# RADIOMAN 3 & 2

BUREAU OF NAVAL PERSONNEL

NAVY TRAINING COURSE NAVPERS 10228-D

# 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 and equipment evolve. This training course will be revised from time to time; between revisions, some obsolescene 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 and 2 was prepared by the U.S. Navy Training Publications Center, Washington, D. C., for the Bureau of Naval Personnel, and was reviewed by the Office of the Assistant Chief of Naval Operations (Communications)/Director, Naval Communications, 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, 1964

# READING LIST

## NAVY TRAINING COURSES

Standard First Aid, NavPers 10081-A
Mathematics, Vol. 1, NavPers 10069-B
Basic Electricity, NavPers 10086-A, chapters 1 through 13, and appendix V
Basic Electronics, NavPers 10087-A, chapters 1 through 14, 17, and appendix II
Basic Handtools, NavPers 10085-A
Basic Military Requirements, NavPers 10054-A
Military Requirements for Petty Officer 3 & 2, NavPers 10056-A

## OTHER NAVY PUBLICATIONS

ACPs 122, 124, 125, 126, 127 (effective edition)
DNCs 5, 14, 26 (effective edition)
NWP 16(A)
Handbook of Test Methods and Practices, NavShips 91828(A), articles 3-1 through 3-6
Bureau of Ships Technical Manual, chapter 67 (to be redeisgnated chapter 9670)
Department of the Navy Security Manual for Classified Information, OpNav Inst 5510. 1B
U. S. Navy Safety Precautions, OpNav 34P1, chapter 18

## USAFI TEXTS

United States Armed Forces Institute (USAFI) courses for additional reading and study are available through your educational services officer. * A partial list of correspondence courses applicable to the Radioman rating follows.

| Number | Title |
|---|---|
| C 781 | Fundamentals of Electricity |
| C 885 | Fundamentals of Radio |
| A 887 | Intermediate Radio |
| A 788 | Introduction to Electronics I |
| A 789 | Introduction to Electronics II |
| D 331 | Elementary Typewriting I |
| C 150 | Review Arithmetic |
| C 151 | General Mathematics I |
| D 164 | Beginning Algebra I |

* 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.

# CONTENTS

# 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.

# 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 their equipment. Good men are plentiful, but their capability depends chiefly upon their TRAINING.

In the performance of practical work, proficiency comes with practice and experience, for which no book — however helpful — can be an adequate substitute. On the other hand, much of the knowledge you must have can be gained only through study.

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. The remaining chapters deal with the technical aspects of your rating. Chapter 2 describes the organization, purpose, and function of naval communications. Chapter 3 is devoted to the various aspects of communication security. The international Morse code and its application are covered in chapter 4. Chapter 5 deals with the many types and forms of messages, and the contents of the various messages are discussed in detail. The next two chapters are devoted to operating procedure; radiotelegraph is covered in chapter 6, and radiotelephone in chapter 7. In chapter 8 the radio wave is discussed, and its propagation through the atmosphere is explained. Antennas also are covered in chapter 8. Chapter 9 deals with radio communication equipment. Teletypewriter equipment is the subject of chapter 10; teletypewriter operating procedures are given in chapter 11. Chapter 12, entitled "Administration," describes some of the miscellaneous jobs of the Radioman. These include maintaining message files, entering corrections to publications, keeping circuit logs, and the like. The all-important consideration of electrical safety precautions is discussed in chapter 13. Maintenance of communication equipment is taken up in chapter 14.

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.

## THE ENLISTED RATING STRUCTURE

The present enlisted rating structure, established in 1957, includes three types of ratings--general ratings, service ratings, and emergency 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.

EMERGENCY RATINGS generally identify civilian occupational fields. Emergency ratings do not need to be identified as ratings in the peacetime Navy, but their identification is required in time of war.

## THE 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. In addition, Radiomen operate teletypewriters and facsimile equipment.

Afloat, the 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 teletypewriter equipment.

Along with operating his equipments, the Radioman must be prepared to keep them 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 everyday 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 also is a 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 are going to 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 is true not only within your own division but with men in other divisions. Being able to get along is, at times, just as necessary as proficiency in performing your technical skills.

The 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 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 develope these skills is given in the training courses Basic Military Requirements, NavPers 10054-A, and Military Requirements for Petty Officer 3 & 2, NavPers 10056-A. 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 technical 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 rate.
2. Complete the required military and professional training courses.
3. Demonstrate your ability to perform all the PRACTICAL requirements for advancement by completing the Record of Practical Factors, 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 a written examination on (a) military requirements and (b) professional 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 760, (3) a NavPers publication called Training Publications for Advancement in Rating, NavPers 10052, and (4) applicable Navy Training Courses. Figure 1-3 illustrates these materials; 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 Qualifications for Advancement in Rating, NavPers 18068A (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) professional or technical qualifications.

## ACTIVE DUTY ADVANCEMENT REQUIREMENTS

| REQUIREMENTS * | E1 to E2 | E2 to E3 | E3 to E4 | E4 to E5 | E5 to E6 | E6 to E7 | † E7 to E8 | ‡ E8 to E9 |
|---|---|---|---|---|---|---|---|---|
| SERVICE | 4 mos. service—or completion of recruit training. | 6 mos. as E-2. | 6 mos. as E-3. | 12 mos. as E-4. | 24 mos. as E-5. | 36 mos. as E-6. | 48 mos. as E-7. 8 of 11 years total service must be enlisted. Must be permanent appointment. | 24 mos. as E-8. 10 of 13 years total service must be enlisted. |
| SCHOOL | Recruit Training. | | Class A for PR3, DT3, PT3. ǂ AME 3 | | | Class B for AGCA, MUCA, MNCA. | | |
| PRACTICAL FACTORS | Locally prepared check-offs. | Records of Practical Factors, NavPers 760, must be completed for E-3 and all PO advancements. | | | | | | |
| PERFORMANCE TEST | | | Specified ratings must complete applicable performance tests before taking examinations. | | | | | |
| ENLISTED PERFORMANCE EVALUATION | As used by CO when approving advancement. | | Counts toward performance factor credit in advancement multiple. | | | | | |
| EXAMINATIONS | Locally prepared tests. | | Service-wide examinations required for all PO advancements. | | | | Service-wide, selection board, and physical. | |
| NAVY TRAINING COURSE (INCLUDING MILITARY REQUIREMENTS) | | Required for E-3 and all PO advancements unless waived because of school completion, but need not be repeated if identical course has already been completed. See NavPers 10052 (current edition). | | | | | Correspondence courses and recommended reading. See NavPers 10052 (current edition). | |
| AUTHORIZATION | Commanding Officer | | U.S. Naval Examining Center | | | Bureau of Naval Personnel | | |
| | TARS are advanced to fill vacancies and must be approved by CNARESTRA. | | | | | | | |

* All advancements require commanding officer's recommendation.
† 2 years obligated service required.
‡ 3 years obligated service required.
ǂ Effective 1 Jan. 1963.

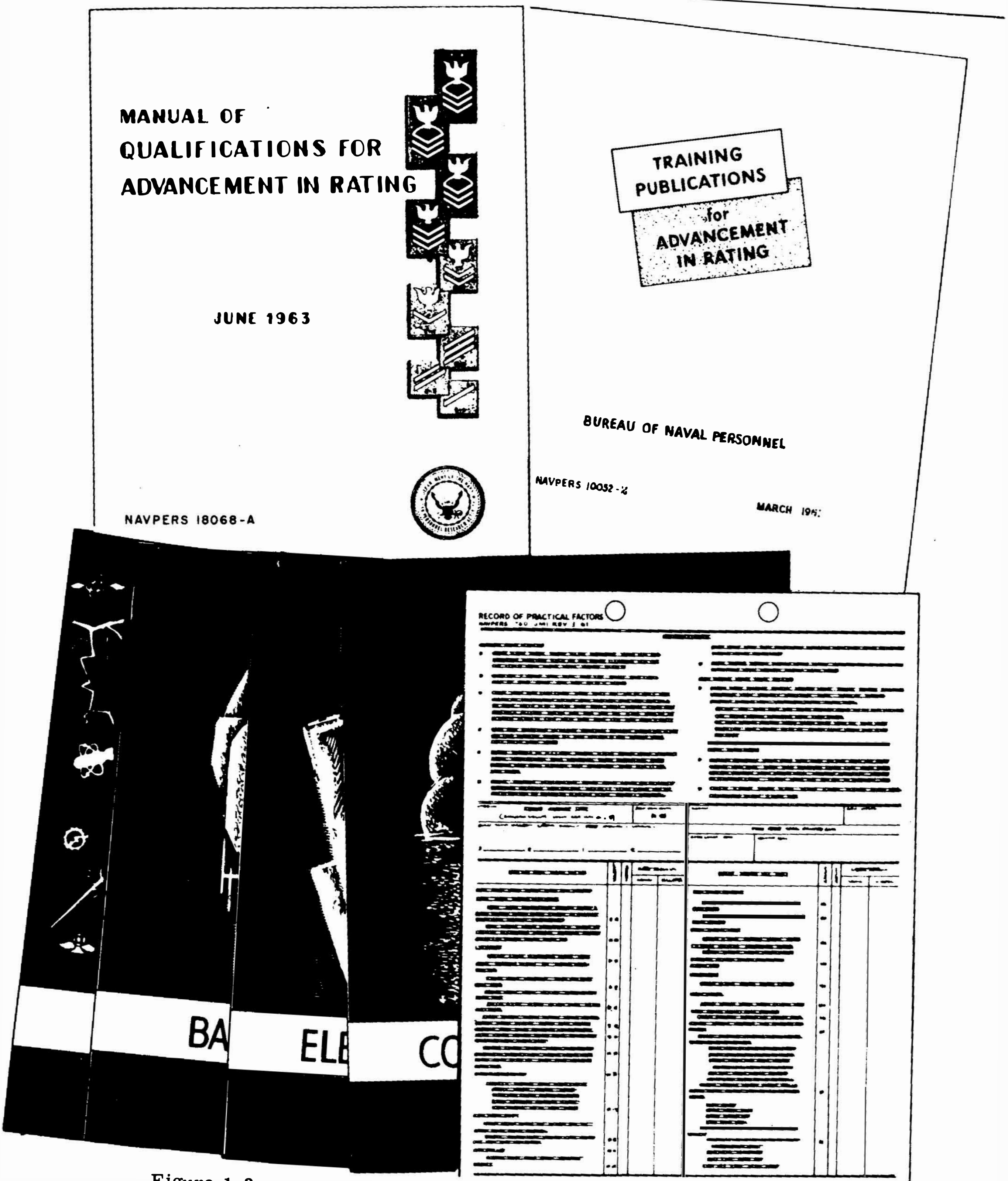
5.1
Figure 1-1. — Active duty advancement requirements.

## 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. | 48 mos. | 24 mos. |
| | 24 | 9 mos. | 9 mos. | 15 mos. | 18 mos. | 24 mos. | 36 mos. | 48 mos. | 24 mos. |
| | NON-DRILLING | 12 mos. | 24 mos. | 24 mos. | 36 mos. | 48 mos. | 48 mos. | | |
| DRILLS ATTENDED IN GRADE † | 48 | 18 | 18 | 45 | 54 | 72 | 108 | 144 | 72 |
| | 24 | 16 | 16 | 27 | 32 | 42 | 64 | 85 | 32 |
| TOTAL TRAINING DUTY IN GRADE † | 48 | 14 days | 14 days | 14 days | 14 days | 28 days | 42 days | 56 days | 28 days |
| | 24 | 14 days | 14 days | 14 days | 14 days | 28 days | 42 days | 56 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. | | | | | |
| PRACTICAL FACTORS (INCLUDING MILITARY REQUIREMENTS) | | Record of Practical Factors, NavPers 760, 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, and Physical. | |
| AUTHORIZATION | | District commandant or CNARESTRA | | | | | Bureau of Naval Personnel | | |

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

5.2
Figure 1-2. — Inactive duty advancement requirements.




5.3

Figure 1-3. —Materials used in preparing for advancement.

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.

PROFESSIONAL QUALIFICATIONS are technical or professional requirements that are directly related to the work of each rating.

Both the military requirements and the professional 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.

The written examination you will take for advancement in rating will contain questions relating to the practical factors and 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.

The Quals Manual is kept current by means of changes. The professional 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 professional qualifications. A special form known as the RECORD OF PRACTICAL FACTORS, NavPers 760, 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 professional. 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 760 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 760 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 as 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 completed 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 school.

Do not overlook the section of NavPers 10052 which lists the required and recommended references relating to the military requirements for advancement. Personnel 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 examinations, 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 professional 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 professional 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

One of the most useful things you can learn about a subject is how to find out more about it. No single publication can give you all the information you need to perform the duties of your rating. You should learn where to look for accurate, authoritative, up-to-date information on all subjects related to the military requirements for advancement and the professional qualifications of your rating.

Some of the publications described here are subject to change or revision from time to time--some at regular intervals, others as the need arises. When using any publication that is subject to change or revision, be sure that you have the latest edition. When using any publication that is kept current by means of changes, be sure you have a copy in which all official changes have been made. Studying canceled or obsolete information will not help you to do your work or to advance in rating; it is likely to be a waste of time, and may even be seriously misleading.

## BASIC NAVY TRAINING COURSES

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.

The contents of some of the basic courses listed in the reading list are summarized in the following paragraphs.

Basic Electricity, NavPers 10086-A, is intended as a basic reference for all enlisted personnel of the Navy whose duties require them to have a knowledge of the fundamentals of electricity. Like the other courses, it starts from the very basics by introducing a broad picture of the electrical characteristics of matter and proceeds with a discussion of static electricity, electricity in motion, and electrical circuits. It explains the uses of Ohm's law and the power equations, and makes applications to actual circuits. Emphasis is placed on the various types of circuits — series, parallel, and series-parallel, and on the theory of induction as applied to electrical motors and other electrical apparatus. The essentials of generators and motors are explained. The closing chapters include a fundamental treatment of transformers, synchro units, and electrical measuring instruments.

Basic Electronics, NavPers 10087-A, is intended as a basic reference for all enlisted men whose duties require that they know the fundamentals of electronics. The RM3, in his preparation for advancement, should be familiar with chapters 1 through 14, 17, and appendix II.

The first few chapters are concerned with electron tubes and transistors, including their application in electronic circuits. Power supplies also are treated in the early chapters. Communication equipment is covered in the chapters entitled "Transmitters," "Transmission Lines," and "Elementary Communication Receivers." One chapter is devoted to electronic test equipment. Appendix II contains the electronic color code and symbols.

Basic Handtools, NavPers 10085-A, presents in a concise form the descriptions of basic handtools and instructions for their use. It also contains information on layout, testing, checking, setting, and cutting. One section is concerned with the care and use of power equipment.

## TRAINING FILMS

Training films available to naval personnel are a valuable source of supplementary information on many technical subjects. A selected list of training films that may be useful to you is given in appendix I of this training course. Other films that may be of interest are listed in the United States Navy Film Catalog, NavPers 10000 (revised).

## SCHOOLS

The Navy has several excellent service schools for rated Radiomen. You should endeavor to attend all of them. Successful completion of these schools will greatly enhance your qualifications and thus your advancement opportunities.

The Teletype Maintenance Schools at Norfolk and San Diego offer excellent courses of instruction in teletypewriter maintenance and repair. Graduates of the Teletype Maintenance Schools are eligible for the Cryptographic Repair Schools at Portsmouth, Va., and Vallejo, Calif.

The Class B Radioman Schools at Bainbridge, Md. and San Diego, Calif. provide, at an advanced level, the knowledges and skills required of Radiomen in fulfilling their shipboard supervisory, operational, and maintenance responsibilities.

# 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.

For instance, 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. This 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 op rational 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 in the past. This increased speed of operation by submarines, surface warships, and aircraft, requires better and faster means of communications. The Navy's communication equipment and methods are changing rapidly and radically to meet this requirement.

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 your duties, you do your part to 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."

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 are out.

## POLICY OF NAVAL COMMUNICATIONS

The policy of naval communications is to —

1. Cooperate with the military services and other departments and agencies of the U. S. Government and Allied Nations.
2. Encourage development of the amateur and commercial communication activities of the U. S. for the enhancement of their military value and for safeguarding the interests of the Nation.
3. Promote the 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 are RELIABILITY, SECURITY, and SPEED.

Reliability of communications is always the first requirement. 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 the conflicting demands of security and speed, or for more convenience. However, there is a variable relationship between security and speed. 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, at least four — radiotelegraph, teletypewriter, radioteletypewriter, and radiotelephone — concern the Radioman as operator. In your message-handling duties afloat and ashore, however, you also will work with traffic sent by other methods. Make sure that you know what they are, as listed here.

1. Electrical communications:
   a. Radiotelegraph;
   b. Teletypewriter (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 a radiowave. In this system an operator separates the radio wave into the dits and dahs of the Morse code by opening and closing a hand key. Radiotelegraph was in use by the Navy as early as 1903, and even today, despite the development of faster and more convenient methods of electronic communications, is one of the most reliable and trustworthy systems used by the Navy.

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."

### Teletypewriter

The mental and manual actions performed by an operator in converting letters to Morse code (and vice versa) are replaced in teletypewriter 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 sequence of signals is transmitted. At receiving stations the signals are fed into receiving machines that type the message automatically.

Teletypewriter signals may be sent either by landline (wire) or by radio. Landline teletypewriter communication is used both by the military services and by commercial communication companies such as Western Union. Radioteletypewriter (RATT) is intended mainly to furnish high-speed automatic communication over ocean areas.

Today the chief shipboard use of RATT is for receiving fleet broadcast schedules, for which it is well suited. Radioteletypewriter can clear traffic at a rate in excess of 100 words per minute, as compared to the 17- to 29-wpm speed of the CW fleet broadcasts. Because the shipboard operator is freed from manual copying, and hundreds of ships may be receiving a single broadcast, 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 operation, radiotelephone is used by ships and aircraft for short-range tactical communication. Its direct transmission of voice makes it possible for a conning officer to have in his hands a means of personal communication with the officer in tactical command (OTC) and with other ships. There is little delay while a message is prepared for transmission, and acknowledgments can be returned instantly. Radiotelephone equipment 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. This limits 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. Transmission 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 what they say.

### Facsimile

Facsimile (FAX) resembles television in that it is a process for transmission of pictures, charts, and other graphic information. It is unlike TV in that (1) facsimile gives the receiving station a permanent record of the transmission, whereas television does not; and (2) facsimile requires several minutes to transmit a picture approximately the size of this page, but television sends a continuous stream of 30 pictures per second.

Facsimile is very useful for transmitting such matter as photographs and weather charts. The image to be sent is scanned by a photoelectric cell, and electrical variations in the cell output, corresponding to the 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 the 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, 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 the operator opens and closes the shutter to form the dots and dashes of the Morse code. Smaller portable lights, in which the source of light is switched on and off to form the code characters, are used also.

Nondirectional flashing light is sent out from lamps located on a yardarm. The operator forms the dots and dashes with a telegraph key that switches the 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, which are not visible unless viewed through a special receiver. Infrared is the most secure means of visual communications, and transmission may be either directional or nondirectional. Directional infrared utilizes the 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 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 generally have the same range limitation as visual methods but are considered less secure.

