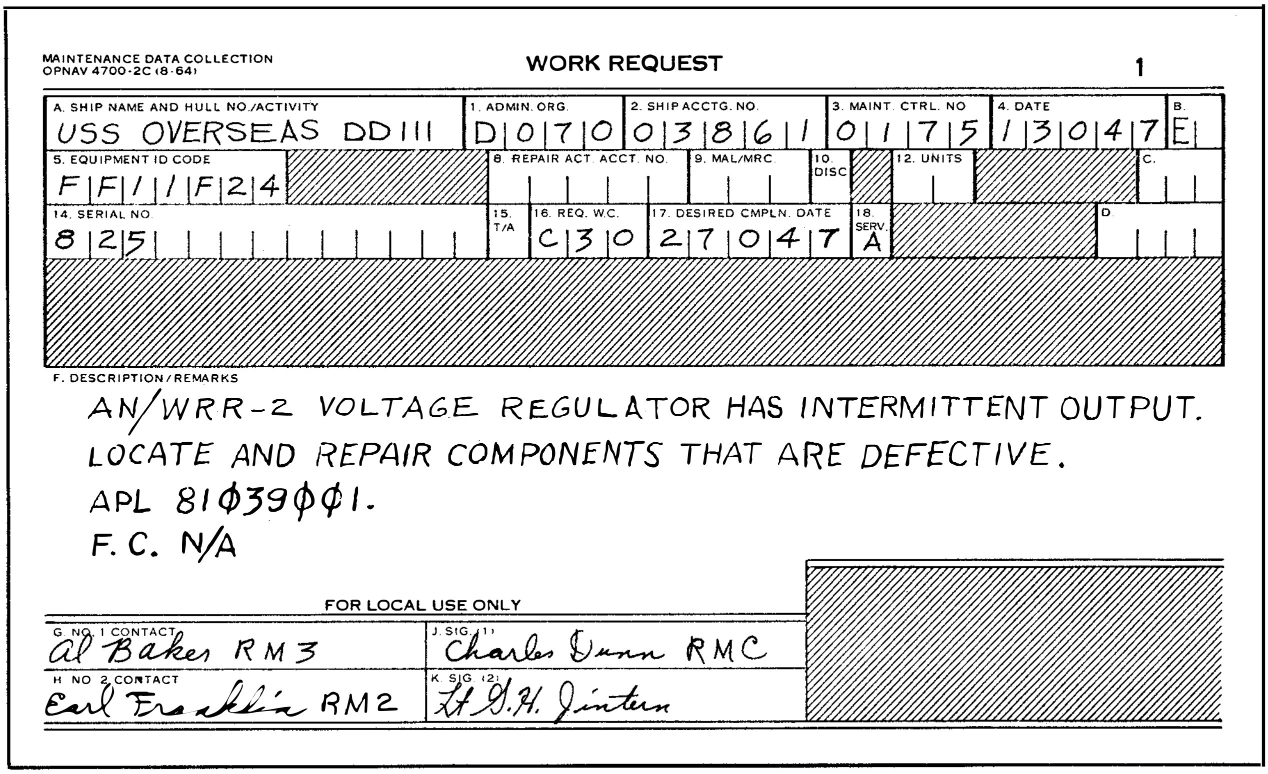
Block C: Leave blank.

Block 14, Serial No: For detailed information on completing this particular block, see chapter 3 of 3-M Manual. Serial number is required for electronic equipment. Use shipboard numbering identification system, followed by abbreviated name of equipment (which does not have a serial number). If block 5 identifies a radio selector switch, for example, and the switch in question is number 1, block 14 should contain the entry "NR 1 RSS."

Block 15, T/A: Leave blank.

Block 16, Requesting Work Center: Give letter/number code that identifies the department, rating, ship, or group requesting assistance from the repair activity. Work center codes are listed in section III of EIC manual.

Block 17, Desired Completion Date: Enter the day, month, and year that an outside repair activity must complete maintenance in order for requesting activity to meet its operational commitments. (If this date were 9 March 1967, for example, entry would be 09037.)


MAINTENANCE DATA COLLECTION
OPNAV 4700-2C (8-64)

WORK REQUEST 1

A. SHIP NAME AND HULL NO./ACTIVITY: USS OVERSEAS DD 111
1. ADMIN. ORG.: D0710
2. SHIP ACCTG. NO.: 03861
3. MAINT. CTRL. NO.: 01175
4. DATE: 13047
B.: E
5. EQUIPMENT ID CODE: FF11F24
8. REPAIR ACT. ACCT. NO.
9. MAL/MRC
10. DISC
12. UNITS
C.
14. SERIAL NO.: 825
15. T/A
16. REQ. W.C.: C30
17. DESIRED CMPLN. DATE: 27047
18. SERV.: A
D.

F. DESCRIPTION/REMARKS
AN/WRR-2 VOLTAGE REGULATOR HAS INTERMITTENT OUTPUT.
LOCATE AND REPAIR COMPONENTS THAT ARE DEFECTIVE.
APL 81Ø39ØØ1.
F. C. N/A

FOR LOCAL USE ONLY
G. NO. 1 CONTACT: Al Baker RM3
J. SIG. (1): Charles Dunn RMC
H. NO. 2 CONTACT: Earl Franklin RM2
K. SIG. (2): Lt G.H. Jinten

17.81C

Figure 14-10.—Work request form.

Block 18, Service: From section VII of EIC manual enter single-letter code identifying type of assistance that requesting ship will furnish repair activity in completing requested maintenance.

Block 19, Scheduled Start Date: This entry, which is for repair activitiws only, is the estimated starting date of requested maintenance.

Block D: Leave blank.

Blocks E and 20, Equipment Downtime and Equipment Operating Time: These entries are required only for equipment identified by green pages in EIC manual. Detailed instructions on information for these blocks are given in section I of EIC manual and in chapter 3 of 3-M Manual.

Block 21, Alteration Identification: If an alteration is to be accomplished, this block must contain the alteration identification from the authorization directive.

The shipboard maintenance action form (OpNav 4700-2B) is a single-sheet document for recording completion of planned maintenance actions, corrective maintenance actions, and authorized alterations performed at the shipboard level by shipboard personnel. All planned maintenance actions except daily and weekly planned maintenance actions must be recorded on this form, in addition to checking them off on weekly and quarterly schedules. Routine preservation, such as chipping, painting, and cleaning should not be reported.

The weekly schedule (fig. 14-4) reflects that O'Brien completed maintenance requirement C-19 M-1 on Wednesday. Figure 14-7 shows the shipboard maintenance action form completed by O'Brien for this maintenance requirement. Note that in addition to entries giving the date (13 April 1967), man-hours (0010), and proper codes from the EIC manual, O'Brien briefly described the maintenance performed (in block F) and signed the form. His leading petty officer signed the form to verify that information is complete and accurate.

Any corrective maintenance actions that are deferred because of ship's operations, lack of repair parts, or requirement of outside assistance are reported on OpNav 4700-2D, the deferred action form. It is a 2-sheet document, the first sheet of which is used to record and report the reason for deferral; the second sheet is for reporting completion of maintenance action. If a corrective maintenance action must be deferred, this form is required at the time a malfunction is noted. A sample sheet 1 of the deferred action form, which resulted from a planned maintenance action, is shown in figure 14-8. Block 11 (action taken code) and block 13 (man-hours expended) on sheet 1 of the deferred action form apply only to action taken and man-hours expended when malfunction was discovered. After the part is received from a supply activity, the carbon (sheet 2) of the deferred action form (fig. 14-9) is completed by inserting date of completion in block 4, new action taken code in block 11, additional man-hours in block 13, and appropriate remarks in block F. The form is signed by the man doing the work and by his supervisor, then it is submitted to the data processing center.

Information contained in blocks A, 1, and 2 of OpNav forms 4700-2B, 4700-2C, and 4700-2D must be identical on all forms for any particular ship. If desired, this information may be preprinted. Each maintenance action is assigned its own unique maintenance control number. If a maintenance task requires more than one form, as in the example illustrated in figures 14-8 and 14-9, numbers must be identical.

Figure 14-10 shows a work request (OpNav 4700-2C) which illustrates that ship's personnel were unable to repair a part that is failing intermittently. In completing block F (Description/Remarks) of the work request, note that—

1. Component must be identified by name.
2. Component CID number must be listed.
3. Field change number must be given, if applicable. If not applicable, it must be listed as N/A.
4. A description must be included, stating what is wrong with the equipment and what the repair activity is to accomplish.

Signature blocks G, H, and J are to be signed by three leading petty officers (one from each duty section) familiar with the work to be done by the repair activity. Signature block K is used by the commanding officer or his authorized representative to indicate command approval of the request for repair assistance.

### Material Usage and Cost Data

Documentation of material usage and cost data on maintenance transactions requires the joint effort of supply maintenance personnel on board ship. Economy of effort and elimination of duplicate recordings are highly desirable.

When repair parts or materials are drawn from the supply department for shipboard maintenance, a NavSandA form 1250 is used to request materials. When submitting this form to the supply department, maintenance personnel are required to furnish the work center code and EIC (form EIC manual), CID number, maintenance control number, name of part, quantity required, and stock number. Supply personnel complete the form. Cost of maintenance requested is documented from this form if the ship has no data processing equipment aboard. If the ship has data processing equipment, a DD form 1348 is used instead of the form 1250.

When material to support a maintenance action is obtained from outside normal supply channels or from preexpended material bins, the reverse side of the appropriate OpNav form (OpNav 4700-2B or 4700-2D) is used. Essentially, the reverse sides of OpNav 4700 series forms are identical. The reverse side of OpNav form 4700-2B is shown in figure 14-11. On this side of the form, wherever applicable, enter the CID number, source code (from section VIII of EIC manual), cognizance symbol (from supply publications) to identify supply account and inventory manager of item used, Federal stock number, reference symbol (from circuit diagrams) or name of part being replaced, unit of issue of material used, quantity used, and unit cost of item. The unit cost is not included when preexpended material is used.

## ANTENNA MAINTENANCE

The worst enemies of shipboard antenna installations are salt spray and soot. They cause corrosion that eats into the antennas, mounting brackets, and associated hardware. They also cover the installations with salt and soot deposits, which, if allowed to accumulate, may short the antennas to ground by providing a path for current flow across insulators.

Careless painting is another cause of trouble in antenna system. Paint that has a metallic base is a hood conductor of electricity, and if enough of this paint is smeared or spattered on an insulator, it will short the antenna in the same manner as salt and soot depositis.

Antenna maintenance consists mainly of simple visual inspections for physical damage and resistance tests for leakage resistance or insulation breakdown.

CID/APL/AEL/AN
55376101

| SOURCE CODE | FEDERAL STOCK NO./PART NO. COG. | | REFERENCE SYMBOL/NOUN | MATERIAL REQ. UNITS | QUANTITY | MATERIAL USED UNITS | QUANTITY | UNIT PRICE |
|---|---|---|---|---|---|---|---|---|
| 1 | 1N | 5905-258-0034 | R1445 | | | EA | 2 | .38 |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |
| | | | | | | | | |

OPNAV FORM 4700-2B (8-64) BACK

17.81BCD

Figure 14-11. —Reverse side of shipboard maintenance action form.

VISUAL INSPECTIONS

At frequent intervals (usually during upkeep periods), lower all wire antennas to the deck and inspect them thoroughly for damage. Pay particular attention to points that are subjected to strain and chafing. These points are where supporting clamps attach to the antennas, and where the antennas connect to trunks or transmission lines. Insulators also are subjected to considerable strain and must be checked for cracks and other signs of deterioration.

While the antennas are down, they should be cleaned to remove salt and soot deposits. Uninsulated transmitting antennas are merely wiped clean with a cloth. (Insulator cleaning is discussed under a separate topic.) Take care not to nick or kink the antennas because this condition weakens them.

After each cleaning, antennas that are not covered with insulating material should be coated, with a corrosion preventive compound. All antenna fittings, such as ringbolts, shackles, and turnbuckles, also should be coated with the compound. Satisfactory compounds are Hard-Film Corrosion Preventive and Gun Slushing Compound, Grade B.