## ELEMENTS OF NAVAL COMMUNICATIONS

Naval communications is comprised of five major elements:

1. Office of Naval Communications;
2. Naval Security Group;

3. Naval Communication System;
4. Communication departments of activities of the shore establishment;
5. Communication organizations of the 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 the communication coordination and planning for the entire Naval Establishment. The staff of the Director of Naval Communications (DNC) assists him in the execution of his responsibilities. The staff includes two Assistant Directors (one for communications and the other for Naval Security Group matters), six special assistants, and five communication divisions: plans and policy, programs, operations and readiness, administrative and personnel, and radiofrequency spectrum. The work embraces radio and visual communications, landline systems, registered publications, and liaison with the other services and other Government agencies.

## NAVAL SECURITY GROUP

The Naval Security Group, under the direction of CNO (DNC), performs special functions in connection with communication security and communication and electronic intelligence. These operations usually are handled by security group departments of the Naval Communication System, although some may be performed by special teams 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, but 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 the 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.

## NAVAL COMMUNICATION SYSTEM

The Naval Communication System may be described as the backbone of naval communications. It includes all shore-based communication activities and the landlines and radio circuits that bind them into a worldwide network. It provides the means for transmission of CNO directives and instructions; broadcast of weather, general messages, orders, and similar message traffic to the fleet; and for the reception of essential intelligence from fleet commanders.

The Naval Communication System is comprised of three major types of activities. These activities are the NAVCOMMSTA, the NAVRADSTA, and the NAVCOMMU.

### U. S. Naval Communication Station (NAVCOMMSTA)

The NAVCOMMSTA includes all communication facilities and equipment required to provide essential fleet support and fixed communication services for a specific area. The various components of the NAVCOMMSTA are discussed in detail later in this chapter.

### U. S. Naval Radio Station (NAVRADSTA)

A naval radio station 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 the 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 from the NAVCOMMSTA.

### U. S. Naval Communication Unit (NAVCOMMU)

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

## COMMUNICATION DEPARTMENTS OF ACTIVITIES OF THE SHORE ESTABLISHMENT

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 Naval Communication System.

## COMMUNICATION ORGANIZATIONS OF THE OPERATING FORCES

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 STATION

The component activities of the Naval Communication System are located strategically ashore throughout the world to provide complete radio coverage of the major portions of the earth's area. These activities are linked to each other by point-to-point radio and landline circuits. They are linked to the operating forces by broadcasts, ship-shore circuits, and other special circuits.

The largest component in the System is the NAVCOMMSTA, of which the Navy has about 19 in strategic locations over the world.

The principal communication functions and facilities usually provided by NAVCOMMSTAs are —

1. Facilities for fleet support, consisting of —
   - a. Fleet and general broadcasts.
   - b. Ship-shore radiotelegraph, radiotelephone, and radioteletypewriter circuits.
   - c. Point-to-point wire and radio circuits.
   - d. Monitoring of distress frequencies.
   - e. Interconnection with Army, Air Force, Federal Government agencies, and commercial communication systems.
2. Facilities for air operational support, including —
   - a. Air-ground radiotelephone and radiotelegraph circuits.
   - b. Monitoring circuits for navigational aids.
   - c. Weather intercept or reception.
   - d. Radio or wire circuits to air traffic control agencies.
3. Operation and maintenance of teletypewriter tape relay facilities.
4. Radio transmitting and receiving facilities.
5. Facsimile facilities.
6. Visual communication facilities.

In addition, NAVCOMMSTAs provide communication support facilities for the headquarters of naval district commandants, fleet or sea frontier commanders, and the commanders of naval bases, stations, or shipyards. Most NAVCOMMSTAs have facilities for issuing Registered Publication System publications. The specific missions assigned depend upon the role for the particular station in the Naval Communication System.

## COMMUNICATION CENTER

The various operational components of a NAVCOMMSTA are controlled by the communication center. Communication centers are designated as primary, major, minor, and tributary or user message centers.

Five NAVCOMMSTAS are designated as PRIMARY communication centers. They are —

NAVCOMMSTA Washington, D. C.
NAVCOMMSTA San Francisco, Stockton, Calif.
NAVCOMMSTA Honolulu, Hawaii
NAVCOMMSTA Guam, Mariana Islands.
NAVCOMMSTA Port Lyautey, Morocco.

Each primary center maintains fleet broadcasts, which usually have CW, RATT, and FAX components, for sending traffic to ships in their particular ocean areas (fig. 2-1). Ships in the Mediteranean, for example, receive traffic from NAVCOMMSTA Port Lyautey, Morocco. NAVCOMMSTA Washington transmits to ships in the

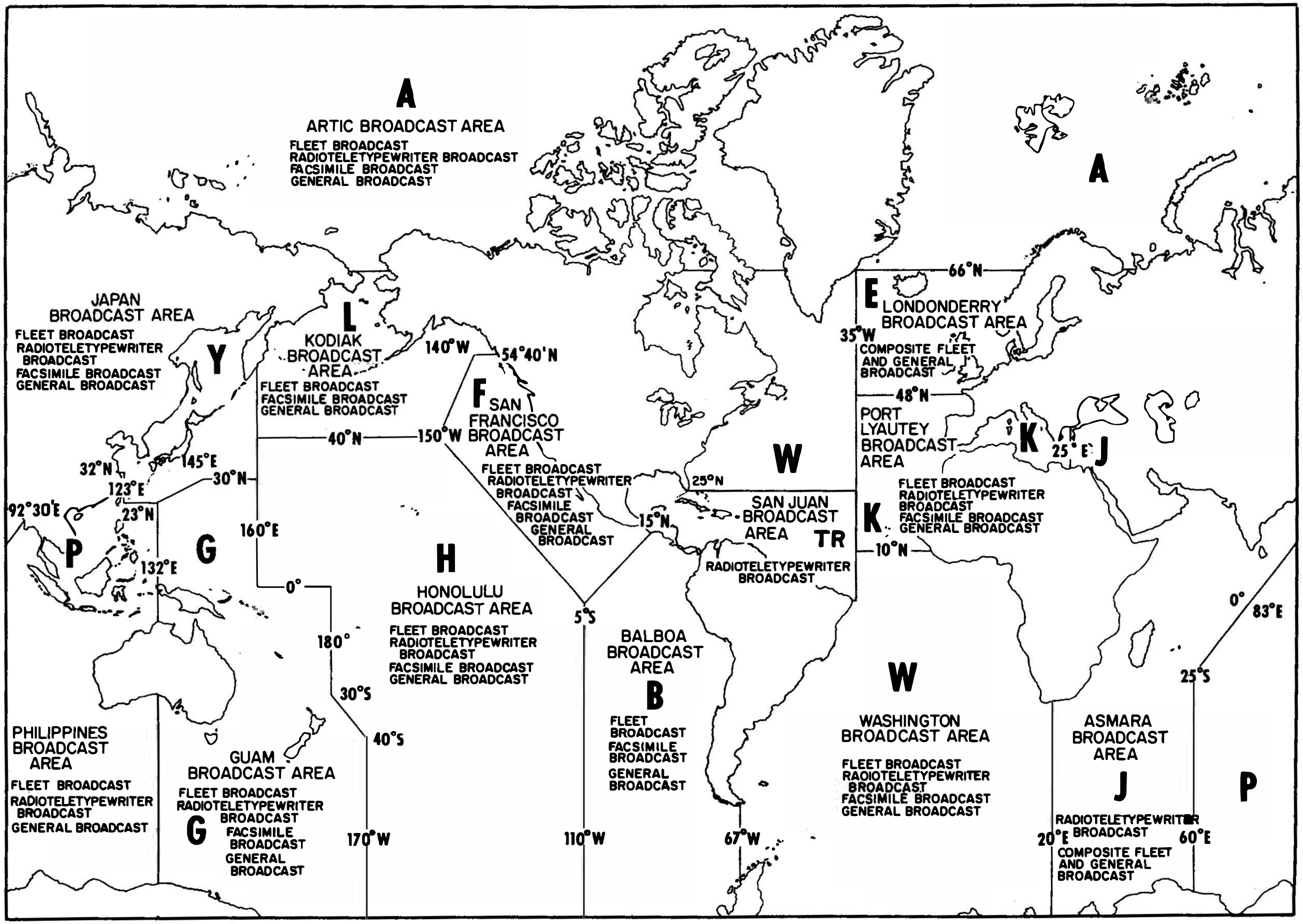



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Figure 2-1.—Fleet broadcast areas.

Atlantic and Caribbean. All the major oceans of the world are covered in a similar manner. Some of the broadcasts may be inactivated at times, because of reduced operations in a certain ocean area, resulting in one broadcast area being extended temporarily to include another. For instance, the Honolulu broadcast area often is extended to include the Balboa area, and the San Francisco area is extended to include the Kodiak area.

Provisions are available so that a primary or major center in a specific ocean may key the transmitters of one or more of the communication stations in the same area simultaneously with its own. This is called coronetting, and results in identical information being broadcast to these areas at the same time.

The RATT component of the broadcast may be utilized to disseminate classified as well as unclassified information to the fleet, in plain language copy, by using cryptographic devices at the sending and receiving ends. This is called a covered broadcast.

Each primary center also sends out a general broadcast of hydrographic information, weather forecasts, time signals, press news, and messages for Navy-controlled merchant ships.

In addition, facilities are provided for ship-shore communication.

The primary communication centers are linked by radio and landline circuits to each other and to the MAJOR communication centers throughout the world. These are also NAVCOMMSTAs or NAVCOMMUs, and each maintains the circuits necessary for interconnection with tributaries and minor communication centers. Many of them operate ship-shore radio circuits and transmit fleet and general broadcasts covering more limited areas than those of the primary centers.

MINOR communication centers serve areas where the traffic volume is not heavy enough to justify a primary or major center. Most are located at such activities as naval air stations and supply and ammunition depots. They handle local communications, and relay messages between tributary stations and the major or primary center with which they are associated.

Each primary, major, and minor communication center maintains a tape relay station. Its function is to forward messages in tape form by means of the automatic or semiautomatic teletypewriter tape relay equipment (discussed later in this manual).

A recent addition to the tape relay system is the switching center, with fully automatic equipment for routing messages in tape form. Messages are handled within the switching center at a speed of 200 wpm, thereby speeding up teletypewriter communications while effecting a saving in operational personnel. Presently there are five automatic switching centers serving naval activities in the continental United States. They are at Washington, Norfolk, and Trenton, N. J. for service to east coast and midwestern activities, and San Diego and San Francisco for activities in the western area.

TRIBUTARIES are small stations serving some particular command. They differ from minor communication centers chiefly in that they perform no tape relay functions and generally handle less traffic. Tributaries are the points at which messages enter and leave the shore communication system, and may be compared with the subscriber in a telephone system. They send and receive messages, as necessary, to serve local command.

All the switching centers, tributaries, and the primary, major, and minor centers discussed, and the radio and landline circuits connecting them, form the Naval Teletypewriter and Tape Relay Network (abbreviated NTX). The NTX is the linkage ashore between communication activities. Teletypewriter (carried by wire or radio) is the means of transmission of all the messages handled by NTX. The NTX network is covered fully in chapter 11.

## COMMUNICATION CENTER ORGANIZATION

Let us take the NAVCOMMSTA for an example of the organization of a communication center ashore. Such establishments have many billets for Radiomen, and you might well be assigned to one on your next tour of shore duty. Although the organization described is a typical one for NAVCOMMSTAs, the size and scope of operations vary considerably so that no two are exactly alike. All, however, handle thousands of messages daily, and their personnel must specialize to a far greater extent than aboard ship.

A NAVCOMMSTA may have a personnel allowance ranging from a hundred to several hundred officers, men, and civilians, depending upon its functions and the scope of its operations. In addition to communication and electronics personnel, there also are personnel for administration, supply, transportation, and other supporting services.

The commanding officer of a NAVCOMMSTA usually is a captain or commander. He establishes policies and procedures for its operations, and initiates and enforces local directives for its upkeep and security. In addition to his station command, the commanding officer of a NAVCOMMSTA normally is the staff communication officer for the naval district commandant or the force or sea frontier commander of the area in which the NAVCOMMSTA is located. He is thereby responsible for coordinating naval communications within his district or area.

### Communication Department

The typical NAVCOMMSTA is organized into eight departments, of which the communication department is by far the largest. It is headed by the communication officer, who has supervision over the personnel and work of the department. He serves as manager of the local communication program and determines its budgetary requirements. Some of his other duties are —

1. Formulating communication plans and directives.
2. Establishing an internal routing and filing system for messages.
3. Providing for physical security of messages and for monitoring facilities.
4. Supervising operation of the publications library by the RPS custodian of the command.
5. Supervising the training of communication personnel and cryptoboard members.
6. Ensuring proper operation and maintenance of electronic and visual communication equipment.

Within the communication department are the radio, traffic, material, and facilities divisions. (See fig. 2-2.)

RADIO DIVISION. — The radio division operates the radio stations of a NAVCOMMSTA. Normally, there are two such stations — a receiving branch and a transmitting branch. Each station is headed by a radio station officer.

TRAFFIC DIVISION. — The traffic division processes incoming and outgoing messages (including facsimile), enforces security, and maintains custody of RPS-distributed matter issued for station use. A traffic and circuit officer is division head. He is assisted by communication watch officers, cryptographers, and a custodian, whose duties are similar to their shipboard counterparts. The following officers may also be attached to this division: a relay station officer, to head the tape relay station; a communication security officer, responsible for monitoring radio circuits and developing communication security measures; and a facsimile officer, to plan and administer operation of facsimile facilities.

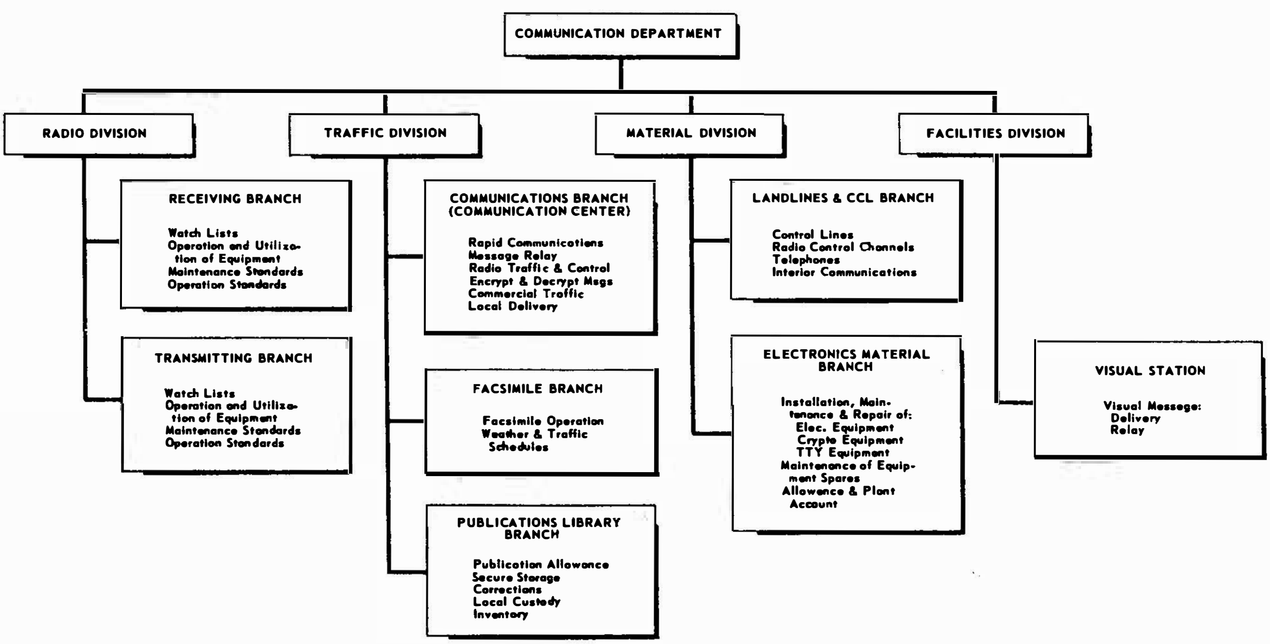



Figure 2-2.—Communication department of a NAVCOMMSTA. 6.3

MATERIAL DIVISION. — The material division is responsible for the physical functioning of wire circuits and for repair of electronic equipment. In charge are a landline officer and an electronics material officer.

FACILITIES DIVISION. — The facilities division operates the visual station. (Inclusion of this division depends upon whether the NAVCOMMSTA is located where these facilities are required.) The visual station is operated by a signal officer. He is in charge of receiving, transmitting, and relaying visual traffic to and from vessels in port or anchorage. His duties parallel those of the shipboard signal officer.

### Communication Center Spaces

The organization of shore communication centers varies considerably from station to station. Although physical arrangements differ, the typical shore communication center includes the following spaces: control center, message center, cryptocenter, relay station, wire room, classified relay, visual signal station, facsimile and radiophoto center, and radio transmitter and receiver stations.

Figure 2-3 shows the physical layout of a typical NAVCOMMSTA. The diagram is schematic, for in practice, buildings and spaces vary so widely in arrangement that generalization is difficult. Usually the elements shown are present, but at some stations they are scattered over many acres. Often transmitting and receiving stations are miles away from the rest of the activity.

CONTROL CENTER. — Essentially the control center is the master switchboard and monitoring station. All of the 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, and landline or radio links lead to the remotely located transmitting and receiving stations serving the communication center. Control center personnel connect radio and landline circuits to appropriate equipment in the message center, relay station, classified relay, and other spaces. The control center contains control and terminal equipment and built-in monitoring and test equipment. It ties together, electronically, all the spaces of the communication center, and is the electrical

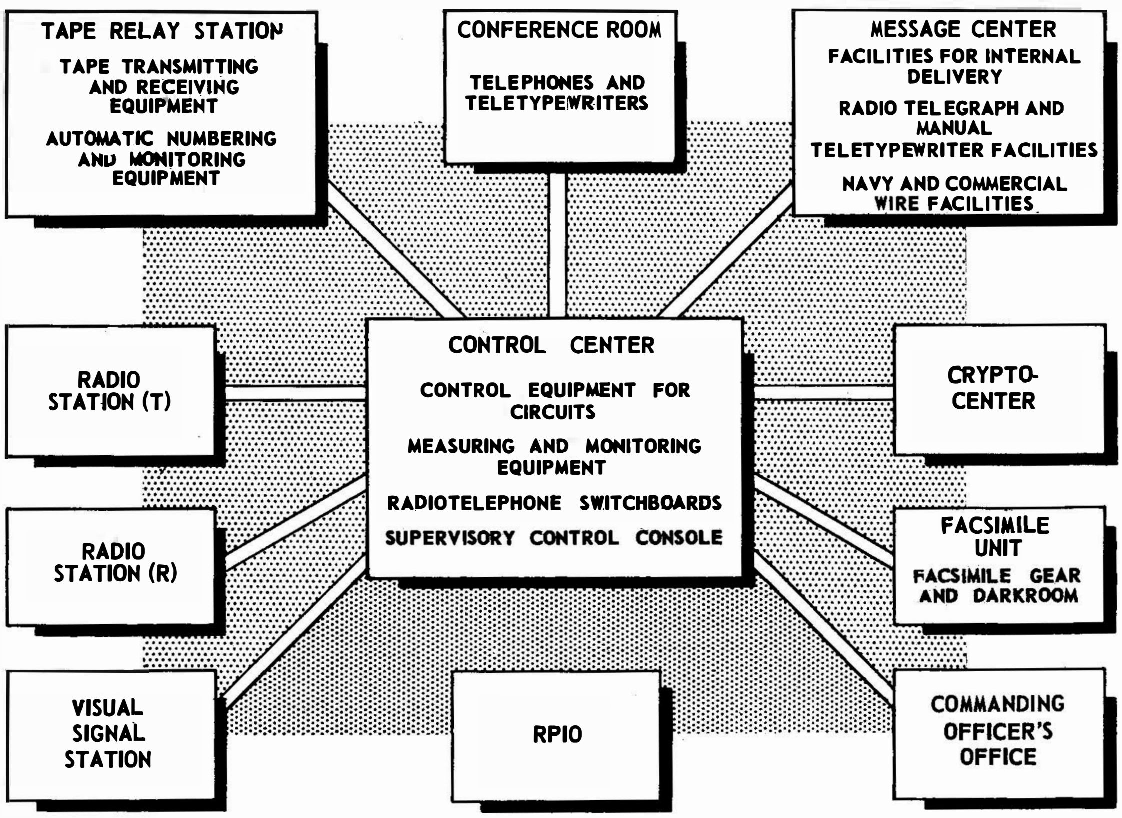



Figure 2-3.—Physical arrangement of a NAVCOMMSTA. 76.2

outlet from the communication center to other communication centers.