Whip antennas usually can be inspected without being lowered. Look for rust spots, loose mounting bolts, and loose or frayed connections. As with wire antennas, check all insulators for chips, cracks, and cleanliness.

Most whip antennas are hollow and may collect moisture inside, depending upon how they are mounted. This condition does not affect their efficiency, but it does contribute to their physical deterioration. To prevent whip antennas filling with water, drill a small drainage hole near their bases.

Maintenance of VHF and UHF antennas is complicated by their inaccessibility. Often it is necessary to climb masts or stacks to inspect them properly for damage. For this reason, they sometimes are neglected until a major casualty occurs. These antennas are as susceptible to rust, loose mountings, and broken connections as are other antennas, and therefore must be inspected regularly.

Technical manuals for the various types of VHF/UHF antennas are available, and should be utilized when checking and maintaining these antennas.

## RESISTANCE TESTS

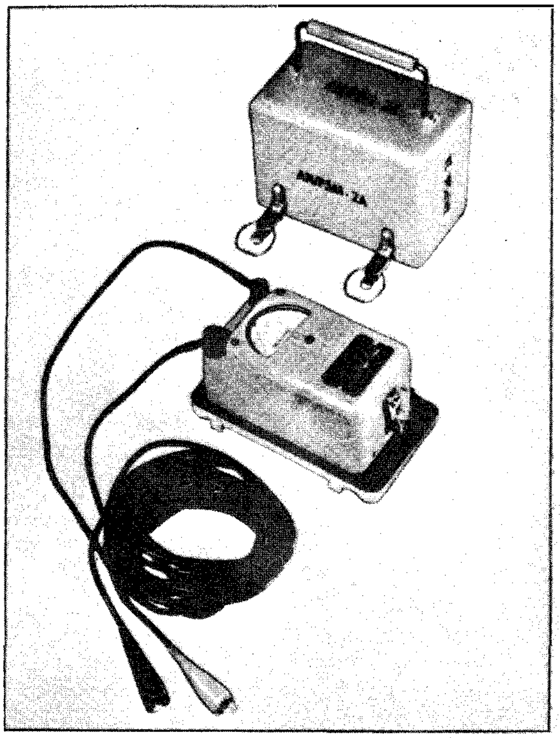
The most common fault in an antenna system is low resistance to ground. Moisture in trunks or coaxial lines, dirty insulators, and breakdown of insulation all cause varying degrees of shunting resistance. These faults must be guarded against if maximum efficiency is to be obtained from antennas.

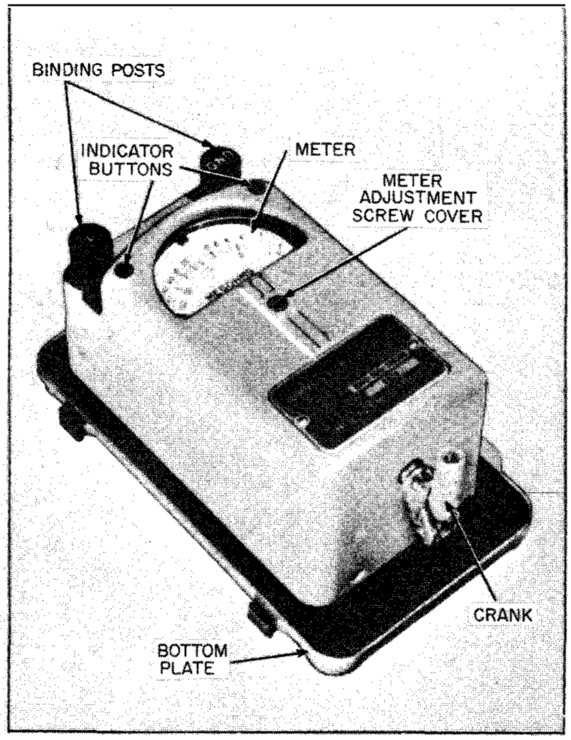
The megger is the test equipment commonly used for testing an antenna system. Essentially, the megger (fig. 14-12) is a combination hand-driven d-c generator and ohmmeter. The ohmmeter measures the amount of resistance through which the generated current flows. The output of the megger should be approximately 500 volts. This voltage is sufficient to break down and reveal any weak spots that may exist in the insulation. Chapter 12 of Basic Electricity (NavPers 10086) explains the megger in detail.

Before testing an antenna, it should be inspected for intentional d-c shorts such as those in receiver protective devices. These protective devices, found in most general-purpose receiving antennas, usually consist of a fixed resistor of about 1/2 megohm connected from line to ground. This resistor protects the receiver by draining off any accumulated static charges on the antenna. To prevent obtaining a constant and misleading resistance reading, the resistor must be disconnected before testing the antenna and transmission line. After protective devices are disconnected from the antenna, proceed as follows:

1. Connect the ground lead of the megger to the hull of the ship (or other suitable ground).

2. Disconnect the transmission line at the equipment, and connect the high side (line connection) of the megger to the inner conductor of the transmission line. (Do






1.55

Figure 14-12. —The megger.

not connect the megger to the equipment at any time.)

3. Crank the handle of the megger until a steady reading is indicated on the ohmmeter. (Don't hesitate to crank the megger. It is equipped with friction clutches that slip when the rated output is exceeded.)
4. Record the resistance reading on the antenna's resistance test record card.

Theoretically, an antenna and its transmission lines should read infinity on the megger, but it is impossible to obtain such a reading at all times. Low readings often result from abrupt changes in the weather, high humidity, or other natural causes. Any antenna indicating under 100 megohms to ground for several successive daily readings should be investigated. Insulation resistance may be raised in many instances by cleaning the insulators and couplings.

For insulation resistance, the following values are suggested:

1. A resistance of 200 megohms or more to ground indicates an antenna in good condition.
2. A resistance of from 5 to 100 megohms to ground indicates the need for cleaning the insulators.
3. A resistance of less than 5 megohms to ground indicates an excessive leak in the system. Immediate steps must be taken to locate the leak and restore the antenna system to its original condition.

The preceding values do not apply to VHF and UHF antenna systems that normally are short circuits to d-c voltages.

## CLEANING INSULATORS

Antenna insulators have a glazed surface to which foreign material does not adhere readily. The glazed surface tends to wash clean during rainstorms. Although helpful, an occasional rain cannot be depended on to keep insulators free of salt spray, soot, and dirt. For this reason, antenna insulators should be cleaned at least once a month, and more often when conditions warrant—as after a prolonged period at sea.

Cleaning insulators is a simple process. Use a sharp knife and a small amount of paint thinner to remove any that may be on the insulators. Wash them with soap and water, and follow with several rinsings with clean, fresh water. Insulators then should be polished with a dry, soft cloth to restore their glaze.

Although the cleaning is a simple process, the importance of doing a thorough job cannot be overstressed. Only one dirty insulator is needed to render an antenna useless.

## PAINTING ANTENNAS

The main purpose of painting antennas and antenna hardware is to protect them against corrosion. If the paint is permitted to deteriorate, then its purpose is defeated and rust soon takes over. Usually, an occasional touch-up job is all that is necessary to keep rust from getting the upper hand.

Isolated rust spots should be treated as follows: (1) wire-brush the spots to remove all rust and loose paint; (2) wipe the surrounding surfaces clean of all soot, salt, and dirt; (3) apply one coat of wash primer pretreatment (formula 117) to the bare metal surfaces; (4) apply one coat of zinc-chromate primer (formula 84) over pretreatment paint; and (5) cover the preceding coats with not less than two coats of outside haze-gray No. 27 (formula 5H).

The foregoing procedure applies also when the extend of damage warrants complete repainting. When only the finish coat is damaged, and there is no sign of corrosion, a thorough cleaning and application of one or two coats of the outside haze-gray paint is sufficient to repair the damage.

Never paint an antenna with a metallic paint. Paint containing metallic flakes attenuates (weakens) electromagnetic energy. Along the same line of thought, never paint, varnish, shellac, or grease any insulating material forming a part of an antenna system—especially insulators. As pointed out previously, metallic paint provides a path for current flow across the insulating material, or attracts foreign substances.

## TROUBLESHOOTING ELECTRONIC EQUIPMENT

Any troubleshooting job on electronic equipment that RMs are required to do should be performed in the following order:

1. Analyze the trouble.
2. Detect and isolate the fault.
3. Correct the fault and test repair work.

In troubleshooting, as in most other matters, there is no substitute for commonsense. A mistake made by most beginners is to remove units from the equipment unnecessarily. The first procedure is to determine if the equipment in question is actually faulty. Very often a preliminary check of the system discloses a faulty remote control box, frayed or broken wiring, and, in some instances, improper operating procedure—especially with new equipment. Occasionally, absence of power to the unit is discovered to be the cause of the trouble.

If there actually is an absence of power, assume temporarily that the set may be all right, and start checking the power source. The first and most important step is to check the condition of fuses and circuit breakers. If a circuit breaker is tripped or a fuse is blown, power should be turned off immediately, because this condition indicates a circuit malfunction, and power should not be reapplied until the malfunction is corrected. If a short, ground, or overload condition is not indicated, continue to take power readings at the circuit checkpoints. The most common faults that interrupt power through a circuit are broken wiring, loose terminal or plug connections, faulty relays, and faulty switches. Be alert for these conditions when checking the successive points along a circuit.

Frequently, headsets or microphones are faulty. Their operation is sometimes intermittent. Before beginning any wholesale removal of components, always make sure that the equipment in question actually is faulty.

Equipment technical manual: Two copies of the equipment technical manual are supplied with each new equipment. The technical manual contains the usual front matter (table of contents, for example, an index, and 6 sections entitled: (1) General information, (2) Installation, (3) Operation, (4) Troubleshooting, (5) Maintenance, and (6) Parts list.

Section 3—Operation—is the section of most concern to Radiomen. It describes equipment controls, tuning adjustments, and operating procedures. Always study this section before attempting to tune or operate any unfamiliar equipment. It also is a good idea to read section 1, which contains a general description of the equipment and its capabilities.

## VISUAL INSPECTION

In any process of troubleshooting, the visible condition of a unit is usually the first detail to check. If certain parts obviously are not in proper condition, correct these faults before going any further in making tests. Such conditions include parts burned, loose from mounting, disconnected, dented, or any other obviously improper condition.

One's nose can be a good pinpointing device for certain troubles. A part that overheats for example, usually gives off an odor that is readily detectable, and sometimes can be located by the combined use of eyes and nose only. Location of a burned part does not necessarily reveal the cause of trouble, however. In determining the cause of trouble, it usually is necessary to refer to equipment technical manuals. These manuals should be available for constant reference when performing maintenance on electronic equipment.

The technical manual for a particular piece of equipment contains a detailed explanation of the theory of operation of each circuit in the unit. Also it has innumerable block diagrams, wiring diagrams, and schematic drawings of each circuit. It gives the location of test points and the readings that should be found on them. Additionally, it shows what voltage, resistance, and (sometimes) what waveshapes appear on each pin of every vacuum tube. The technical manual also contains directions for troubleshooting.

## SIGNAL TRACING

The following procedure is recommended for tracing signals in communication receivers and audioamplifiers. This general procedure, with modifications, can be applied to most electronic troubleshooting. Signal tracing is a highly effective method for locating defective stages in many types of electronic equipment. It is especially useful when servicing communication receivers, audioamplifiers, and other equipments that normally contain no built-in meters. In signal tracing, a signal voltage similar to that present under operating conditions is taken from a signal generator and then is applied to the input of the equipment in question. Signals resulting from this application then are checked at various stages, starting at the output with test instruments such as voltmeters, oscilloscopes, output meters, or other appropriate devices, and working back toward the input until the correct signal is detected.

By signal tracing methods, the gain or loss of amplifiers can be measured. In the same way the points of origin of distortion and hum, noise, oscillation, or any abnormal effect can be localized.

Gain measurement can be used as an example of an important method in signal tracing. By this procedure, a defective stage can be found quickly in a radio receiver or audio-amplifier. A signal generator (with the output attenuator calibrated in microvolts) and an output meter are used. It is helpful to have data concerning the normal gain of the various stages of the device. These data are found in the equipment technical manual for the receiver under test.