MESSAGE CENTER. — The 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. The message center operates circuits with the relay station for the reception or transmission of these messages.

CRYPTOCENTER. — As its name implies, the function of the cryptocenter is the encryption and decryption of messages. Messages to be encrypted or decrypted are passed from the message center and, after appropriate processing, returned for internal delivery or onward transmission as necessary.

RELAY STATION. — Messages handled by the relay station are in tape form. The relay station is the communication center's linkage with the Naval Teletypewriter and Tape Relay Network (NTX). It contains automatic or semiautomatic teletypewriter tape receiving, tape transmitting, and message numbering and monitoring equipment. This equipment is wired to the control center and, through the control center, to other NTX relay stations.

WIRE ROOM. — The wire room operates those radio or landline circuits that are not a part of the NTX system. These circuits include circuits to commercial companies, circuits to other Government agencies, fleet and general broadcasts, and certain ship-shore circuits.

CLASSIFIED RELAY. — The methods, procedures, practices, and functions of the classified relay are similar to those of the relay station. Using on-line cryptographic equipment, the classified relay provides naval communications with a secure and rapid means of handling classified messages.

As equipment becomes available, all teletypewriter circuits operated by the Navy are being converted to on-line operation.

VISUAL SIGNAL STATION. — A visual signal station is established at a NAVCOMMSTA only when the communication station is within sight of a harbor or anchorage. The visual signal station usually is located in a tower high above surrounding buildings so that there is an unrestricted view of the harbor. Messages to and from ships in the harbor are sent by flashing light, semaphore, or flaghoist.

FACSIMILE AND RADIOPHOTO CENTER. — The facsimile and radiophoto center operates the equipment required for sending and receiving pictures, photographs, weather maps, charts, and other material in graphic form. Facsimile traffic is processed in the message center along with regular messages.

RADIO TRANSMITTER AND RECEIVER STATIONS. — Depending upon the equipment installed, a radio station provides either transmitting or receiving facilities for the communication station of which it is a part. Radio stations usually are located some distance from the communication center to minimize the interference that results when high-power transmitters are located too near receiving units. Additionally, large fields are required for transmitter and receiver antennas, and suitable fields often are difficult to find near the communication center. Transmitters and receivers at the radio station are wired into the control center and, from the control center, are patched to remote operating positions or equipment in other communication spaces.

## DEFENSE COMMUNICATION SYSTEM

The Defense Communication System (DCS) was established in 1960 to provide a single communication system within the Department of Defense. The Defense Communication System is supervised and operationally controlled by the Defense Communication Agency (DCA). 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 or 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) that are required to provide communications from the President, down the chain of command, to the fixed headquarters of the various subordinate commands. This takes in the 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.

## JOINT COMMUNICATIONS

The need for coordinated and standardized communications among the United States military services was clearly apparent during the early stages of World War II. Army and Navy facilities sometimes were duplicated in one location, and differences in procedures made efficient interservice communications difficult. Now communication procedures are standardized through 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). You will become familiar with these publications as you study 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 the communication instructions and procedures essential to the conduct of combined military operations and communications in which two or more of the Allied Nations are involved. Your work in communications undoubtedly will require that you be familiar 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 a local disaster situation or a general emergency.

The operators, many of them former Navy personnel, generally operate from their own amateur stations with Navy-assigned calls. They handle message traffic of a morale nature that does not qualify for regular transmission over Navy circuits.

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 good will, and public service.

## STANDARD SHIPBOARD ORGANIZATION

Each person in the communication division, from the Radioman striker to the watch supervisor, must know the departments aboard his ship and the nature of the work performed by each. Figure 2-4 is representative of a standard shipboard organization, and serves as a guide for type commanders in preparing the organizations of ships under their command. Shipboard organization varies slightly among types. In addition to figure 2-4, study the organization book for your individual ship. If necessary, make exploratory visits to other spaces.

The operations department is one of the five command departments of the ship. Its functions embrace all external communications, the combat information center, control of aircraft in the air, and repair of electronic equipment.

The effectiveness of the many changes taking place in ships, in equipment, and in weapons rests more and more heavily upon the capability and output of the operations department. Men who constitute, maintain, and give effect to the components of the operations department exert a marked influence upon the quality and extent of the ship's total capability.

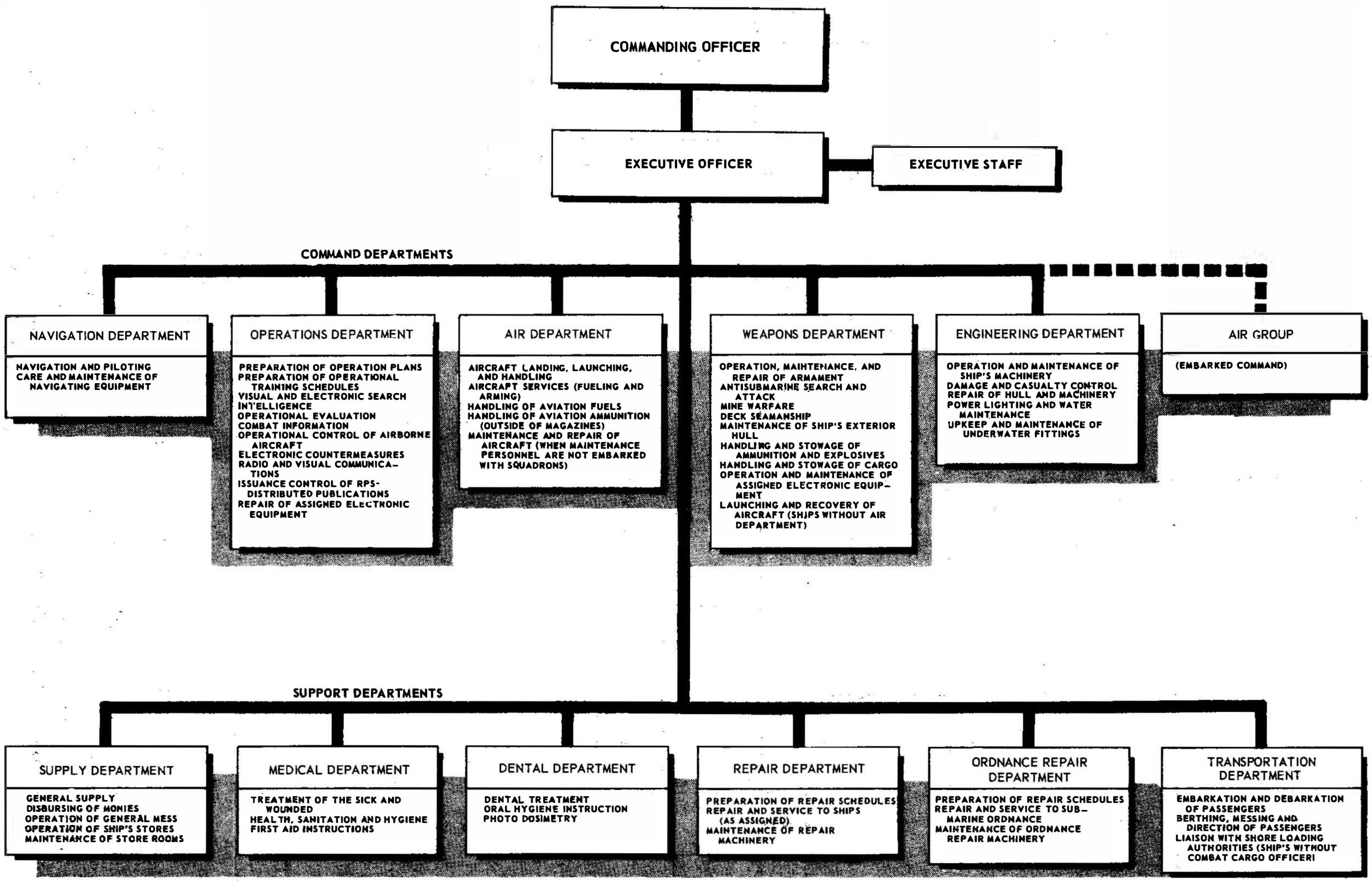
## SHIPBOARD COMMUNICATION ORGANIZATION

The shipboard communication organization, shown in figure 2-5, is a branch of the operations department. As such, it comes under the cognizance of the operations officer.

### OFFICER BILLETS

The communication organization is headed by the communication officer, who is responsible for all communications sent and received by radiotelegraph, radiotelephone, radioteletypewriter, facsimile, and visual means. He is not responsible for the ship's interior communications.

The communication officer is responsible also for (1) the care and maintenance of communication equipment (including landlines and teletypewriter 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




76. 3

Figure 2-4.—Standard shipboard organization.

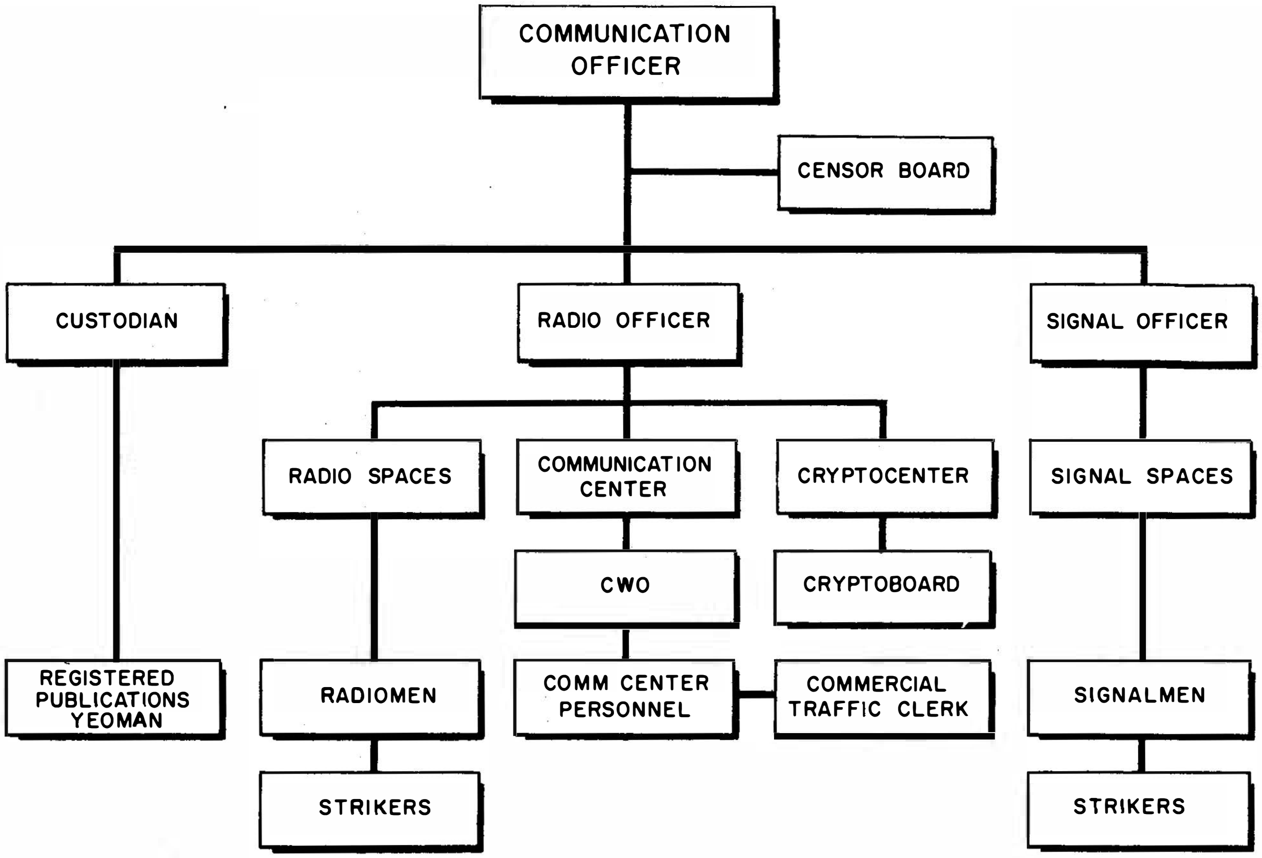



Figure 2-5.—The shipboard communication organization. 76.4

of the cryptoboard; and (5) cleanliness and upkeep of assigned spaces.

In large ships the communication organization is divided into two divisions--the OR (radio) division, headed by the radio officer, and the OS (visual) division, headed by the signal officer. In addition, the communication organization is assigned a custodian of registered publications, communication watch officers, cryptographers, and a cryptosecurity officer.

The radio officer 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. His responsibilities for the internal handling, routing, and filing of messages are usually delegated to communication watch officers. The radio officer is the communication officer's principal assistant.

The signal officer, heading the OS division, is charged with operation of the 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 the junior officers of the OR division. The CWO on watch is in active and immediate charge of the ship's communications, and during his watch 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 addressees, 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. On small ships an experienced Radioman may himself act as CWO.

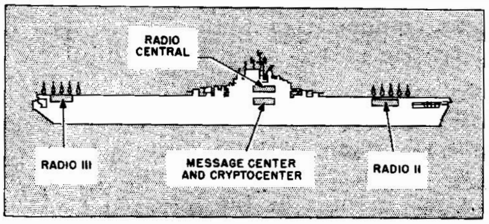
Cryptographers — collectively called the cryptoboard — assist the CWO with encryption and decryption of messages when the traffic load is so heavy he cannot handle it by himself. Members of the cryptoboard are designated in writing by the commanding officer. All cryptoboards have commissioned officers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

The cryptosecurity officer is assigned full time only on the largest ships. He is charged with the training, assignment, and detailed performance of the cryptoboard and serves as advisor to the communication officer and the commanding officer in all matters relating to cryptosecurity and the 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 that of Top Secret control officer, and membership on the censoring board.

## SHIPBOARD COMMUNICATION SPACES

The number, size, and arrangement of the communication spaces of a ship depend upon her size, type, and mission. Most large warships have communication spaces located fore, aft, and amidships (fig. 2-6). Besides scattering the ship's antennas, thereby helping to reduce interference, this arrangement minimizes the danger of loss of communications by 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 important 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), the message center, and the cryptocenter. Communication functions also are carried out in other radio spaces, in other battle control locations, and in visual signal stations.




76.5

Figure 2-6.—Location of communication spaces, CVA.

### Radio Central

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

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. If the message is classified, it is passed to the cryptocenter, 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. There are certain exceptions, such as operational messages received and sent direct from the OOD or CIC.

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

### Cryptocenter

Adjoining the message center is the cryptocenter, where outgoing messages are encrypted and incoming messages are decrypted. Here are located cipher equipment and cryptographic publications (called cryptoaids), safes for the stowage of classified messages, and desks and typewriters as necessary. Files kept in the cryptocenter include a file for classified general messages and one for edited plain language copies of encrypted messages. Access to the 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. The door ordinarily is locked, and traffic is passed in and out through a window or slot in the bulkhead.

### Other Radio Spaces

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

Most of the ship's transmitters are located in the forward radio space, called the transmitter room or radio II. It usually is manned by a Radioman in charge, assisted by watch standers. The duties of the watch are to keep transmitters tuned to prescribed frequencies and connected or "patched" to keys, microphones, teletypewriters 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 ship's entertainment receivers.

Originally the larger Navy ships kept their emergency radio room (radio III) in readiness for emergency use only, but in many vessels the increasing demand for radio circuits has turned this into an active transmitter room. In ships where radio III still is 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 are small spaces 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 the 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 in CIC are often paralleled. For instance, a tactical maneuvering net 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 the superstructure of the ship. 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 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 the size, type, and mission of the ship. The principal duties of the Radioman are to operate radiotelegraph, radiotelephone, teletypewriter, and facsimile equipment in accordance with prescribed procedures.

The senior Radioman, as the leading petty officer, is in direct charge of all enlisted men in the radio division. He prepares the watch lists for Radiomen and makes daily checks of the message files and logs. Another of his most important 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 the cleanliness and preventive maintenance of all radio and teletypewriter equipment and for the compartments and deck spaces occupied by equipment under his cognizance.

The watch supervisor in radio central must be an experienced Radioman. The proper handling of traffic is his main responsibility. The equipment in use and the 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 the CWO insofar as the 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 in event of equipment failure, and maintaining a communication status board listing information relative to the nets and circuits in use.

The operators in radio central are under the authority of the supervisor while on watch. They must know and use correct operating procedures for radiotelegraph, radiotelephone, radioteletypewriter, and facsimile circuits; must keep accurate logs; must know how to tune transmitters and receivers and associated equipment; and must be able to patch 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 the equipment's range, and know the power panels and switches for both normal and emergency power distribution systems. Other duties include patching transmitters and receivers to remote positions, and keeping records relating to equipment tests and inspections.

The Signalmen are concerned primarily with visual communications, although they have the secondary duties of standing quartermaster watches and operating the radiotelephone.

## SMALL SHIP COMMUNICATION ORGANIZATION

Preceding sections outlined the communication organization aboard a large ship, where the specific duties of each officer are more clearly defined and standardized. Communication organizations of smaller ships (DD or DE types, for example) carry on much the same work, but their personnel allowances are smaller, and each individual must accept more varied duties and a heavier workload.

Communications on a DD or DE still is one of the functions of the operations department, but radio and visual signaling personnel are combined into one division, the OC division. The communication officer may not have any commissioned assistant, or perhaps only one, and must himself do work that on a larger ship would fall to the radio officer, signal officer, custodian, or CWOs. On a destroyer the communication officer is an active assistant to the operations officer. He has deck as well as communication duties, and spends many hours daily on the bridge. If this duty is heavy, he may have little time to devote to the routine of communications, and must depend on his Chief Radioman or leading Radioman to carry the load.

## 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. 2-7).

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

Aboard many ships the midwatch is from midnight to breakfast. The morning watch runs from breakfast to dinner, and the afternoon watch from dinner to supper. The first dogwatch runs from supper to 1800, or until movie call, and the second dogwatch until 2000. The 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, the evening watch may last from supper until midnight. If there is one dogwatch, it usually is from supper to 2000 and is followed by the evening watch that runs to midnight.

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 peak load 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, and standby men maintain duplicate facilities in other radio spaces, keeping duplicate logs of traffic coming into radio central.