The output meter may be connected across the voice coil of the speaker or across the primary of the output transformer. The output of the signal generator is applied to the grid circuit of the stage under test. Then the attenuator of the signal generator is adjusted until the output meter reads an appropriate value that will serve as a reference figure. The output of the signal generator then is applied to the output of the stage under test (or to the grid of the next stage), and the attenuator is adjusted until the same reference value is again registered on the output meter. The gain of the stage is found by dividing the second value of the signal (taken from the calibrated attenuator) by the value of the signal applied to the input of the stage.

Assume that the signal generator applies a voltage of 400 $\mu$v to the grid of an i-f amplifier. This voltage causes the output meter to indicate some value to be used as a reference. When the generator signal is applied to the following grid, the signal strength must be increased to 4000 $\mu$v to cause the output meter to indicate the same reference value. The gain of the stage is $4000 \div 400$, or 10.

If similar measurements made in the remaining stages of the receiver reveal one in which gain is lower than normal, or is zero, that stage can be thoroughly checked by voltage measurement, by resistance measurement, or by simple replacement of parts until the defective one is found.

When making stage gain measurements in receivers, the value of applied signals must be low enough to prevent the automatic volume control system from functioning; otherwise, measurements are inaccurate. In equipment technical manuals, recommended signal values usually are stated in terms of the reference value to be used at the output meter.

## VOLTAGE CHECKS

Voltage measurements are made at various points in the stage suspected of being at fault, and observed voltage values then are compared with normal voltage values given in the equipment technical manual. From this comparison, a defect often can be isolated. Voltage checks are most effective when applied within a single stage, and after previous checks are made to localize the defect partially.

Some electronic equipments have built-in meters or plugs for front panel application of meters. These meters usually work in conjunction with a selector switch, and read values of voltage or current at designated points. A defective stage very often can be isolated in this manner.

When a defective stage is isolated, it becomes a matter of point-to-point checking to isolate the fault within the stage itself. A voltmeter pinpoints the trouble, but it often becomes necessary to use an ohmmeter to determine the exact cause of trouble, such as shorted capacitors, open resistors or transformers, or wires grounded to chassis.

## RESISTANCE CHECKS

The method of making resistance checks is similar to voltage checking except that power is removed from the set and resistance values are measured with an ohmmeter. Resistance values then are compared with normal values given in the technical manual. This method, like voltage measurement, is used most effectively after the trouble is isolated to a particular stage, because reliance on resistance measurement alone is too time-consuming to be efficient. After the trouble is isolated, the ohmmeter is a useful instrument and often quickly leads the troubleshooter to the cause of trouble.

A typical example of a routine resistance check applied to a single part is the ohmmeter method of checking electrolytic capacitors. A resistance measurement is made on the discharged capacitor, using the high-resistance range of the ohmmeter. When the ohmmeter leads are first applied across the capacitor, the meter pointer rises quickly and they drops back to indicate a high resistance. Then the test leads are reversed and reapplied. The meter pointer should rise again-even higher than before—and again drop to a high value of resistance. The deflections of the meter are caused when the capacitor is charged by the battery of the ohmmeter. When the leads are reversed, the voltage in the capacitor adds to the applied voltage, resulting in a greater deflection than at first.

If the capacitor is open-circuited, no deflection is noted. If the capacitor is short-circuited, the ohmmeter indicates zero ohms. Resistance values registered in the normal electrolytic capacitor result from leakage present between the electrodes Because the electrolytic capacitor is a polarized device, resistance is greater in one direction than the other.

Should a capacitor indicate a short circuit, one end of it must be disconnected from the circuit, then another resistance reading is made to determine if the capacitor actually is at fault.

Unless an ohmmeter has a very high resistance scale, a deflection of the meter will not be seen when checking small capacitors. Even a scale of R x 10,000 is insufficient for very small ones; the smaller the capacity the less leakage across the plates, therefore more resistance.

When making resistance checks, be sure to determine what circuits are connected to the points where checks are made. The equipment technical manual indicates what resistance should be found at various checkpoints throughout the set, and contains a complete schematic diagram of the set as well as a circuit schematic of the stage under test. The schematics may set up conditions under which voltage and resistance measurements are to be made, such as positions of switches and control knobs, relays energized or deenergized, tube in socket, and so forth. These conditions duplicate the conditions under which measurements first were made. A typical condition might be: "Power switch off—all controls fully CCW (counterclockwise)." It is important to follow these instructions to obtain accurate values to compare with specified values. Otherwise, incorrect values may be obtained.

## SOLDERING

New designs and new techniques in the manufacture of electronic equipment require revision of some of the old manufacturing standards. Among the new techniques are methods of soldering special parts, such as transistors and crystal diodes. Unless a heat shunt is used, these semiconductors cannot safely withstand the heat that even the pencil-type soldering irons must produce to melt the solder that connects them in a circuit.

Another change that new design dictates is the method of soldering wires or parts to terminal posts or connectors. The discussion that follows sets forth the recommended soldering procedures developed by the Navy Electronics Laboratory.

### SOLDERING SEMICONDUCTORS

Much new circuit design is based on the use of semiconductors. Although some devices operate safely at high temperatures, the majority of transistors and crystal diodes are particularly sensitive to temperature.

For the most part, transistors are mounted in sockets. They should be removed from their sockets before any soldering of socket terminals takes place. Some transistors and most crystal diodes in printed circuits are soldered directly in place. In these instances, it is best to use a heat shunt clipped on the lead being soldered, between the joint and the transistor, diode, or resistor, to dissipate the excess heat. Pointed nose pliers can be used for the heat shunt. Better still are surgical hemostats, which can be clamped in place, eliminating the need for continuous holding by hand. (Hemostats may be obtained from the sickbay or hospital when they no longer are usable for surgical purposes. They will prove an invaluable addition to one's toolbox.)

### STRENGTH OF SOLDERED CONNECTIONS

The Navy Electronics Laboratory tested many standard capacitors and resistors soldered to terminals of various types. These devices were subjected to vibrations far in excess of those encountered in military ships, aircraft, and armored vehicles. Although the connections deliberately were made with no wrapping of wires around terminals, but instead with reliance for support placed in the soldered joint, there were no failures. Similar tests, with equally encouraging results, were made by a number of commercial electronic firms.

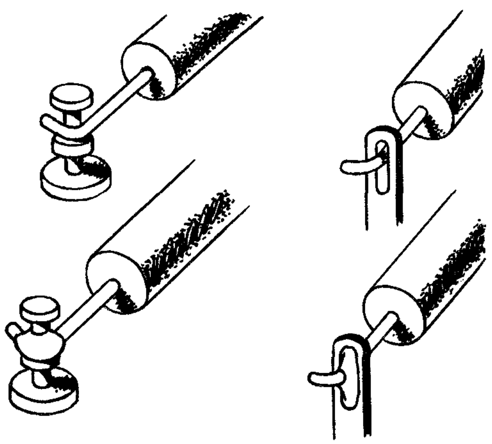
Advantages to be gained from using connections that depend on solder for strength are ease of assembly; ease of removal for test or replacement; less chance of poor soldering (lack of solder in joints or rosin joints), because faulty soldering is detected more readily by visual or electrical inspection methods than when wire is wrapped before soldering; less heat required in soldering and unsoldering; and less strain on parts because their leads do not sustain as much pulling and twisting as with the conventional wrapping technique.

Recommendations have been made to revise Federal specifications to require that small parts be connected with no more than one-half turn of wire around the terminal, followed by a simple and neat soldering job. (See fig. 14-13.)

## TEMPERATURE OF SOLDERING IRONS

All high-quality irons operate in the temperature range of 500° to 600° F. Even the little 25-watt midget irons produce this temperature. The important difference in iron sizes is not temperature, but the capacity of the iron to generate and maintain a satisfactory soldering temperature while giving up heat to the joint to be soldered. Naturally one would not try to solder a heavy metal box with the 25-watt iron. But that iron would be quite suitable for replacing a small resistor in a printed circuit. A 150-watt iron is satisfactory for use on a printed circuit, provided proper soldering techniques are used. One advantage of using a small iron for small work is that it is lightweight and easy to handle and has a small tip that is inserted easily into close places. Even though its temperature is high, it does not have the capacity to transfer large quantities of heat.

One type of iron is equipped with several different tips that range in size from 1/4 inch



76.29

Figure 14-13. —Soldering method recommended by Navy Electronics Laboratory.

to 1/2 inch diameter and are of various shapes. This feature makes it adaptable to a variety of jobs. Unlike most tips that are held in place by setscrews, these tips are threaded and screw into the barrel. This feature provides excellent contact with the heating element, thus improving heat transfer efficiency. A pad of antifreeze compound is supplied with each iron. This compound is applied to the threads each time a tip is installed in the iron, thereby enabling the tip to be removed easily when another is to be inserted.

A special feature of this iron is the soldering pot that screws in like a tip and holds about a thimbleful of solder. It is useful for tinning the ends of large numbers of wires.

## SOLDERING GUN

Because it heats fast and cools fast, the soldering gun has gained great popularity in recent years. It is especially well adapted to maintenance and troubleshooting work where only a small part of a repairman's time is spent actually soldering. A continuously hot iron oxidizes rapidly and is difficult to keep clean.

A transformer in the gun supplies about 1 volt at high current to a loop of copper that serves as the tip. It heats to soldering temperature in 3 to 5 seconds, but heats to as as 1000° F if left on longer than 30 seconds. Because it operates for relatively short periods of time, very little oxidation is allowed to form. Thus, it is one of the easiest soldering tools to keep well tinned. A disadvantage is that this tip is made of pure copper with no plating, so pitting can occur easily as a result of the dissolving action of the solder. Offsetting this disadvantage, however, is the low cost of replacement tips—about 13 cents.

If delicate wires or printed circuits are to be soldered with a gun, remember that overheating can occur easily. With practice, heat can be controlled accurately by pulsing the gun on and off with its trigger switch. For most jobs, even the low position of the trigger overheats the tip after 10 seconds. The high position is only for fast heating and for soldering to especially large terminals.

## REPAIRING PRINTED CIRCUITS

Printed circuits are appearing more and more in electronic equipment. They have proved equal in operation to conventional-type construction, with savings in space and weight as well as economy of manufacture. A few simple machine operations automatically produce circuits that formerly required a production line of workers performing the same jobs by hand.

Even printed components or parts are no longer unusual, the most common being resistors and capacitors. Printed components have not yet gained wide or extensive use, hence this discussion is confined to printed circuits and methods of repairing them.

One method of manufacturing a printed circuit is the photoetching process. A plastic or phenolic sheet with a thin layer of copper coating is used. The copper coating is covered with a light-sensitive enamel, and a template of the circuit that ultimately will appear on the plastic sheet is placed over it. The entire sheet is then exposed to light. The area of the copper that is exposed reacts to the light. This area then is removed by an etching process. Exposure of the printed circuit is similar to a photographic exposure. Enamel on the unexposed circuit protects the unexposed copper from the etching bath that removes the exposed copper. After the etching bath, the enamel is removed from the printed circuit. This operation leaves the surfaces in a condition for soldering parts and connections.

Some manufacturers use machinery to mount standard parts like capacitors, resistors, and tube sockets, further speeding manufacture. Circuits thus produced operate as well as conventional circuits are repaired easily.

Should a printed circuit become broken, it is repaired easily by placing a short length of bare wire across the break and soldering both ends to the print. If the break is small, simply flow solder across it. When performing these operations, do not apply too much heat, and do not permit solder to flow to other printed areas. The soldering gun, if used, properly, is an excellent device for making these repairs because it affords constant and instantaneous control of the heat of the tip. If a conventional soldering iron must be used (one larger than a "pencil" iron), it is advisable to wrap a length of heavy copper wire around the tip of the iron and let one end of the wire extend as the soldering tip. This procedure reduces the size of the tip, and therefore the heat transfer.

Many maintenance men think that printed circuits are very delicate and cannot be heated without danger of burning the baseboard or causing the conducting strips to separate. This attitude stems from lack of experience in soldering printed circuits. It is true that both of these conditions can happen, but with a little care and commonsense, satisfactory repairs can be made to any printed circuit. In most instances, repairs can be made as easily as in conventional assemblies.