# WATCH, QUARTER & STATION BILL

SECTION 1 DIVISION OR

| BILLET | NAME | BUNK NO. | LKR. NO. | RATE COMP. | RATE ALL. | RATE ACT'L. | CLEAN STATION | BATTLE STATIONS CONDITION I (GENL. QTRS.) | BATTLE STATIONS CONDITION II | BATTLE STATIONS CONDITION III | LANDING PARTY | EMERG. GETTING UND'WAY | WATCH DETAIL AT SEA | WATCH DETAIL IN PORT | SPECIAL SEA DETAIL | FIRE STATION | FIRE PROVIDE | RESCUE & ASSIST. PARTY | RESCUE & ASSIST. PROVIDE | COLLISION | ABANDON SHIP STATION | ABANDON SHIP PROVIDE | MAN OVERBO. | SPECIAL DETAIL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| C-101 | H.J. SAYER | 4 | 4 | RMC | RMC | RMC | ← IN CHARGE → | | | | | RAD I | | | | ↑ STANDBY ↓ | | ↑ STANDBY ↓ | | ↑ STANDBY ↓ | 6 | | ↑ QUARTERS ↓ | |
| 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 | | | | | | | | | 3 | | | |
| 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 | RM3 | RM3 | RMSN | 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 2-7.—Watch, quarter, and station bill.

A Radioman is placed in charge of the cleaning detail in each communication space, and the 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 your 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. Most of the vast amount of intelligence carried in the messages handled by naval communications passes at some point through the hands of Radiomen--data that, if available to an enemy, would enable him to learn the strength and intent of our forces, and to gather a wealth of technical information relating to the procedures and operations of the United States Navy.

You 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, for the more an enemy knows about our communications the better his chances are 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, and messages in the four security classifications of Top Secret, Secret, Confidential, and Confidential—Modified Handling Authorized. Following are examples and definitions of each.

### 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 expecially important, or are changed frequently for security reasons.
4. Devices and material relating to communication security.
5. Information that reveals strength of our land, air, or naval forces in the United States and overseas areas, identity of 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 paragraphs 10, 11, and 12 is classified Confidential only if its unauthorized disclosure could be prejudicial to the defense interests of the Nation. If such information does not relate strictly to defense, it must be safeguarded by other means than the Confidential classification.

### CONFMOD

The Confidential classification has a subdivision: Confidential—Modified Handling Authorized (CONFMOD). CONFMOD may be authorized for matter the originator believes will be protected sufficiently by somewhat less strict stowage and transmission safeguards than are necessary for Confidential. CONFMOD material normally is stowed in the same manner as other Confidential material.

Material that may be classified CONFMOD includes, but is not limited to, the following:

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.

## CLEARANCES

No one may have access to classified matter without proper clearance. A security clearance is an administrative determination that an individual is eligible, from a security standpoint, for access to classified matter. If your duties require you to use classified publications and documents (and they are virtually sure to), the commanding officer is authorized to grant you clearance up to Confidential after ascertaining that you are 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 Office of Naval Intelligence. 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 rank, duties, or clearance.

If it is known—or even suspected—that classified material is lost, or passed into the hands of some unauthorized person, the matter 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. Never fail to report a compromise that comes to your attention.

## 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, 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 those persons whose duties require access and who possess appropriate security clearances are authorized to enter, after being positively identified.

### LIMITED AREA

Radio central, the 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 the classified information located within the area.

The 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 the controlled area does not contain classified information, it serves as a buffer zone of security restriction and provides greater control, safety, and protection for the limited or 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. There are four phases of communication security: 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 placed face down or covered 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. Meantime, they must be handled and safeguarded as classified matter.

At the close of each watch or working day, make certain that all classified material that must be passed from watch to watch is inventoried properly and that custody is transferred to your relief. 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 and the burn bags 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. You should 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 assure yourself that all drawers of safes and file cabinets are held firmly in the locked position.

If you are working with classified material and are interrupted by a fire alarm or other emergency, which requires you to leave the classified material unguarded, it should be stowed in the same manner as at the end of a working day. It is your personal responsibility to safeguard all classified material in your possession.

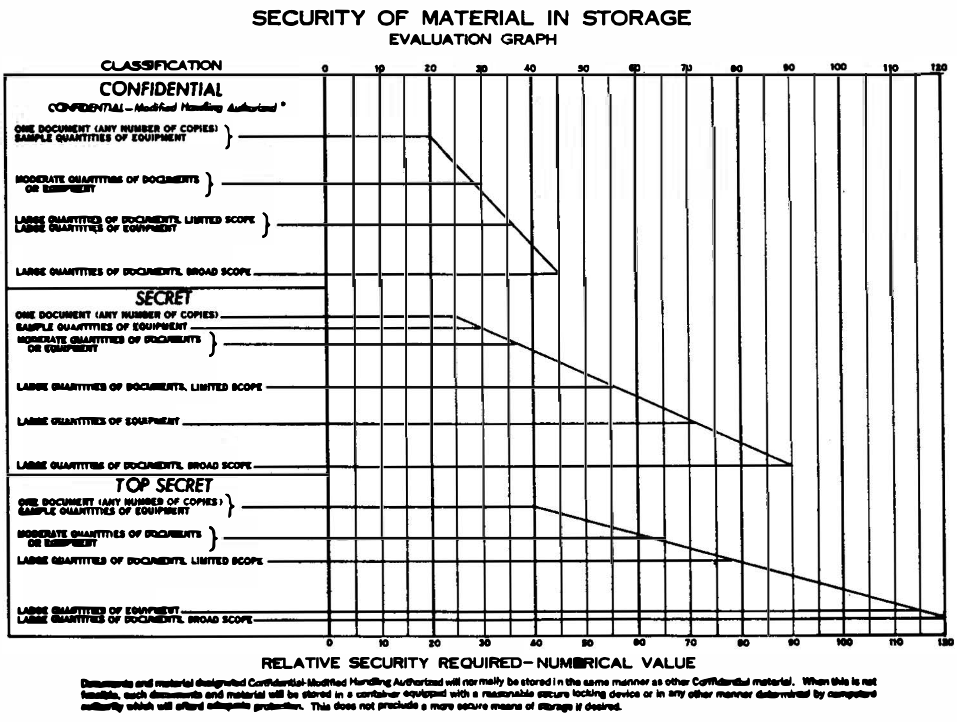
Stowage

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.

The graph, figure 3-1, shows the numerical values required for quantity and type of documents of each classification. The table, figure 3-2, is a guide for evaluating stowage facilities. These two must be used together.

For example, a ship stows plain language translations of encrypted messages in a heavy steel safe in the cryptocenter. Visitors are not allowed in any of the communication spaces, and 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 the table (fig. 3-2), we can assign a numerical value to these facilities as follows:




31.2

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

| | VALUE |
|---|---|
| **1. SHELTER** | |
| None | 0 |
| Light structure, such as a quonset hut, which can be locked and barred | 10 |
| Heavy structure, such as masonry building | 15 |
| Commissioned ship | 15 |
| **2. STOWAGE CONTAINER** | |
| None | 0 |
| Any portable container | 0 |
| Wooden container, any type of lock | 2 |
| Metal container, key lock | 5 |
| Metal container, combination lock | 15 |
| Lightweight steel safe | 20 |
| Light vault | 20 |
| Heavy steel safe | 30 |
| Bank vault | 40 |
| **3. GUARDING** | |
| Unguarded | 0 |
| Military guard in general area | 15 |
| Military guard checks container every hour | 20 |
| Military guard checks container every 30 minutes | 25 |
| Military guard in attendance at container | 35 |
| No supporting guard force | 0 |
| Military supporting guard force | 20 |
| **4. PROTECTIVE ALARM SYSTEM** | |
| No alarm on container | 0 |
| System to detect opening of container | 15 |
| System to detect tampering with or opening of container | 20 |
| System to detect approach to, tampering with, or opening of container | 30 |
| No general area alarm | 0 |
| System to detect entry into general area | 25 |
| **5. CONTROL OF PERSONNEL ACCESS TO CONTAINER WHEN CLOSED, AND TO CONTENTS WHEN OPEN** | |
| System necessary but not in effect | -20 |
| System not required | 0 |
| System in effect | 5 |

41.1

Figure 3-2.—Table of numerical equivalents (simplified).

| | Value |
|---|---|
| Sheltered aboard a commissioned ship . . | 15 |
| Stowed in heavy steel safe. . . . . . . . . . . | 30 |
| Military guard in attendance at container . . . . . . . . . . . . . . . . . . . . . . . | 35 |
| System in effect for control of personnel access to container when closed, and to contents when open . . . . . . . . . . . | 5 |
| TOTAL | 85 |

From the graph (fig. 3-1) you can see that stowage facilities with a numerical value of 85 are secure enough for everything but the most sensitive class of Secret and the two most sensitive classes of Top Secret material.

The keys or combinations to safes and lockers containing classified material are made available only to persons whose duties require access to them. The keys or combinations must be changed at least every 6 months. 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 you find a safe or cabinet containing classified material unlocked and unattended by assigned persons, be sure to 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.

Consult chapter 6 of the Department of the Navy Security Manual for Classified Information for further details on stowage of classified matter.

## Destruction

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

ROUTINE DESTRUCTION. — The 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, therefore, that you will be called upon to assist in burning classified material. As a member of the burn detail, you 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. The material must be watched until it is completely consumed, and ashes 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 at any time when necessary to prevent its capture by an enemy. On board ship, classified material is not subjected to the same risks as on land. However, if a ship is in danger of sinking or is severely disabled, action is taken in accordance with the ship's emergency destruction bill (fig. 3-3), 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

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 1960

| 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 3-3.— Emergency destruction bill (typical).

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 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 the enemy from conducting successful salvage operations.

If the ship is in shallow water (100 fathoms or less), combustible classified material must be burned, and may be jettisoned only as a last resort. Classified communication equipment must be smashed beyond recognition before jettisoning in shallow water, and 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 5-letter groups.

The cryptoboard, under the direction of the communication officer, is responsible for the 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, for subsequent transmissions with the same key list might be little better than plain language. The work and expense of superseding a key list, though great, are insignificant compared with the consequences of compromise.

The enemy constantly and painstakingly studies our 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 which 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 addressees and certain civilian agencies throughout the world. ARFCOS courier transfer stations are located in designated areas. Every item of classified material sent via ARFCOS is in the physical custody and control of a commissioned officer courier from the time of entry into the 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 AFRCOS.

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 3-4. 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 one designated by proper authority for the transmission of classified information in the clear. Messages classified Secret and below may be transmitted on such circuits.

A nonapproved circuit is one that is not designated by proper authority for the 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. Approved telephone circuits are equipped with security devices to minimize the possibility of wire tapping.

Tapping often 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 the ship's position. They are more secure than radio because reception is limited to units in the immediate vicinity of the sender.

Visual communication methods rank, in order of security, according to the distance from which the 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.

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

Transmission of plain language message is kept to a minimum. This is 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

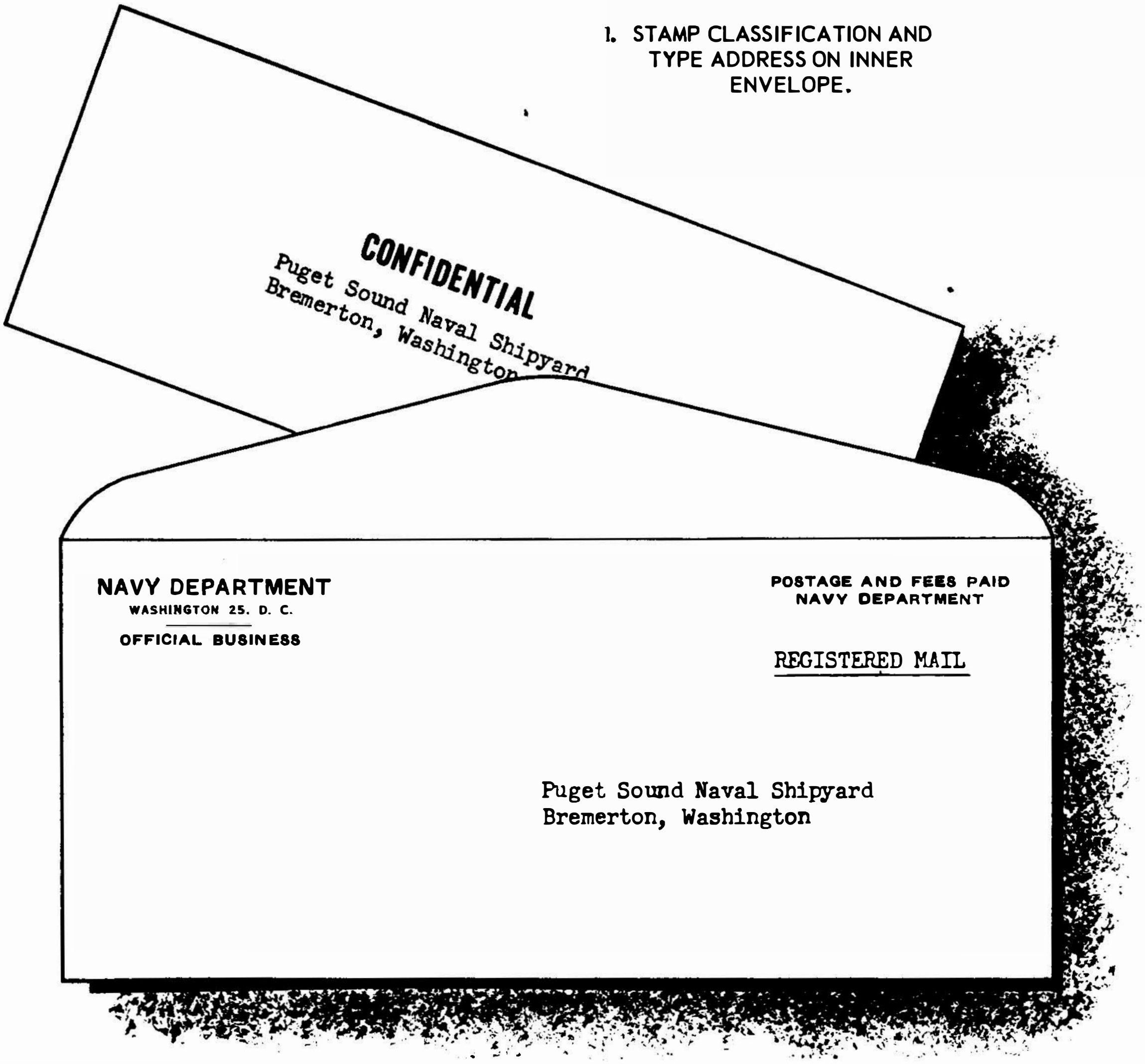



Figure 3-4.—How mailable classified matter is prepared. 6.1

prescribed by the Rules of the Road. Sound systems have the same range limitations as visual methods and are less secure. Their use is largely 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. Thus, in addition to obtaining intelligence, the enemy may be able to fix the location of operating forces through direction finding. By employing deceptive techniques, he could confuse and hamper our communications and, by traffic analysis, forecast the intentions of our 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 are frequently exceeded. Consequently, it is important 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 its proper and intelligent use.

INTERCEPT AND DIRECTION FINDING. — The best defense against enemy intelligence efforts by interception and direction finding is strict radio silence. It is apparent that the enemy cannot gain intelligence from radio transmissions if none are sent. Radio silence is placed in effect when it is reasonable to assume that the enemy is unaware of the location or impending movements of a ship or force. If it is impracticable 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 transmitters, 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. — The enemy may gain valuable information from his study of our communications by traffic analysis. Traffic analysis includes the study of 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. The enemy's 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. The enemy may logically conclude that a convoy from Bravo to Romeo is planned, and that these transmissions probably are arranging for an escort.

Some measure that can be taken to render traffic analysis by the 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 our forces. This practice is known as imitative deception. There are many deceptive techniques the enemy might use to obstruct our 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.

The best defense against imitative deception is proper authentication. This is a security measure 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, the operator can distinguish between genuine and fraudulent stations or transmissions. A station may include authentication in a transmitted message—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. The challenging station must determine the reply to be correct before any exchange of messages commences. Authentication is mandatory when —

1. Any station suspects imitative deception on a circuit.
2. Any station is challenged or requested to authenticate.
3. Making contact and amplifying reports in plain language or brevity code.
4. Directing radio silence or requiring a station to break an imposed radio silence.
5. Transmitting a plain language cancellation of an encrypted message by radio or by other methods when sending stations cannot be recognized.
6. Transmitting to a station that is under radio silence.

Authentication is advisable under the following circumstances:

1. When transmitting operating instructions affecting the military situation; for example, closing down a station or shifting frequency.
2. When making initial radio contact. Authenticators should be exchanged to prevent an enemy station from opening a circuit by asking a legitimate station to authenticate.

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 properly authenticated. The decision regarding its authenticity is made by the addressee.

Other effective defenses against imitative deception are —

1. Thorough training in operating procedures, as described in subsequent chapters.
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 the 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. Circuit discipline is discussed in greater detail in chapter 6.

JAMMING. — Jamming is another method an enemy may use in his efforts to disrupt our communications. It is accomplished by transmitting a strong signal on the victim frequency. You must be able to recognize jamming, cope with it, and, at the same time, prevent the 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).

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

1. Route messages via alternate circuits, meanwhile continuing live traffic on the jammed circuit to create the impression that the 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 the directional effects of available antennas.
4. Request the sending station to increase power or to shift frequency.
5. Take advantage of split-phone reception by copying signals simultaneously keyed on two frequencies.

6. Keep the receiver volume at a low level when copying through jamming. Your hearing can better 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. —Radiotelephon 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 the enemy.

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

1. Use each circuit for its intended purpose only.
2. Keep the number of transmissions to a minimum.
3. Write the 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.

Radiotelephone procedure is discussed in detail in chapter 7.

## CENSORSHIP

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

In the course of your duties, you may possess highly classified information, the knowledge of which is shared oftentimes only by the commanding officer, the communication officer, and yourself. You must be alert against a slip of the tongue that might reveal this information to someone not authorized to know. The Security Manual states that "indiscreet conversation and personal letters constitute the greatest menaces to security." The only safe policy to follow concerning classified information is KEEP YOUR MOUTH SHUT AND YOUR PEN DRY. When on duty, discuss classified subjects only as necessary to accomplish your job. When off duty, don't discuss classified matters with anyone. This includes your family and best friend. The desire to impress others with the importance of your job is usually quite strong. Divulging classified information is a very unwise way of trying to impress anyone, particularly when you may be endangering your 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 scientifically trained to collect particles of seemingly harmless information from such conversations. Once pieced together and analyzed, they sometimes reveal military information of incalculable value.

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

1. Location, identity, or movement of ships or aircraft.
2. The forces, weapons, military installations, or plans of the United States or her allies.
3. Casualties to personnel or material by enemy action.
4. The employment of any naval or military unit of the United States or her allies.
5. Criticisms of equipment or morale of the United States or her allies.

Personal censorship also extends to telephone conversations. As we have seen, 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 the 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 your Nation.

## CALL SIGN ENCRYPTION

Call signs and address designators are encrypted to conceal the identity of the originator and addressees of certain types of messages. The encryption and decryption of these call signs is part of your job, hence you 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, your supervisor will show you how to operate the device.

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 and then send the encrypted version in the message. This results in a compromise of the call sign and gives enemy intelligence a lever with which he may break the entire system.

## CONELRAD AND EMCON

Control of electromagnetic radiation (from which the word conelrad is derived) is the control of equipment capable of emitting radio waves to reduce the likelihood of interception by the enemy. It embraces radio communication equipment, radar, navigational aids (beacons), identification devices (IFF), and aerological devices (radiosonde).

Two terms are applicable when referring to control of electromagnetic radiation. Conelrad is used in the Department of Defense Plan within the United States and the Panama Canal Zone. The term EMCON (short for emission control) is used in the U. S. fleet.

In peacetime, conelrad or EMCON restrictions are imposed only if required for operational purposes or for training. The various degrees of restrictions are found in NWP 16(A).

## 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 plann d, security considerations are paramount. As the 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 security cannot be totally disregarded even then.

## ADDITIONAL SECURITY INFORMATION

The security precautions mentioned in this manual do not guarantee protection, nor do they attempt to meet every conceivable situation. The man who adopts a commonsense outlook, however, in addition to knowledge of the basic regulations, can solve most security problems.

The effective editions of the following publications contain additional information on security. Those marked with an asterisk are classified.

- Department of the Navy Security Manual for Classified Information, OpNavInst. 5510.1B
- U. S. Navy Physical Security Manual, OpNavInst. 5510.45
- Security, Armed Forces Censorship, OpNavInst. 5530.6
- U. S. Navy Regulations, 1948, chapter 15
- *RPS 4
- DNC 5
- *ACP 122
- *NWP 16(A)
- The 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)

For information on local security rules, study the security regulations of your ship or station.

# CHAPTER 4

# INTERNATIONATIONAL MORSE CODE

The international Morse code is a telegraphic alphabet, with letters and numbers represented by sound patterns. Mastery of the code is one of the most important of the Radioman's skills.

If you are a graduate of a Class A Radioman School, you were taught the Morse code, and 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, many hours of hard work ahead. Do not be discouraged on this account. Many fine Radiomen learn the code for themselves. Most ham operators are self-taught. You can learn it too—if you stay with it.

The international Morse code is a dit and dah system. (By the way, the code is pronounced by saying "dit" and "dah," NOT "dot" and "dash." So forget about dots and dashes and think only in terms of dits and dahs.) 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. Don't let yourself get in the habit of doing so. It's 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 this means, 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 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 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. Get in 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 |
|---|---|
| Dash - - - - - - - | DAH-di-di-di-di-DAH |
| Parenthesis - - - | DAH-di-DAH-DAH-di-DAH |
| Period or decimal 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 |
| Hyphen - - - - - | DAH-di-di-di-di-DAH |

## STUDYING CODE

If you have any trouble learning the 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.

| 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

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

## 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, and 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 decreases 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 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 different from the way you are accustomed to form them. This is 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. Even more important is the distinction between the letter O and the figure zero. Zero is always written with a slant through it: Ø. Also exercise care to avoid confusion between letter I and figure 1, 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. USAFI also offers a typing course for beginners.

## SENDING

Your ability to send well depends mainly upon two capabilities. First, you must know the

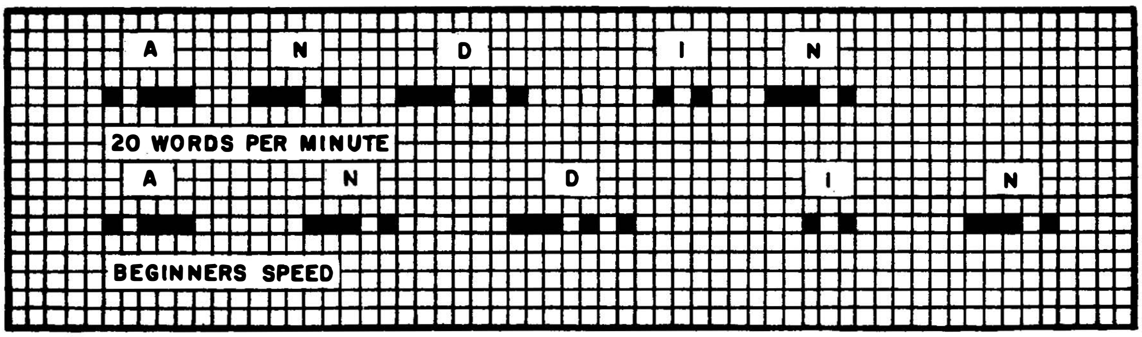
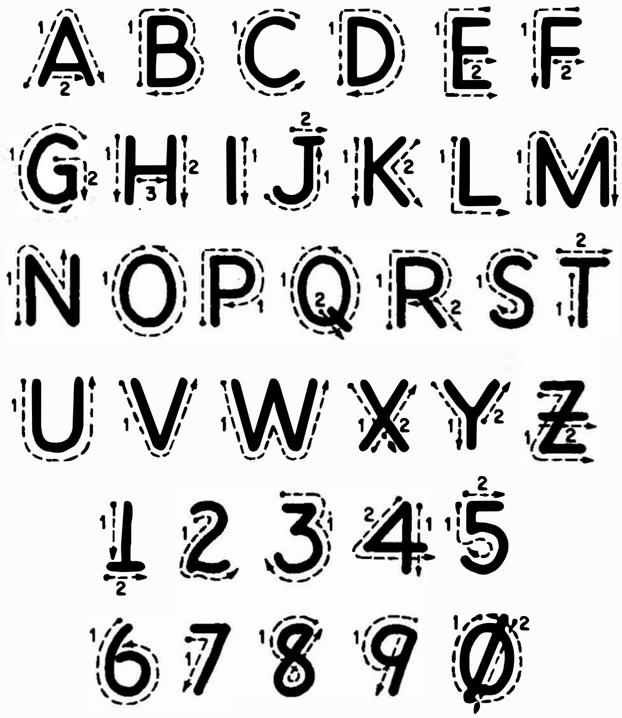



Figure 4-1.—Correct keying of Morse characters. 51.5




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

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.

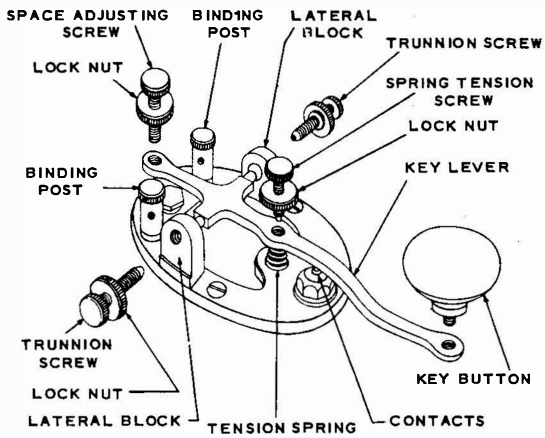
## HAND KEY

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 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



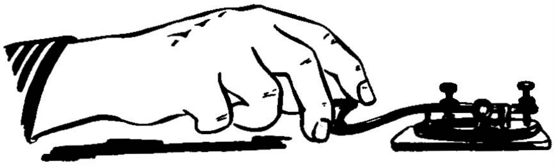

76.8A
Figure 4-3.—Hand key.

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. The trunnion screws at either side of the key control this alignment. 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, with your third finger bent and relaxed lightly with the remaining two fingers. 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



76.8B
Figure 4-4.—Grasping the key.

76.8C
Figure 4-5.—Your thumb rests against the side.

muscle of your forearm—not your elbow—should support the weight of your arm. Your elbow should not stick out 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.

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 exercising 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, and 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.

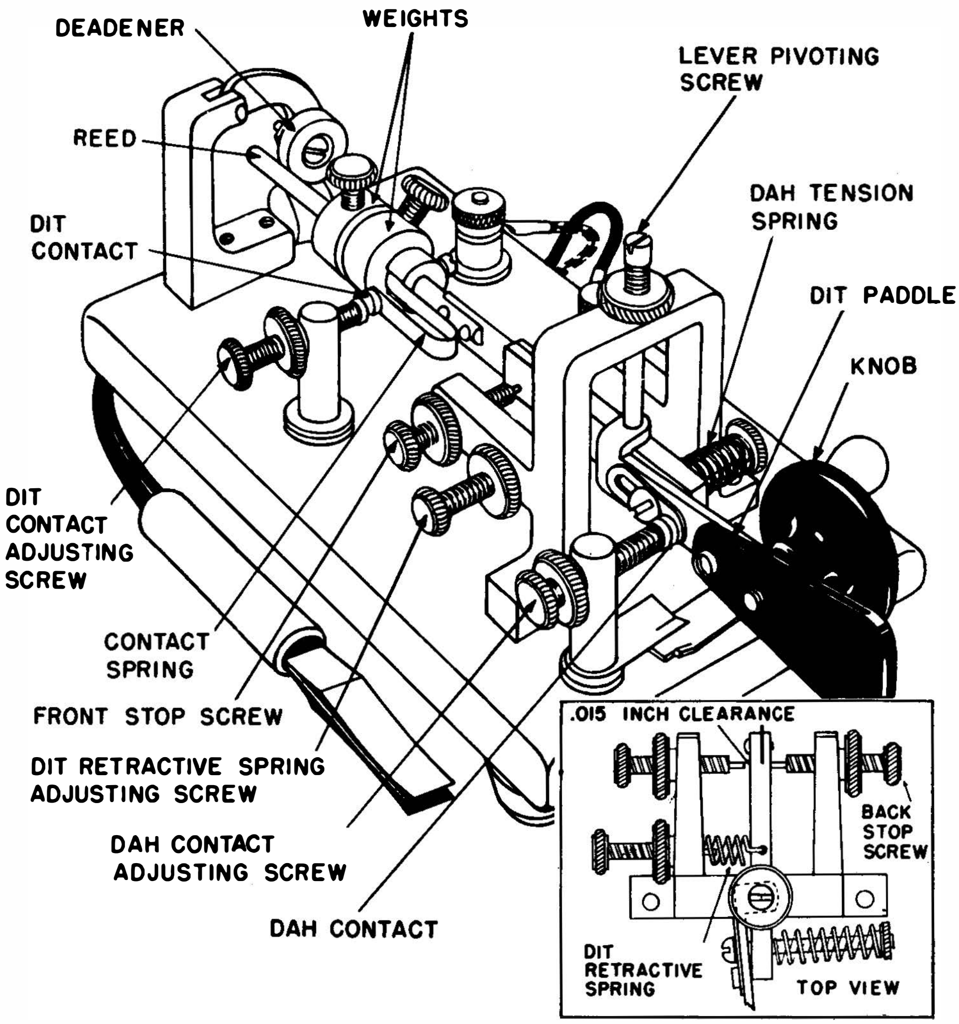
Adjust the key as follows (locate the parts in fig. 4-6 when adjusting the key):

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 just meet. 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 weight, located on the reed, in the direction of the deadener. If the dits are too slow, move the same weight in the opposite direction.
5. Adjust the dah contact adjusting screw to a clearance of approximately one thirty-second of an 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.




76.9
Figure 4-6.— Semiautomatic key.

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.

CHARACTER E

The dit characters require a good "fist." They must be transmitted quickly and rhythmically. Make a series of Es (dits). These 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 dit-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) a 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 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 this 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

DAH-DAH-DAH is O. 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. That's 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." 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, these combinations have the same swing given them as when speaking or chanting.

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 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 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 57 72
XR RJ ZM 43 65 VH 97 LM 12 46 70 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 GLM 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 65288 ZONIG
FYEQU ARQNV RNLPT KAKOZ
8784Ø BVGAN WKOQT SRQMT
UJVWN 45872 YXBCX AFKOZ
OGLCT NIHGP 12349 ATUS K
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
KXBOU

14. UTHA VNCB RFDS EDCD CXVD
RWQI MNJF STRO TNBL UJHK
NIOQ JUYR GBNS 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.

Make the transition from pencil copying to the typewriter as soon as possible.

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. As you gain skill, try copying the 18-wpm to 20-wpm fleet broadcasts. This does not mean for an hour now and then; it means for as much time as possible—15 or 20 hours per week. Don't be afraid to use some of your off-duty time. At the same time, 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 get 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 get the knack, you will find copying behind to be 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 thing further: It is common for a student learning code to hit a plateau. The regular progress to higher speed 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 man 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 traffic handled by the Navy is class A, consisting 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 besides 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. The 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. For example, suppose your ship is in the Atlantic and has a Class E message addressed to a man at a naval air station in Cuba. Your ship transmits the message to Radio Washington, which relays it via San Juan, P. R., to a station at Guantanamo Bay, Cuba, from which point delivery is made to the naval air station. The message never leaves Navy channels, and the originator pays nothing. But 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 Regional Accounts Office (NRAO), 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 regarding 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 the 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

The originator of a message is the command by whose authority the message is sent. The drafter—usually the communication officer or a department head—is the person who actually composes the message for release. The 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 if he wishes.

A Radioman charged with accepting locally originated messages must know who has releasing authority, and 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 the message, but who do not have the 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, very 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;
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, and 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.

The station sending a book message divides addressees into groups according to the 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 commercial teletypewriter services, substantial time and expense are saved by the 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 of which 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 the calendar year; for example, ALNAV 12-63, signifying the twelfth ALNAV sent during 1963.

You will see other general messages with titles not listed in table 5-1. These are originated by sea frontier commanders, commandants of naval districts, and fleet, force, and ship type commanders to publish 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 the general message file until cancelled 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 and 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

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. |
| | FLTOP | Messages concerning fleet units and their operational commanders. |
| | 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. |

Table 5-1. — General Messages — Continued

| Originator | Title of series | Description |
|---|---|---|
| CINCPACFLT | 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 | ALLANTFLT . . . . . . . | Messages for general distribution to commands under CINCLANTFLT. |
| | MERCASTLANT . . . . . | The merchant ship equivalent to an ALL ALLANTFLT. |
| Communications Electronics Director-ate/Joint Staff. | ALJAP. . . . . . . . . . . . . | Promulgates to holders information pertaining to CED/JS-adopted publications when rapid delivery to all branches of the armed forces is required. |
| 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. |

reports or information of a recurring nature and may follow a specific format. A few of the more common types of special-purpose messages follow.

## 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 the 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 both to command and to efficient administration to have an up-to-the-hour knowledge of the location of every vessel. This large-scale change of address work is carried on by 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 receives 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 the 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 messages concerning navigation warnings. These messages are given wide distribution on special hydrographic broadcasts. There are two subdivisions of HYDRO messages. HYDROLANTS contain navigational information relating to the Atlantic, Mediterranean, and Indian Oceans. HYDROPACS furnish such information for the Pacific Ocean areas.

## NOTICES TO AIRMEN

Notices to airmen (NOTAMs) are originated by military activities and civil agencies concerned with the safety of aircraft. 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 for ships within visual signaling range. They 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 the 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." The message ordering MINIMIZE consists of the word MINIMIZE followed by the scope (area affected) and the reason, and the 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. The four kinds of station and address designators are 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 for establishing and maintaining communications that identify some communication activity. 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 are the following:

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

The 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 the military call signs are derived the 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, but may represent any one or any group of these. Examples:

NERK . . . . . . . . (To) any or all U. S. Navy ships(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 the identity of originators and addressees. In such instances this information is placed in the encrypted test.

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, 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 combinations of any of these, 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, although, in military communications, 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 distinquished 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, the 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 communications facilities. For example, (1) senior commands and commanders ashore, such as the Secretaries of Defense and of the Navy, bureaus 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 call sign 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. Included in the group are the commander and his subordinate commanders. Examples:

DSWN ------ DESRON 16.
AMGK ------ SIXTHFLT.

Conjunctive Address Groups

You must remember that conjunctive address groups have incomplete meanings. It is always necessary to complete the meaning by the addition of 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 ____________." This particular group must be followed by a geographic address group to complete the meaning.

Geographic Address Groups

Geographic address groups are the equivalent of geographic locations or areas, and 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, 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 the SOGs, together with their meanings, is in ACP 100.

ROUTING INDICATORS

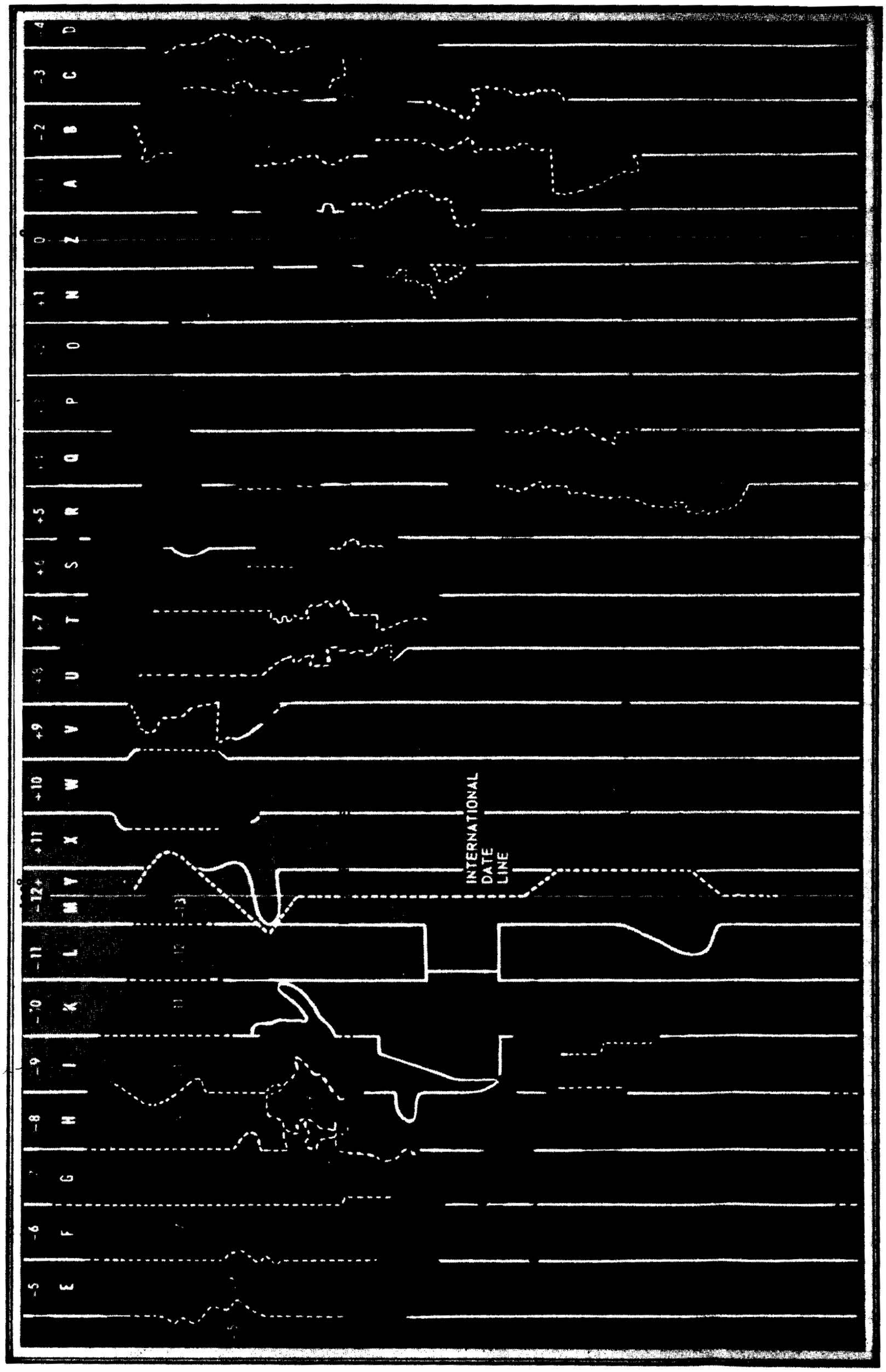
Routing indicators are groups of letters whose purpose is to identify stations in a teletypewriter tape relay network. Depending upon the type of station, routing indicators vary in length from four to seven letters. It is easy to distinguish routing indicators from call signs or address groups because routing indicators always begin with either the 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 the headings of messages. Some abbreviated titles are written as single words. Others have conjunctive titles and geographical locations. Examples:

BUSHIPS
NAVCOMMSTA GUAM

Plain language address designators have wide application in messages originated and addressed within the shore establishment. They




13.76
Figure 5-1. — Time zone chart of the world.

also are used in communications with the Army, Air Force, and the armed forces of Allied Nations. They are not used in the 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 GMT (Greenwich mean time). You may hear some oldtimers call it GCT (Greenwich civil time); both names mean the same. Each zone, in turn, is indicated by the number that represents the difference between the 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 the 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 meridan is the international date line, where each worldwide 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 the hours and minutes expressed as a four-digit group. The first two figures of the group denote the hour and the second two the 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 means the 17th day of the current month 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 the message is prepared for transmission. For standardization, the time expressed by a date-time group normally is GMT. The date-time group in a message heading serves two purposes: It indicates the 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 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. The additional digits represent the general message sequential serial number. Example: 1Ø2347Z/35.