The phenolic boards used for printed circuits are similar to the phenolic strips for conventional terminal strips and mounting boards. There has been no difficulty in soldering to the metal connectors on these terminal strips and mounting boards, so there should be none in soldering printed circuits. In rare instances, where excessive heat causes separation of printed conductors from the phenolic board, repairs can be made by using jumper wires.

Parts such as resistors and small capacitors are removed most conveniently if first cut free of their leads. Much less heat is required to remove a part if the leads are free. Where it is inconvenient to remove a board for access to the wiring side, it usually is possible to cut the leads of small resistors and capacitors so that a small portion of the lead is exposed. The new part then can be soldered to the old leads. Care must be taken to prevent cold solder joints.

Should it become necessary to remove a tube socket or any other part that required simultaneous movement of several soldered connections, the following procedure should be observed.

1. Remove all excess solder from each connection with a soldering iron or soldering gun.
2. While heating a connection, use a scribe or other pointed instrument to scrape away remaining solder. (CAUTION: Do not "rock" or pry the part to loosen solder. "Rocking" can damage the printed circuit.)
3. When all connections are free, simply lift the part from the board.

When a part is removed from a printed circuit board, the holes left in the board should be cleaned of excess solder before the new part is installed. A small fiber glass brush is useful for brushing away excess solder while it still is soft.

A metal probe, slotted at one end and pointed at the other, is useful in manipulating wires and lugs on parts to be removed from printed wiring boards. These devices, known as soldering aids, are made of chrome plated steel to which solder does not adhere readily. They are also quite useful for handling wires to be soldered in conventional circuits.

Some printed circuit boards are coated with lacquer that must be removed before repairs can be made. Acetone or lacquer thinners are satisfactory solvents. New lacquer should be painted on the board after repairs are completed.

## CLEANING ELECTRONIC EQUIPMENT

All electronic equipment should be cleaned, not just for appearance, but to assure good performance. Before starting any kind of cleaning, be sure to secure power to equipment. The safest and best method of cleaning inside transmitters and receivers is to use a vacuum cleaner with a nonmetallic hose. A small typewriter brush is handy for getting dust out of congested areas where the vacuum cleaner will not reach. A hand bellows can be used for blowing out dust particles, but is not as satisfactory as the vacuum cleaner because of the likelihood of blowing dust into inaccessible spaces where it is harder to remove.

During routine transmitter cleaning periods, the contacts of rotating inductors should be checked, as well as the surface of these parts. Poor operation of contacts is disclosed sometimes by erratic "jumping" of the plate current meters as the circuit is tuned through resonance. Both the contacts and the surface of the inductors must be clean and smooth. A tiny amount of vaseline may be applied if necessary to prevent scoring the copper surface.

Steel wool or emery in any form must not be used on electronic equipment. Sandpaper and files may be used only on competent advice, or not at all.

Uses of solvents and their necessary safety precautions were discussed in chapter 13.

## MAINTAINING AIR FILTERS

The cleaning of air filters is exceedingly important for the proper operation of electronic equipment. For some reason (perhaps their importance is not fully recognized), air filters often are neglected or disregarded until excessive heating causes a breakdown of the equipment.

Forced air cooling is used in most modern transmitters and receivers. This type of cooling system moves a large volume of air over the hot portions of the equipment. The air is filtered to keep dust and other foreign particles out of the equipment. If the filters are efficient, they remove most of this foreign material from the air that passes through them. Dust and dirt tend to clog the filter and prevent the air from moving through. The result is that the equipment becomes overheated and may be ruined.

An analysis of the failures of parts in electronic equipment indicates that the majority of failures can be traced to excessive heat caused by dirty air filters. On the basis of this condition alone, it is readily apparent that the maintenance man can reduce his workload substantially by ensuring that air filters are serviced properly.

## TYPEWRITERS

A typewriter that is treated with care will give many years of service. Typewriter manufacturers claim that a modern typewriter never really wears out if it is not dropped or otherwise abused. The fact is that with ordinary careful use, and with regular cleaning and adjustment, typewriters can be counted on for about 10 years of satisfactory service.

A typewriter should be brushed out by the operator at the end of each day. Type should be cleaned often with one of the various cleaners available for the purpose. Nothing looks worse than messages written up for delivery with the letters o and e filled up because dirt in the characters is printing through the ribbon. Any commercial type cleaner procured by the Navy is satisfactory.

Eraser waste must be cleaned away often if the typewriter is to stay in good condition. It can be removed with a long-handled brush. The best way to prevent accumulation of rubber crumbs is to move the carriage far enough to left or right that the point of erasure is not over keys or other mechanical parts of the typewriter. Erasure waste then will drop on the typist desk from where it can be brushed away.

Typewriter cylinder and rollers should be cleaned occasionally with alcohol. This treatment prevents their leaving streaks of dirt on paper inserted in the typewriter. In this connection, it is best to use only one typewriter in the office for cutting and correcting stencils; otherwise the rollers of all typewriters will become coated with wax from the stencils.

A typewriter should be oiled occasionally, but it must be done carefully. Apply oil only at friction points, and don't use too much. When finished, wipe away excess oil; otherwise, it will drip on other parts and in time form a gummy mass with dust and eraser crumbs. Keep oil from falling on rubber parts, the ribbon, and any place in the machine where it might stain the paper.

Keep typewriter covered when not in use. No matter how clean an office, a certain amount of dust is always in the air. When a typewriter is uncovered for long periods, dirt gets into the moving parts of the machine and causes wear.

## FREQUENCY MEASUREMENTS

It is extremely important to keep Navy transmitters on their assigned frequencies. To aid RMs in keeping transmitters within the frequency tolerances, the Navy provides each ship and station with accurate frequency meters. A frequency meter is of little value though unless it is calibrated accurately against the primary frequency standard.