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 the time zones. Zone X 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. For example, to calculate the time in zone U when it is Ø5ØØ hours in zone I, 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,

| | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | |
| | Y | X | W | V | U | T | S | R | Q | P | O | N | Z | A | B | C | D | E | F | G | H | I | K | L | M | |
| | +12 | +11 | +10 | +9 | +8 | +7 | +6 | +5 | +4 | +3 | +2 | +1 | 0 | −1 | −2 | −3 | −4 | −5 | −6 | −7 | −8 | −9 | −10 | −11 | −12 | |

Table 5-2. — Time Conversion Table

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 addresses 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 DNC. The rules governing precedence are set forth in table 5-5 on page 77.

In addition to the precedences given in table 5-5, precedences of EMERGENCY and DEFERRED are assigned messages originated by NATO and other Allied Nations. Messages introduced into U. S. Military Communications Systems carrying an EMERGENCY (Y) precedence are handled before IMMEDIATE and after FLASH messages of the United States. Messages carrying a DEFERRED (M) precedence are handled after ROUTINE messages of the United States.

## 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 the normal pause between the letters. Overscores are ignored in teletypewriter work.

Although some prosigns seem to be abbreviations of their assigned meanings, prosigns are <u>never</u> referred to as abbreviations. Prosign $\overline{\text{IMI}}$, used internationally for many years by military radio operators, means "repeat." Some veteran operators would have you believe that $\overline{\text{IMI}}$ derived from the words "I missed it."

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.
$\overline{\text{AR}}$ . . . . End of transmission; no 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 the 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.
CFN . . . . . . . . Confirmatory material to follow. (Used teletypewriter operation only.)

## OPERATING SIGNALS

Radio operators and teletypists frequently exchange routine advice and operating information, and 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, and 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 the customary operating signals, the radiotelephone operator transmits operating information in brief spoken phrases. An exception is made to this rule 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 the 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 teletypewriter 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 8578, which means "I hear you best on 8578 kc."

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. Special 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 5-3. Remember that the Q code is used internationally, and speaks of "telegrams" whereas 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 teletypewriter, or by automatic tape equipment. The format exists in four versions, one of which is adapted to the special requirements of each of these primary transmission media. Here we will study the radiotelegraph message format, the one of first and most immediate importance to the Radioman. 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 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 5-4, the message is divided into

Table 5-3. --Operating Signals

| Signal | Question | Answer, advice, or order |
|---|---|---|
| QCB | . . . . . . . . . . . . . . . . . . . . . . . | Delay is being caused by ____( (1) your transmitting out of turn; (2) your slowness in answering; (3) lack of your reply to my____). |
| QRA | What is the name of your station? | The name of my station is____. |
| QRG | Will you tell me my exact frequency (or that of____)? | Your exact frequency (or that of ____) is____ kc (or mc). |
| 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. |
| QRN | Are you troubled by static? | I am troubled by static. |
| QRO | Shall I increase power? | Increase power. |
| QRP | Shall I decrease power? | Decrease power. |
| QRQ | Shall I send faster? | Send faster. (____wpm.) |
| QRS | Shall I send more slowly? | Send more slowly. (____wpm.) |
| QRT | Shall I stop sending? | Stop sending. |
| QRU | Have you anything for me? | I have nothing for you. |
| QRW | Shall I inform____that you are calling him on____kc (or mc)? | Please inform____that I am calling him on ____kc (or mc). |
| QRX | When will you call me again? | I will call you again at____(hours) on____kc (or mc). |
| QRZ | Who is calling me? | You are being called by____on____kc (or mc). |
| QSA | What is the strength of my signals (or those of ____)? | The strength of your signals (or those of____) is____(1 to 5). |
| QSO | Can you communicate with___direct or by relay? | I can communicate with___direct (or by relay through___). |
| 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)). |
| QSZ | Shall I send each word or group more than once? | Send each word or group twice (or____times). |
| QTC | How many telegrams have you to send? | I have ___telegrams for you (or for____). |
| ZAA | . . . . . . . . . . . . . . . . . . . . . . . | You are not observing proper circuit discipline. |
| 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). |

Table 5-3.--Operating Signals--Continued

| Signal | Question | Answer, advice, or order |
|---|---|---|
| ZBO | Of what precedence and for whom are your messages? | I have (or___has)___(numeral indicating number of messages, may be followed by precedence prosign to indicate the precedence) message(s) for you (or for____). |
| ZBM | . . . . . . . . . . . . . . . . . . . . . . | Place___on watch on this frequency. ((1) A qualified speed key operator, (2) a competent operator.) |
| ZBP | . . . . . . . . . . . . . . . . . . . . . . | Your___((1) characters are indistinct, (2) spacing is bad). |
| ZDK | Will you repeat message___(or portion ___)? Or, rerun No.___? | Following repetition (of___) is made in accordance with your request. |
| ZDQ | . . . . . . . . . . . . . . . . . . . . . . | Message___was relayed to___at___by___ (on___kc (or mc)). |
| ZEC | Have you received message___? | Message___((1) not received, (2) unidentified, give better identification data). |
| ZEH | . . . . . . . . . . . . . . . . . . . . . . | Accuracy of___portion of following message (or message___) is doubtful. Correction or confirmation will be forwarded when received. ((1) Heading, (2) text, (3) group to___.) |
| ZEN | . . . . . . . . . . . . . . . . . . . . . . | This message has been delivered by other means or by a separate transmission to the addressee(s) immediately following this operating signal. |
| ZEU | . . . . . . . . . . . . . . . . . . . . . . | Exercise (drill) message. |
| ZEV | Request you acknowledge message____. | Message (or message___) is acknowledged. |
| ZEW | . . . . . . . . . . . . . . . . . . . . . . | Your attention is invited, for___((1) action, (2) information), to message which is in your files. |
| ZEX | . . . . . . . . . . . . . . . . . . . . . . | This is a book message and may be delivered as a single address message to addressees for whom you are responsible. |
| ZFF | . . . . . . . . . . . . . . . . . . . . . . | Inform me when this message (or message ___) has been received by___((1) addressee(s), (2) addressee's authorized representative, (3) by___). |
| 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___. |
| ZFL | Was there any traffic addressed to me on___Broadcast schedule between serial number___and___? | Following traffic was addressed to you on ____ broadcast schedule between serial numbers ___and___. |

Table 5-3.--Operating Signals--Continued

| Signal | Question | Answer, advice, or order |
|---|---|---|
| ZFO | . . . . . . . . . . . . . . . . . . . . . . . | Message___is being delivered as a basegram 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). |
| ZKA | Who is controlling station (NCS) on this frequency (or on___kc (or mc))? | I am (or___is) controlling station (NCS) on this frequency (or on___kc (or mc)). |
| ZKI | . . . . . . . . . . . . . . . . . . . . . . . | Set watch on___kc (or mc)___((1) continuous, (2) until further notice). |
| 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. |
| ZOI | . . . . . . . . . . . . . . . . . . . . . . . | Pass this message to the nearest (or___) weather central control. |
| 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). |
| ZOU | How should traffic for___be routed? | Route traffic for___through___(on___kc (or mc)). |
| ZOV | . . . . . . . . . . . . . . . . . . . . . . . | Station designation preceding this operating signal is the correct routing for this message rerouted by___. |
| ZOY | . . . . . . . . . . . . . . . . . . . . . . . | Relay this message only to the station(s) whose designation(s) precede this operating signal. |
| ZUE | . . . . . . . . . . . . . . . . . . . . . . . | Affirmative (Yes). |
| ZUG | . . . . . . . . . . . . . . . . . . . . . . . | Negative (No). |
| ZUI | . . . . . . . . . . . . . . . . . . . . . . . | Your attention is invited to___. |
| ZUJ | . . . . . . . . . . . . . . . . . . . . . . . | Standby. |
| ZWL | . . . . . . . . . . . . . . . . . . . . . . . | No forwarding action to the addressee designation(s) immediately following is required. |

Table 5-4. — Radiotelegraph Message Format

| Parts | Components | Elements | Format line | Contents |
|---|---|---|---|---|
| H | Beginning procedure | Handling instructions . | 1 | Not used in radiotelephone and radiotelegraph. |
| | | a. Call . . . . . . . . | 2<br>3 | Station(s) called; prosign XMT (exempt) andexempted calls.<br>Prosign DE (from) and designation of station calling. |
| E | | b. Transmission identification.<br>c. Transmission instructions. | 4 | Station serial number.<br>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. |
| A | 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). |
| D | Address | a. Originator's sign; originator. | 6 | Prosign FM (originator 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. |
| N | | 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. |

Table 5-4. —Radiotelegraph Message Format—Continued

| Parts | Components | Elements | Format line | Contents |
|---|---|---|---|---|
| | | d. Exempted addressee sign; exempted addressee(s). | 9 | Prosign XMT; exempted addressee designation(s) expressed as call signs, address groups, or plain language. |
| G | 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 in- | 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). |

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

It should be understood that there is no relationship between format lines and typed 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 teletypewriter and tape relay work, but is omitted in radiotelephone and radiotelegraph. The abbreviated plaindress heading (discussed later) may omit any or all of the following:

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 occasion for them. The messages themselves are, for this reason, much simpler than the basic message format, which must provide for everything. You seldom see a message with every format line, and you may never see one that used all the contents. But 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 you 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 messages 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. The preliminary call also alerts the receiving operator to prepare to copy a message.

A simple preliminary call consists of the station called, the prosign DE, the calling station, and the prosign K. If desired, the precedence of the message may be included. Following are two examples of a preliminary call.

1. NCFX DE NAUC K
2. NCFX DE NAUC P K

From the earlier discussion of call signs, it is apparent that transmission of the 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 - 22345Z | 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<br><br>FOR YOU AT FIRST LIGHT. | Text. |
| 13 | $\overline{\text{BT}}$ | Break. Separation between text and ending. |
| 16 | K | Go ahead and transmit. |

On receiving the 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 $\overline{\text{AR}}$. 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.

It must be apparent to every station handling the message (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 the 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 the 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 - | 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 62 percent shorter than the expanded text, which reads: CARRIER QUALIFICATION LANDINGS COMPLETED. ESTIMATED TIME OF ARRIVAL GUANTANAMO BAY CUBA 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 NR522 W NR522 - | NAVCOMMSTA Washington broadcast serial number 522 - - that is, the 522d message placed on this broadcast schedule since the beginning of the current month. |
| 5 | PP - | PRIORITY precedence to action addressees. |
| 5 | RR - | ROUTINE precedence to information addressees. |

| Format line | Transmission | Explanation |
|---|---|---|
| 5 | 11Ø847Z 11Ø847Z | 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 | BT | Break. |
| 12 | (156 groups text) | Text. |
| 13 | BT | Break. |
| 16 | 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 the capabilities of teletypewriter equipment, thereby eliminating much of the processing formerly required for incoming messages. It also decreases the originator's preparation time and the 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 NTX (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 the 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
B. COMTHIRTEEN 13153ØZ
1. REQUEST DESIGNATED COMMITTEE
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 |

SCP 4

If a message does not require all of the elements, the format is adjusted accordingly by omitting the 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 charge 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; and when there is only one reference, the reference identification is included in the body of the paragraph. For example:

UNCLAS
YOUR 1ØØ915Z. 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 parts are forbidden: (1) preamble, (2) address, (3) prefix, and (4) text.

## MESSAGES BETWEEN COMMUNICATION PERSONNEL

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

### SUPERVISORY WIRES

Supervisory wires are the means of correcting traffic-handling errors in teletypewriter tape relay operation. You can recognize them easily, because they invariably are addressed to the supervisor (SUPVR) of the called station. Examples of supervisory wires are shown in chapter 12.

### PROCEDURE MESSAGES

Procedure messages obtain and provide corrections, verifications, and/or repetitions. The test 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 ($\overline{BT}$) 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 normally contain all the necessary format lines, including The DTG and $\overline{BT}$. They may even be encrypted, but in an encrypted service message, you cannot recognize it as a service—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:

1. Referenceto another service message;
2. The 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 communications 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. The operating signal ZFO (Message ____________ is being delivered as a basegram) is transmitted, along with the message identification. Example:

```
WR NR34Ø4
M 11Ø254Z
FM NSS
TO NERK
BT
UNCLAS
ZFO ALNAV 1Ø192ØZ/Ø5
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 the general messages that were received and the basegrams for which only the 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, following 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

A plaindress message has originator and addressee designations in the heading. Unless the call serves as the address, the message contains all the 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

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 may be omitted from the heading: precedence, date, DTG, and group count.

## CODRESS

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, information to COMCRUDESLANT and COMASDEFORLANT. USS Joseph K. Taussig (DE 1030), although a part of the task group is on detached duty and not participating. The 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, the call signs are encrypted in accordance with current instructions. Example:

K3M3 - XMT - NFFN DE E2L4 -
P - 18Ø934Z
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
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. (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 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. With a single exception, no alteration can be made to the original message from the precedence to the end of the text. If the message to be readdressed carries a DTG besides the current month, the abbreviation of the month of origin is added following the original DTG.

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 thefollowing plaindress message, NTAA readdresses it to NUYO for information. Here is the original message received from NTSY:

NTAA DE NTSY -
P - 281634Z -
FM NTSY -
TO NTAA -
INFO NBFJ

GR32
BT
TEXT
BT

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

NUYO DE NTAA -
R - 281832Z -
FM NTAA -
INFO NUYO -
P - 281634Z -
FM NTSY -
TO NTAA -
INFO NBFJ
GR32
BT
TEXT
BT

## ADDITIONAL MESSAGE EXAMPLES

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

Table 5-5. —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. Examples: (1) Initial enemy contact reports. (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. (3) Warnings of imminent large-scale attacks. (4) Extremely urgent intelligence messages. (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>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). Examples: (1) Amplifying reports of initial enemy contact. (2) Reports of unusual major movements of military forces of foreign powers in time of peace or strained relations. (3) Messages that report enemy counterattack or request or cancel additional support. (4) Attack orders to commit a force in reserve without delay. (5) Messages concerning logistical support of special weapons when essential to sustain operations. (6) Reports of widespread civil disturbance. (7) Reports or warnings of grave natural disaster (earthquake, flood, storm, etc). (8) Requests for, or directions concerning, distress assistance. (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>Time standard:<br>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. Examples: (1) Situation reports on position of front where attack is impending or where fire or air support will soon be placed. (2) Orders to aircraft formations or units to coincide with ground or naval operations. (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). (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 with PRIORITY is used.<br>Time standard:<br>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. Examples: (1) Messages concerning normal peacetime military operations, programs, and projects. (2) Messages concerning stabilized tactical operations. (3) Operational plans concerning projected operations. (4) Periodic or consolidated intelligence reports. (5) Troop movement messages, except when time factors dictate use of a higher precedence. (6) Supply and equipment requisition and movement messages, except when time factors dictate use of a higher precedence. (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>Time standard:<br>3 hours—start of business following day. |

## CHAPTER 6

# RADIOTELEGRAPH

Radiotelegraph operating procedure explained in this chapter is of great importance to the Radioman. The teletypewriter and radiotelephone procedures described in later chapters really are adaptions of this basic communication procedure and are easily understood by the operator versed in radiotelegraph procedure.

The effective edition of ACP 124 contains the operating instructions for radiotelegraph communications. Chapter 9 of DNC 5 (effective edition) presents an expansion of the material and modifications, where necessary, for Navy usage. Another publication, Supplement 1 to ACP 124, details the 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 this chapter is to show how they are employed in circuit operation.

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

### CIRCUIT DISCIPLINE

We learned in chapter 3 that radio is potentially the least secure of all the various means of communication. One way in which the 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 the violations that endanger radio transmission security.

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

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. For 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 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 will frequently identify a unit or station even when frequency and call signs are changed. This 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.

You may be surprised at such a long list of incorrect ways of performing on circuits. Yet, each one 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.

The 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. The station serving the senior commander usually is designated as net control, although it may be another station if that station is in better position to control the net.

The duties of the net control station are to speed flow of traffic on the net, to maintain circuit discipline, to limit transmissions to the essential minimum, to settle disputes incident to traffic handling, and to 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; COMMON; FUNCTIONAL NETS

Nets are classified into three types according to mission or purpose: (1) command, (2) common, 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. For example, a task force command net is activated by the task force commander and is guarded by the task group commanders.

A common net links all ships (and in amphibious operations, troop units) of the same task organization. For example, a task group common net is activated by the task group commander and is guarded by all ships and troop units in the task group.

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 picket vessels and controlled by a sector AAW ship.

## TYPES OF RADIO WATCHES

Radiomen stand four types of radio watches. The requirements of each type are prescribed in the effective edition of DNC 5 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, however, do not provide the Radioman with a choice. The communication plan under which your 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 is done by either using the prosign $\overline{\text{AS}}$, meaning "Wait," or the operating signal ZKF, meaning "Station leaves net temporarily." The operating signal may be followed, if desired, 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, the intercept method, and the 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 is the normal method 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, 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 or 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.

The intercept method is not currently 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 the 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 menas 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 the ships can tell if any messages are missed.

Automatic keying for CW broadcasts is at speeds between 17 and 29 words per minute. When the traffic load is light, the speed of transmission is dropped to 14 wpm between the hours of 0000 and 0600. 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. All large naval ships and most of the smaller ones are now equipped to copy the radioteletypewriter broadcasts. A ship copying the RATT broadcast is not required to copy the CW broadcast. This 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 the CW broadcast. A prompt shift to the 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 the "Fox Skeds" for so many years that you seldom hear 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 the CW broadcasts. Ships having only one Radioman are required to copy only the one-operator periods. This consists of 5 hourly schedules each day, beginning at 0000, 0600, 1200, 1600, and 2200 GMT.

Ships carrying two Radiomen copy the two-operator periods. This includes all the schedules 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. You may assume that your station has good strength and readability unless notified otherwise. You do not exchange strength of signals and readability with another station unless you cannot hear him clearly or he cannot hear you.

The operating signal QSA preceded by the prosign $\overline{\text{INT}}$ means "What is the strength of my signals (1 to 5)?" The reply calls for the same signal (QSA) with the appropriate number affixed. The meaning of signal strength numerals is as follows:

1. Scarcely perceptible;
2. Weak;
3. Fairly good;
4. Good;
5. Very good.

The use of the signal strength report generally is limited to occasions in which the actual signal strength instead of readability is the 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 NHDYs 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

You will notice a short dash between certain letters in the message examples in this chapter. This 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 teletypewriter 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 the originator's call sign and the prosign TO, between the call sign of the last action addressee and the prosign INFO, and between the call sign of the last information addressee and the 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 hyphen (-), 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 always must be used in encrypted messages. Sometimes the group count is omitted in messages having plain language texts, although this omission is more common in teletypewriter procedure than in radiotelegraph messages.

A message having an accounting symbol in the prefix (format line 10) must always have either a numerical group count or the prosign GRNC. The prosign GRNC means "The groups in the text of this message have not been counted." This prosign can be used only with plain language texts. Remember that messages with encrypted texts must always indicate a numerical count of the text groups.

The break prosign $\overline{\text{BT}}$ 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 text 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. This is called indirect communication, and one or more relays are required to get the message to its destination. This 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. To do this, however, remember 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 the prosign T in the transmission instructions (format line 4). When a message is received with the 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-<br>
T -<br>
R - 311615Z -<br>
FM NTSY -<br>
TO NUYO<br>
SQFK<br>
GR6<br>
$\overline{\text{BT}}$ (Etc.)

The 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 -<br>
T - SQFK -<br>
R - 161813Z -<br>
FM NTSY -<br>
TO SQFK -<br>
INFO NUJC<br>
GR18<br>
$\overline{\text{BT}}$ (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.

The 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, requesting NUBJ to relay the message to NTFJ:

NUBJ NUYO DE NWFD -<br>
NUBJ - T - NTFJ -<br>
R - 181927Z -<br>
FM NWFD -<br>
TO NTFJ<br>
NUBJ<br>
NUYO<br>
GR29<br>
$\overline{\text{BT}}$ (Etc.)

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

The prosign XMT (exempt) is not used in conjunction with the 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 the transmission instructions. For example, in the following message, 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 -<br>
T - ZWL NTFJ -<br>
R - 171315Z -<br>
FM NTSY -<br>
TO NFFN<br>
NHDY<br>
NTFJ<br>
NUBJ<br>
SQFK<br>
GR98<br>
$\overline{\text{BT}}$ (Etc.)

The 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 the transmission instructions. Operating signal ZOC is used most frequently in general messages. Here is the way it appears in the transmission instructions of a typical general message:

NERK DE NSS W NR156 -<br>
ZOC -<br>
R - Ø61216Z/17 -

FM SECNAV -
TO ALNAV
GR85
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 you should transmit an excessive number of Es. The error prosign is sent immediately after the error. The manner in which transmission is resumed varies somewhat, depending on whether the error was made in the message heading or text.

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 - 13 Ø93Ø Z -
FM NAU -
TO NENB
NHTG EEEEEEEE
TO NENB
NHTZ -
INFO NHDY
GR15
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 -
O - 211827Z
GR21
BT
UNCLAS
CONDUCT NO SUBMERGED OPS SOUTH
OF LAT 38 EEEEEEEE
LAT 373ØN (Etc.)

The preceding example can be used to illustrate another point. The question sometimes 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 NALJ -
P - 1ØØ256Z -
FM NALJ -
TO STRK
EEEEEEEE AR

After a transmission is receipted for, the error prosign method of canceling the transmission cannot be used. A procedure message or a service message—properly released—is used for this purpose.

## REPETITIONS; CORRECTIONS; VERIFICATIONS

Occasionally, messages or parts of messages must be repeated, corrected, or verified. To accomplish this, the prosigns AA (all after), AB (all before), WA (word after), and WB (word before) are used in procedure messages in conjunction with prosigns IMI, 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. This may be done by using the date-time group and/or the 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 it is 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 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 -
FM NHAP -
TO NIQC -
INFO NOKB
GR9
BT
UNCLAS
TWO ARTIC SURVIVAL KITS
REQUIRED BY 6 AUG
BT
K

The prosign BT appears in the message twice. Therefore, a request using (1) AB BT denotes all before the text (the first BT); (2) AA BT denotes all after the heading (the first BT); (3) WA ARCTIC denotes the text word SURVIVAL; (4) AA AUG BT denotes the message ending (after the second BT).

It is important that you 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 examples:

YOBV DE NTSY -
R - 271545Z -
FM NTSY -
TO NUYO -
INFO NCFX
NTFJ
GR 11
BT
BPHTJ ODZNM WEBJL OPNGB DPBIR
FLMBJ RRWZA WUJQE DPJAF OHRUC
BPHTJ
BT
K

USE OF IMI

The prosign IMI means REPEAT. It may be used by the receiving operator to mean "Repeat all of your last transmission," or, with identifying data, to mean "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." The prosign IMI cannot be sent to request repetition of a message for which a receipt has been given. Either a procedure message, containing operating signals, or a service message must be used for this purpose.

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
AB BT -
YOBV DE NTSY -
M - 271545Z -
FM NTSY -
TO NUYO -
INFO NCFX
NTFG
GR11
BT
K

The previous example shows how to request and send a repetition of the entire heading. When you need repetition of only a portion of a message heading, you must 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
IMI FM TO INFO K

NTSY answers:

NUYO DE NTSY
FM TO INFO -
FM NTSY -
TO NUYO -
INFO
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
R TO INFO -
R - 271545Z -

FM NTSY -
TO NUYO -
INFO
K

The following examples show how to obtain repetitions of parts of the message text. Note how the 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
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

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
3 TO 8 - WEBJL OPNGB DPBIR FLMBJ
RRWZA WUJQE K

Here is a worthwhile rule to remember: If you need repetitions of more than one portion of a message, be sure to incorporate all your 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
3 - WEBJL - 6 TO 8 - GLMBJ RRWZA
WUJQE K

## USE OF C

The prosign C, used alone, means "You are correct." It is applicable in this respect if an operator questions a portion of a message you sent him, and you find 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." The uses of C are brought out in the following discussions of INT and J.

## USE OF INT

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

The 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 the prosign C, meaning "You are correct." An example of this follows:

NCFX DE NTSY C K

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

Never hesitate to question the group count when you are not in agreement with the transmitting operator. 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 follow.

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 the following message to NCFX:

NCFX DE NTSY -
R - 272113Z
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 is used: 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 following example.

Station NTSY transmits to NCFX a message having 76 encrypted text groups. 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 the group count is checked by the foregoing procedure.

The INT prosign is used also to question other portions of messages besides the group count. 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 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 our discussion of the prosign INT, consider the next message example and the transmissions following it. They show how to use INT with prosigns WA and WB when questioning parts of a plain language text. Here is the message:

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

The 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, the 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 your 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, the prosign J may be sent instead of a receipt.

The following examples show how prosign J is used in typical situations.

Station NTSY desires NTFJ's 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
C 171623Z -
R - 171623Z -
FM NTFJ -
TO NUYO -
INFO NTSY
GR8
BT
UNCLAS
PROCEED ON DUTY ASSIGNED. MAKE MOVEMENT REPORTS
BT
K

In the example just given, note how NTFJ uses the prosign C following the callup in his reply. Here is an important 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 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 BT K

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

NUYO DR NTFJ
C 171623Z AB BT -
R - 171623Z -
FM NTFJ -
TO NUYO -
INFO NTSY
GR 8
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, 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 BT -
INFO NTSY
GR9
BT -
AA DUTY -
ASSIGNED. MAKE OWN MOVEMENT REPORTS
BT
K

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

YOBV DE NTFJ
IX BT
TURN NINE
BT
K

Before receipting, NABC asks for verification:

NTFJ DE NABC J K

After verifying with the originator, NTFJ sends:

NABC DE NTFJ C -
IX BT
TURN NINE
BT
K

Prosign 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, you will need to break in on someone's transmission. This is permissible if you observe the proper break-in procedure.

When only two stations are concerned in a transmission, breaking in is permitted if necessary. The 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 break-in. This pause allows the station breaking in to arrange for a shift of frequency, request repeats, and so forth. When two stations are working directly on a circuit, the most frequent use of the break-in procedure is for on-the-spot "fills" or 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 AS

When ready to receive, NFFN transmits:

DE NFFN 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 you press your 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. Discretion must be practiced on all such occasions.

## RECEIPTS

The prosign R indicates the receipt of a transmission. Example:

NFFN DE NHDY R 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 by using the 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 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 would apply if receiving conditions were poor and you obtained several repetitions before receiving the message correctly.

## ACKNOWLEDGMENTS

An acknowledgment is a communication announcing that the message to which it refers has been received and is understood. Do not confuse an acknowledgment with a receipt or a reply. A receipt, as you have learned, is sent by one operator to another to indicate only that the message has been received. An acknowledgment says that the message has been received and is UNDERSTOOD. A reply is an answer to a message. A prompt reply referring to the message also meets the requirement of an acknowledgment.

Acknowledgments usually are obtained by means of a request within the text. The acknowledgment itself consists of the message reference and the word acknowledged. For 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, you must remember that acknowledgments must always be authorized by the addressee of the message.

If the 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 occurs, a separate message is sent requesting the acknowledgment.

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

An operating signal, ZEV, means "Message is acknowledged," but the effective edition of DNC 5 limits its use to acknowledging procedure messages only.

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

Every radiotelegraph transmission you make must end with either the prosign K or $\overline{AR}$.

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 the transmitting station requires or expects a response from the receiving station.

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

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

Prosigns K and $\overline{AR}$ are not used together. End every transmission with one or the other--but never both.

## 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 called 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 light. They use it to call ships whose call signs are unknown, such as warships of merchantmen too distant to identify.

## MESSAGES IN STRINGS

When communication is good, traffic handling frequently is speeded when one station sends several messages to another without 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
(QSG means "Send 5 messages at a time.")

The 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 -
FM NGTA -
TO EZRA
GR 15
$\overline{BT}$
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:

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 is used frequently. It is employed when some action must be executed at a certain instant, especially 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 delayed executive and immediate executive. Only the delayed executive method is authorized for use on radiotelegraph circuits, hence it is the only method discussed here.

In the delayed 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 delayed executive method messages may seem complicated at first. Actually, the steps are simple, and a few drills will do much toward squaring you away on this method. You can start by learning these four rules for handling executive messages:

1. Only abbreviated plaindress messages may be used in the delayed 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 the 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 the 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 delayed 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 IX (5-second dash)
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 IX (5-second dash) 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 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
IX BT
FORM QUEBEC 1ØØ TACK SPEED 16
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 the prosigns IX BT in the heading indicates that it is part of a message transmitted previously. Example:

NFFN NHDY DE PKWN
SPEED 16 IX (5-second dash) AR

Before executing the message, PKWN decides to cancel it. He then transmits:

NFFN NHDY DE PKWN
BT
NEGAT
BT
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
BT
NEGAT TURN SIX
BT
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:

IX BT
SIERRA HOTEL WHISKEY TACK DELTA ZULU ROMEO
BT
K

Station NCFX receipts for the message, but NWBJ requests verification of the first part of the message with this transmission:

HEFT DE NWBJ
J 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
C BT TO TACK --
BT SIERRA HOTEL WHISKEY TACK
K

To obtain a repetition, the same procedure is followed, except that 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 NWBJ 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

As a Navy communicator you 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, you must have a thorough understanding of commercial practices.

The subject 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. Your best 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 -
M - 291646Z -
FM USS ENTERPRISE --
TO MARK L VECELLIO 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 the addressee. The purpose of an accounting symbol is to indicate the Government agency financially responsible for the message. In addition to NAVY, there are many other accounting symbols for each of the various Government agencies. 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. NAVCOMMSTA Washington's teletype transmission takes the following form:

BEAØ45
CK 12 WASHINGTON DC 29 JUL 6Ø 515P
GOVT NAVY
MARK L VECELLIO
7927 GATEWAY BLVD
DISTRICT HEIGHTS MD
YOUR LEAVE EXPIRES ON BOARD AT NORFOLK VA
Ø745 6 AUG 6Ø
COMMANDING OFFICER USS ENTERPRISE

You will note in the transmission that the order of some of the message parts changed, and 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 the toll charges begin there. 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 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 to the following: 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. For example, a ship in the Atlantic, Mediterranean, Middle East, or Caribbean 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. The ships are in direct communication, hence the call serves as the address.