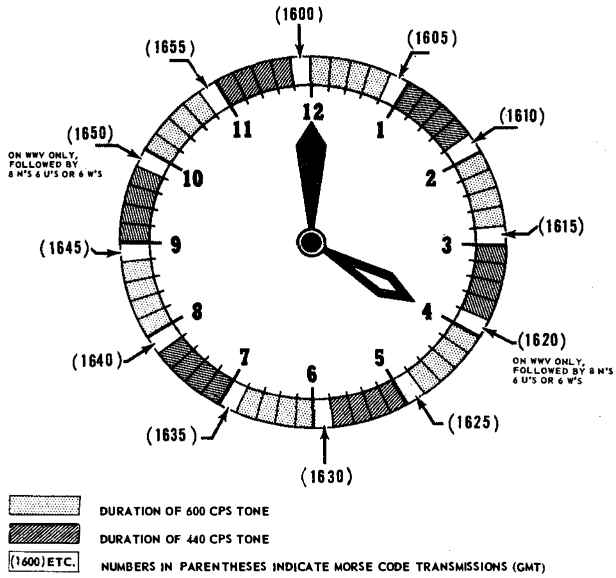
The primary frequency standard is supplied by the National Bureau of Standards through its radio stations WWV at Boulder, Colorado, and WWVH on the island of Maui, Hawaii.

Provisions of DNC 5 require that frequency meters be checked against radio stations WWV or WWVH at least once weekly. A log must be kept of checks conducted. Radiomen must consult the equipment technical manual for a particular model frequency meter for instructions on adjusting the frequency to coincide with the primary standard. Figure 14-14 shows the structure of WWV and WWVH signals.

## RADIO STATION WWV

Technical radio services broadcast by radio station WWV include—

1. Standard radiofrequencies. Six frequencies. Six frequencies are broadcast continuously, day and night—2. 5, 5, 10, 15, 20, and 25 mc.
2. Time announcements.
3. Standard time intervals.




76. 40

Figure 14-14. —Structure of WWV and WWVH signals.

4. Two standard audiofrequencies, 440 and 600 cycles per second, alternated each 5 minutes.
5. Radio propagation disturbance warning notices for the North Atlantic area.

### Standard Radiofrequencies

Any desired radiofrequency may be measured accurately in terms of standard frequencies, which are accurate to better than 1 part in 100, 000, 000 cycles. Any of the 6 radiofrequencies can be used for checking frequency meters being used.

### Time Announcements and Standard Time Intervals

When radio station WWV is tuned in, the audiofrequency of 440 or 600 cycles is heard as a steady tone. A series of clocklike ticks is superimposed on the tone. Time and intervals of time to the finest degree can be determined through (1) regular interruptions of the ticking, and (3) Morse code and voice time announcements.

The audiofrequencies are interrupted at exactly 2 minutes before the hour and resumed exactly; on the hour and each 5 minutes thereafter. Each 5-minute period therefore consists of 3 minutes of tone and 2 minutes of no tone around the clock. One can see that, by listening, an operator is given exact time intervals of 2 minutes, 3 minutes, and 5 minutes.

The time in GMT is broadcast in telegraphic code each 5 minutes, and is followed by a voice announcement of the eastern standard time. These transmissions are made near the end of the 2-minute period when the audiofrequency is off, and refer to the time it will be when the audiofrequency, or tone, returns. For example, just before 1655 Z, or 11:55 a.m. eastern standard time, a listener will hear 1655 in Morse code followed by a voice: "This is radio station WWV; when the tone returns it will be 11:55 a.m. eastern standard time; 11:55 a.m." If an RM were correcting the message center clock, he would preset hour, minute, and second hands to exactly 1655 while the announcements were going on, and would start the clock the instant the tone resumed.

The ticking is a pulse on the carrier frequency of 0.005-second duration, which occurs at intervals of precisely 1 second. "Time ticks" are used by Quartermasters in determining the rate of gain (or loss) of a ship's chronometers. A Radioman's duties in this regard are limited to tuning the receiver and making switchboard connections that pipe the sound to earphones in the charthouse.

### Standard Audiofrequencies

The two standard audiofrequencies of 440 and 600 cycles per second are of no particular interest to a Radioman. Other users of the technical broadcast services find them useful for accurate measurement or calibration of instruments operating in the audio or supersonic regions of the frequency spectrum.

### Radio Propagation Disturbance Warnings

Radio propagation disturbance warnings are notices that tell users of radio transmission paths over the North Atlantic the condition of the ionosphere at the time of the announcement and also how good or how bad communication conditions are expected to be for the next 12 hours. They are prepared four times daily and are sent at 19.5 and 49.5 minutes past the hour. Report of current conditions is made by letters N, U, or W, signifying normal, unsettled, or disturbed, respectively. A digit is the forecast of expected quality of transmitting conditions on a scale of 1 (impossible) to 9 (excellent), as in the accompanying table.

| Digit (forecast) | Propagation condition | Letter (current) |
|---|---|---|
| 1 | Impossible | W |
| 2 | Very poor | W |
| 3 | Poor | W |
| 4 | Fair to poor | W |
| 5 | Fair | U |
| 6 | Fair to good | N |
| 7 | Good | N |
| 8 | Very good | N |
| 9 | Excellent | N |

If propagation conditions at time of forecast are normal for example, but are expected to be only "fair to poor" within the next 12 hours, the forecast notice would be broadcast as N4 in Morse code, sent five times: N4 N4 N4 N4 N4.

## RADIO STATION WWVH

Station WWVH, on the island of Maui, Hawaii, is WWVs sister station serving the Pacific. Station WWVH broadcasts on three radiofrequencies—5, 10, and 15 mc. Reports indicate that station WWVH may be usefully received at many locations not served by station WWV and that simultaneous reception of WWV and WWVH does not interfere with ordinary use of standard frequencies and time signals. Except for propagation warnings, services are the same as those offered by WWV, but schedules are somewhat different. Further information about both stations may be found in Radio Navigational Aids, H.O. Pubs. 117A and 117B.

## OTHER STATIONS

Many Navy radio stations rebroadcast the signals of WWV. Moreover, radio stations in several other countries broadcast signals comparable to signals broadcast by WWV and WWVH. The system employed by the foreign stations may differ somewhat from that of the United States. Usually, however, time signals can be obtained from them without too much difficulty.

A complete list of all stations broadcasting time signals, the time of broadcasting, and the system employed by each station are contained in H.O. Pubs. 117A and 117B.

# INDEX

☆ U. S. GOVERNMENT PRINTING OFFICE : 1967 301-441/6