NTAA DE NWKY -
R - 281417Z
GR14
BT
MSG LTJG DALY REGRET CANNOT
MEET YOU PHILADELPHIA THIS WEEK
AS PLANNED LTJG JORDAN
BT

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.

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 - 25143ØZ -
FM NFFN -
TO HAYY
GR37
BT
MSG CK24 NL COMLE MRS MARCELLA CROWLEY 3319 79TH AVE FORESTVILLE 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 you can see, the message requiring tolls is slightly more complicated. Following MSG is the check (count) of the 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. The 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 the 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 is as a full-rate telegram, which carries no class-of-service indicator.)

Following the class-of-service indicator is the commercial indicator COMLE. This 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. Or it is 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, NewYork, 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 refiledwith 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. There is, however, one exception to the inter-area refile as outlined. The Navy has radio circuits from Washington direct to Honolulu, Hawaii, 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 NTX teletypewriter circuits. Class E messages sent by NTX are illustrated in chapter 11.

The 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 the chargeable words, and also must be able to compute the toll charges from the rate tables in the effective edition of DNC 26.

The Radioman designated by the commanding officer as commercial traffic clerk handles the money, keeps the records, and makes the required reports. Duties and responsibilities of the commercial traffic clerk are explainedfully in DNC 26.

## OPERATOR ENDORSEMENTS

Several minor details in connection with the transmission and reception of a message are important and necessary. For instance, the 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 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."

Before discussing the contents of an operator's endorsement, here are some terms you should know.

1. Time of delivery: The TOD is the time the transmitting station completes delivery of the message. (Do not confuse this with the time offile (TOF), which is the time an outgoing message is delivered to the communication c nter for processing and onward transmission.)

2. Time of receipt: The TOR is the time the receiving station completes the receipt of a message.

3. Personal sign: Each operator and supervisor is assigned a 2-letter personal sign, usually his initials, for use in message endorsements to indicate individual responsibility. Initials cannot be used in all instances, however, because of possible conflict with prosigns or channel designations, and because of the requirement that no two signs can be alike within a particular station. Personal signs are never transmitted.

Operator endorsements are of two types: servicingfor outgoing messages andfor incoming messages. Now let's take a look at the two types of endorsements.

## OUTGOING ENDORSEMENT

Servicing for an outgoing message is penciled on the face of the message blank as shown in

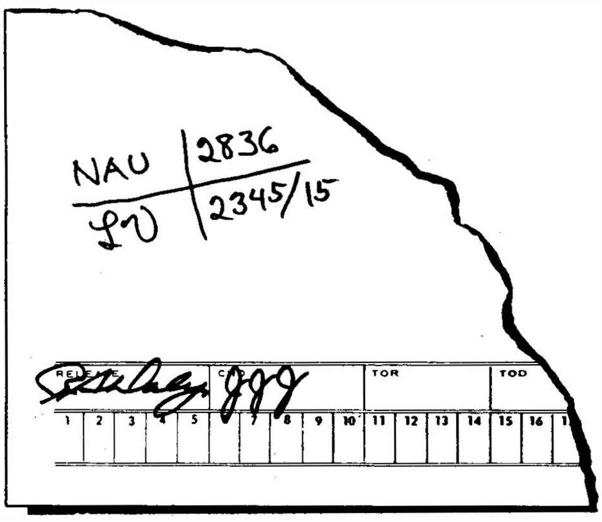



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Figure 6-1.— Servicing an outgoing message.

figure 6-1. The supervisor makes the crossed lines and fills in the two upper spaces with the following information:

1. Call sign of the ship or station to be called.

2. The circuit frequency in kilocycles or megacycles.

After transmitting the message, the circuit operator adds the following data in the two lower spaces:

1. Operator's personal sign.

2. 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, the servicing for an incoming message is typed on the message blank. The information is typed because the receiving operator keeps the message blank in his typewriter until after he receipts for the message. Slant signs separate the 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 the 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, life-raft, and survival craft frequency. |
| 121.5 mc | - | International aeronautical emergency frequency for VHF band. |
| 243.0 mc | - | Aeronautical emergency frequency for UHF band. |

You will note that 500 kc is used in times of distress and also is the international calling frequency. In routine radiotelegraph communications, merchant ships contact each other on 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 the operators of the silent periods. Except for actual distress messages, all traffic ceases at these times on frequencies between 480 and 520 kc.

Guarding the 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 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.

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 the SS Blank, whose call sign is WUBN, is in distress. The call sign of your ship is NTAA. Your answer to her distress message would be:

WUBN WUBN WUBN DE NTAA NTAA
NTAA RRR SOS AR

The answer to a distress message usually is followed by the name of your ship, position, and maximum speed at which you are proceeding toward the vessel in distress. This answer, of course, must be originated by your commanding officer.

If your ship is not in position to give assistance to the SS Blank, your 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 your ship's call sign repeated 3 times. Authority to relay the message must come from your 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 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 your ship (NTAA) was control vessel for WUBN. At the end of the distress traffic, your commanding officer would originate the following message:

SOS CQ CQ CQ DE NTAA SS BLANK
WUBN QUM AR

Note that DE is followed by the call sign of the ship transmitting, and this in turn is followed by the name and call of the ship that originated the distress call. The signal QUM means "Distress traffic is ended."

A naval vessel in distress ordinarily does not use the international distress signal SOS. Instead, Navy communication channels and cryptoaids are utilized.

Although 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 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.

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 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 the following five signals are used by merchant ships to indicate distress due to enemy action:

| 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. |

Further 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).

## FACSIMILE BROADCAST

Facximile (FAX), as you learned 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 that are not equipped to transmit FAX have equipment aboard for receiving only. It is used for copying the facsimile component of the fleet broadcasts. 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 |

The areas covered by FAX broadcasts are the same as those covered by the RATT and CW broadcast schedules. The 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.

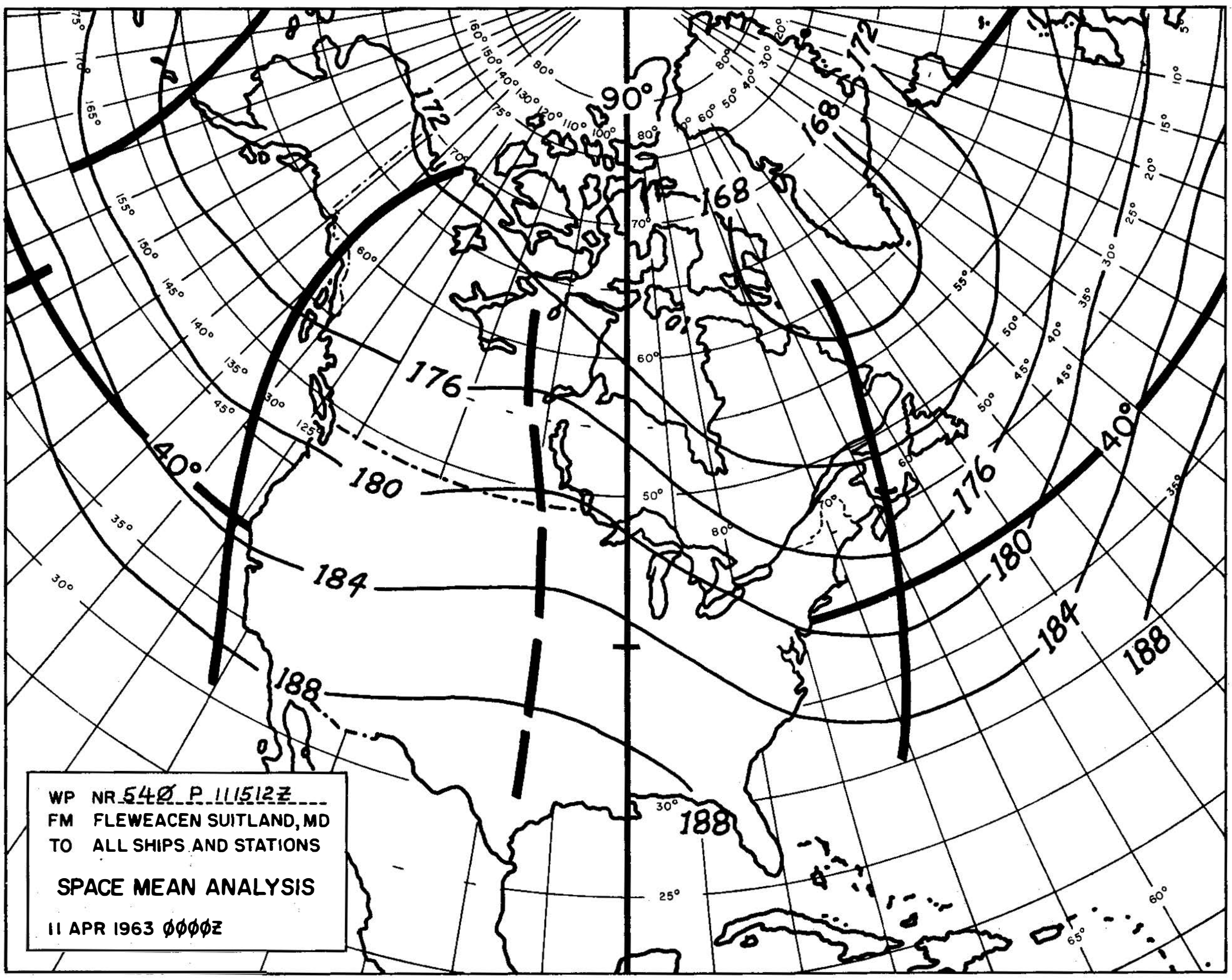


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Figure 6-2. — Weather chart transmitted on Washington FAX broadcast.

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 generally 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. The test calls consist of a series of Vs, followed 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 the test calls are transmitted, and at least 2 minutes before scheduled broadcast time a synchronous signal is transmitted. This permits receiving stations to synchronize their equipment with the transmitting station.

The last item of each day's transmissions is the station log of messages sent. The log consists of the 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 usually are not requested.

Normally, requests for repetitions received by the transmitting station are answered on the first schedule following receipt of the request.

A vessel wishing to transmit facsimile traffic to a shore station or to another ship makes prior arrangement, 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 the 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. It is important that you 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 $1\frac{1}{2}$ 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. At the completion of the drill, the monitor log is examined and each ship is sent a copy of the log or a summary indicating the errors noted, with corrections referencing appropriate publications.

As a result of your ship's operations, you often obtain little or no CW transmitting experience. Therefore, do not fail to take advantage of every opportunity to participate in a CW drill.

## PERFORMANCE TEST

Before you can take the fleetwide competitive examination for advancement to RM3 or RM2, you must demonstrate your proficiency in sending and receiving international Morse code by successfully passing the performance test. Your local examing board schedules performance tests at least once each quarter.

Preceding the official test, you are given a rehearsal test consisting of messages that are similar to the official test, but different in content and length. The main purpose of the rehearsal test is to give you a good limbering-up exercise. The results of the rehearsal test do not, of course, affect your score on the official test.

The official transmitting test for RM2 consists of 3 messages, containing a total of 500 characters, to be sent in 8 minutes. Time limits include servicing each message with TOD, circuit used, and operator's sign. You are permitted a total of 5 uncorrected errors or omitted characters, therefore you should correct a known errors. A standard hand key must be used for the transmitting test.

The official receiving test for RM3 consists of 4 messages (different from the transmitting test), totaling 600 characters, which must be received and recorded on a telegraphic typewriter within 8 minutes, including time for servicing. Five errors are permitted in the receiving test.

The code transmitting test for RM2 consists of 4 messages, totaling 600 characters, to be sent within 8 minutes, including time for servicing. The code receiving test for RM2 has 5 messages, contains 700 characters, and must be received within 8 minutes.

Radiomen must pass an additional performance test in touch teletypewriting. Details of the teletypewriting test are given in chapter 11.

# CHAPTER 7

# RADIOTELEPHONE

Most of what you learned about radiotelegraph nets is equally applicable to radiotelephone. Just 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.

The lessons you 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 is a guide that you should use in developing good microphone technique. Practice the DO's and avoid the DON'Ts. Remember, though, that nothing can take the place of good commonsense.

DO:

1. Listen before transmitting. Unauthorized break-in causes confusion and often blocks the 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. This overrides unavoidable background noises and prevents 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, when possible, and interrupt your carrier. This 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'T:

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 follows:

| Numeral | Pronounced |
|---|---|
| Ø | Zero |
| 1 | Wun |
| 2 | Too |
| 3 | Thu-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. Examples:

| Number | Pronounced |
|---|---|
| 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 hundred |
| 812,681 | Ate wun too six ate wun |

A few special instances, however, require procedures different from the normal pronunciation—digit by digit. Let us examine the prescribed rules for these exceptions. Notice how some of the examples given differ from the general rule for pronouncing numerals.

1. Ranges, distances and speeds given in mile units are always transmitted as cardinal numbers. Examples:

| Number | Pronounced |
|---|---|
| 10 | Ten |
| 13 | Thur-teen |
| 25 | Twen-ty fi-yiv |
| 50 | Fif-ty |
| 110 | Wun hun-dred ten |
| 300 | Thu-ree hundred |

2. Altitude is always expressed in feet (except for weapons orders, which are always expressed in yards) and spoken in cardinal numbers. Examples:

| Number | Pronounced |
|---|---|
| 700 | Seven hun-dred |
| 1100 | Eleven hun-dred |
| 5500 | Fif-ty fi-yiv hun-dred |
| 10,500 | Ten thow-zand fi-yiv hundred |
| 20,000 | Twen-ty thow-zand |

3. Altitude in weapons orders and information concerning gunfire support are always expressed in yards and are transmitted digit by digit, except that exact multiples of hundreds and thousands are spoken as such. Examples:

| Number | Pronounced |
|---|---|
| 10 | Wun zero |
| 25 | Too fi-yiv |
| 100 | Wun hun-dred |
| 1000 | Wun thow-zand |

4. Bearings are always given in three digits and are transmitted digit by digit. Examples:

| Number | Pronounced |
|---|---|
| 090 | Zero niner zero |
| 180 | Wun ate zero |
| 295 | Too niner fi-yiv |

5. Position angles, always less than 100°, are expressed in two digits and are pronounced as cardinal numbers. The phrase "position angle" must precede the numerals. Examples:

| Number | Pronounced |
|---|---|
| 5 | Position angle fi-yiv |
| 10 | Position angle ten |
| 15 | Position angle fif-teen |
| 27 | Position angle twen-ty seven |

## 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 practiced at every opportunity.

| Letter | Phonetic equivalent | Pronounced |
|---|---|---|
| A | ALFA | AL FA |
| B | BRAVO | BRAH VOH |
| C | CHARLIE | CHAR LEE |
| D | DELTA | DELL TAH |
| 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 |

## 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. Also, they are used in the same manner. A list of the prowords (except for precedence prowords), together with an explanation of each and the corresponding prosign (if one exists), is given in table 7-1. Learn them now, because you will use them often. The precedence of a radiotelephone message is indicated by the actual word(s) of the precedence. For example: PRIORITY, IMMEDIATE, and so on.

## RADIOTELEPHONE MESSAGES

Radiotelephone uses a 16-line message format that is comparable to the formats in radiotelegraph and in 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. But the three major message parts still are there: heading, text, and ending. Each of these, 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, but, 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 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.

### 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." The 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

Table 7-1. --Radiotelephone Prowords

| Proword | Meaning | Corresponds to |
|---|---|---|
| ALL AFTER | All after | AA |
| ALL BEFORE | All before | AB |
| BREAK | Separation of text from other portions of the message. (Used only when confusion between text and heading or ending is likely.) | $\overline{BT}$ |
| CORRECTION | Error | EEEEEEEE |
| DISREGARD THIS TRANSMISSION. | This transmission is in error Disregard it. | EEEEEEEE $\overline{AR}$ |
| DO NOT ANSWER | Do not answer | F |
| EXECUTE | Carry out the meaning of the message or signal to which this applies. | $\overline{IX}$ (5-second dash) |
| EXECUTE TO FOLLOW and IMMEDIATE EXECUTE. | Action on the message or signal that follows is to be carried out upon receipt of EXECUTE. EXECUTE TO FOLLOW is used with the normal and delayed executive methods. IMMEDIATE EXECUTE is used with the immediate executive method. | $\overline{IX}$ |
| EXEMPT | Exempt following addressees from the collective call. | XMT |
| FIGURES | Numerals or numbers follow. | — |
| FROM | Originator's sign | FM |
| GROUPS | Group count | GR |
| GROUP NO COUNT | The groups in this message have not been counted. | GRNC |
| INFO | The addressee designations immediately following are addressed for information. | INFO |
| INITIAL | The following phonetic equivalent is to be recorded as a single letter initial of a name. | — |

Table 7-1.--Radiotelephone Prowords--Continued

| Proword | Meaning | Corresponds to |
|---|---|---|
| I READ BACK | The following is my response to your instructions to read back. | — |
| I SAY AGAIN | I am repeating transmission or portions indicated. | — |
| I SPELL | I shall spell the next word phonetically. | — |
| I VERIFY | I have verified with originator and am repeating. | C |
| MESSAGE FOLLOWS | A message that requires recording is about to follow. | — |
| MORE TO FOLLOW | More to follow | B |
| NUMBER | Station serial number | NR |
| OUT | End of transmission; no response required. | $\overline{\text{AR}}$ |
| OVER | Go ahead; or, this is the end of my transmission and a response is necessary. | K |
| READ BACK | Repeat this entire transmission back to me exactly as received. | G |
| RELAY (TO) | Transmit this message to all addressees or to the addressee designations immediately following. | T |
| ROGER | I have received your last transmission satisfactorily. | R |
| SAY AGAIN | Repeat | $\overline{\text{IMI}}$ |
| SERVICE | The message that follows is a service message. | SVC |
| SIGNALS FOLLOW | Groups that follow are taken from a signal book. (This proword need not be used on nets primarily employed for conveying signals. It is intended for use when tactical signals are passed on non-tactical nets.) | — |

Table 7-1.--Radiotelephone Prowords--Continued

| Proword | Meaning | Corresponds to |
|---|---|---|
| SILENCE . . . . . . . . . . . . . . . . . . . | Emergency silence sign (spoken three times). | $\overline{\text{HM}}$ $\overline{\text{HM}}$ $\overline{\text{HM}}$ |
| SILENCE LIFTED . . . . . . . . . . . . | Resume normal transmissions. | — |
| SPEAK SLOWER . . . . . . . . . . . . . | Your transmission is at too fast a speed. Reduce speed of transmission. | — |
| THAT IS CORRECT . . . . . . . . . . . | Correct | C |
| THIS IS . . . . . . . . . . . . . . . . . . . . | From . . . . . . . . . . . . . . . . . . . . . . . . | DE |
| TIME . . . . . . . . . . . . . . . . . . . . . . | The following is the time or data-time group of this message. | — |
| TO . . . . . . . . . . . . . . . . . . . . . . . | Action addressee . . . . . . . . . . . . . . . | TO |
| UNKNOWN STATION . . . . . . . . . . | Unknown station . . . . . . . . . . . . . . . . . | $\overline{\text{AA}}$ |
| VERIFY . . . . . . . . . . . . . . . . . . . . | Verify with originator and repeat. | J |
| WAIT . . . . . . . . . . . . . . . . . . . . . | I must pause a few seconds . . . . . . . . | $\overline{\text{AS}}$ |
| WAIT OUT . . . . . . . . . . . . . . . . . . | I must pause longer than a few seconds. | $\overline{\text{AS}}$ $\overline{\text{AR}}$ |
| WILCO . . . . . . . . . . . . . . . . . . . . | I have received your message, understand it, and will comply. | — |
| WORD AFTER . . . . . . . . . . . . . . . | Word after . . . . . . . . . . . . . . . . . . . . | WA |
| WORD BEFORE . . . . . . . . . . . . . . | Word before . . . . . . . . . . . . . . . . . . . | WB |
| WORDS TWICE . . . . . . . . . . . . . . | Communication is difficult. Transmit (or transmitting) each phrase twice. (Can be used as an order or request.) | — |
| WRONG . . . . . . . . . . . . . . . . . . . | Your last transmission was incorrect. The correct version is ______________. | — |

Table 7-2. —Radiotelephone Message Format

| Parts | Components | Elements | Format line | Contents |
|---|---|---|---|---|
| | | | 1 | (Not used in radiotelephone.) |
| H | Procedure. | a. Call . . . . . . . . . . . . | 2 and 3 | Station(s) called (proword EXEMPT, exempted calls). Proword THIS IS and station calling. |
| | | b. Message follows . . . . | | Proword MESSAGE FOLLOWS. |
| E | | c. Transmission identification. | | Proword NUMBER and station serial number (when authorized). |
| A | | d. Transmission instructions. | 4 | Prowords RELAY TO; READ BACK; DO NOT ANSWER. Operating signals; call signs; address groups; address indicating groups; plain language. |
| D | Preamble . . | a. Precedence; date-time group; message instructions. | 5 | Precedence designation. Proword TIME; date and time expressed in digits and zone suffix; operating signals. |
| I | Address . . . | a. Originator's sign; originator. | 6 | Proword FROM; originator's designation as address group(s), call sign, or plain language. |
| N | | b. Action addressee sign; action addressee. | 7 | Proword TO; action addressee designation as address group(s), call sign, or plain language. |
| G | | c. Information addressee sign; information addressee. | 8 | Proword INFO; information addressee designation(s) as address group(s), call sign(s), or plain language. |
| | | d. Exempted addressee sign; exempted addressee. | 9 | Proword EXEMPT; exempted addressee designation(s) as address group(s), call sign(s), or plain language. |
| | 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; station designation. |
| | | c. Ending sign . . . . . . . . . | 16 | Prowords OVER; OUT. |

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, means "anchor is dragging." The meanings of such code groups are given in appropriate signal publications.

It may sound strange to you that flag signals are sent by radiotelephone, but they are; this is done often. You must be able to recognize whether you are hearing a flag signal or a word or group spelled phonetically. Here is how you will know: 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, you would write it as DO. Without that proword, you can assume the alphabet flags are intended, and record the transmission as DELTA OSCAR.

## SIGNAL FLAGS AND PENNANTS

The Radioman need not be an 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. The alphabet flags represent letters; the 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; to indicate units; to identify units, and for other specialized purposes. The names of the special flags or pennants and their spoken and written equivalent are given in the following lists.

| Flag or pennant | Spoken | Written |
|---|---|---|
| CODE or ANSWER | CODE or ANSWER | CODE 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 |

In addition, there are the 1st, 2nd, 3rd, and 4th SUBSTITUTE flags. They are used only for flag communication, however, and are of no concern to the 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:

| Preceding the signal | Pennant | Following the 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 CODE

Your duties as a radiotelephone operator require that you know and use correctly the special "language" developed for tactical maneuvering, air control, anti-air warfare, naval gunfire support, electronic countermeasures, antisubmarine warefare, and other specialized uses are called operational brevity codes.

For a complete list of operational bervity code words, refer to the effective edition of ACP 165. ACP 165 is divided into sections according to subject area. Following are the major section headings, along with representative code words from each section. They are presented here to acquaint you 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.)

ANGLES: Height of friendly aircraft in thousands of feet; or fly or am flying at height indicated in thousands of feet.

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— Antiaircraft coordination.

GUNS 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 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: Attacking ship of surface antisubmarine unit.

COLD: ASW contact has been lost and measures are being taken to regain contact.

SINKER: Disappearing radar contact.

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.

GADGET: Radar equipment.

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.

You should understand that the words and phrases of the brevity code provide no communication security. The purposes of the codes are to (1) standardize the vocabulary, (2) increase the accuracy of transmission, and (3) shorten the 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 the actual names of the ships, afloat commands, or the phonetic equivalents of the international radio call signs. Under certain circumstances, however, the phonetically spelled international call sign is used in radiotelephone for station identification, and at other times the ship's name serves as the call sign. These usages are explained in later paragraphs. First, let us consider the voice call signs contained in the JANAP 119 series.

### JANAP 119 VOICE CALLS

The 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 the military call signs listed in the ACP 113 series is in preparation at the time of writing this training course. Because it may be some time before this method is implemented, the voice call signs used in this chapter to illustrate radiotelephone procedure are the type found in JANAP 119.

### 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 the 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 not necessary 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.)

(NORFOLK) CONTROL THIS IS (*USS) ROANOKE

COMDESRON TWELVE THIS IS (NORFOLK) DEGAUSSING CONTROL

(NEWPORT) CONTROL THIS IS (*TJ) GARY

(PORTSMOUTH) SHIPYARD CONTROL THIS IS (*USS) FORRESTAL

(FRANKLIN *D) ROOSEVELT THIS IS (CHARLESTON) CONTROL

(NEW YORK) TUG CONTROL THIS IS *LSM ONE SIX ZERO

(NORFOLK) FUEL CONTROL THIS IS (*USNS) PECOS

It is important to remember that the simplified type of call is authorized only in U.S. ports or U.S. controlled ports. If your ship is in a port that is not under U.S. control, you must conform to the international practice of using phoneticized international call signs on radiotelephone circuits.

## RADIOTELEPHONE PROCEDURE

A radiotelephone circuit would soon become very 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.

The examples of radiotelephone transmissions are assumed to pass over the net shown in figure 7-1. The dashes in the examples indicate natural pauses.

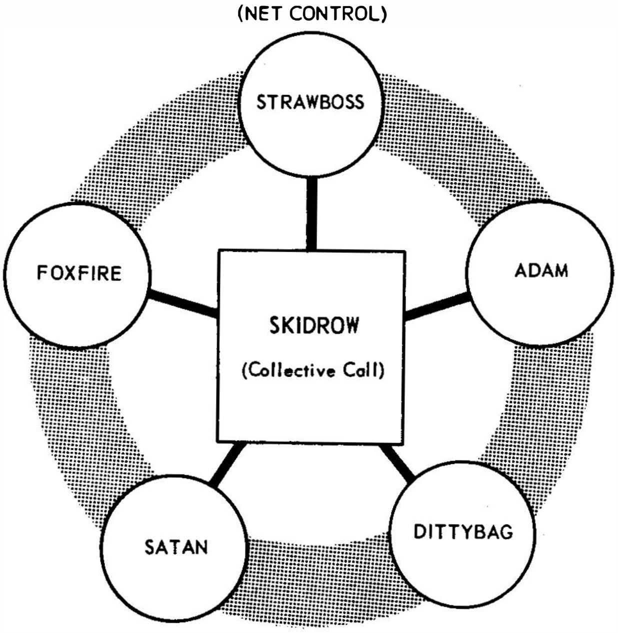



Figure 7-1. —Radiotelephone net.

## CALLING AND ANSWERING

Radiotelephone communication is established by a preliminary call and the answer thereto. In our discussion of radiotelegraph procedure in chapter 6, we found that a preliminary call may be made to individual station(s) or to a group of stations collectively. We learned also that a reply to a preliminary call may be abbreviated in certain instances.

### Single Call

The 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 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.

| | |
|---|---|
| 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 transmission 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, as follows:

| Transmission | |
|---|---|
| FOXFIRE -- . . . . . . . | Call signs of re- |
| SATAN -- . . . . . . | ceiving stations. |
| THIS . . . . . . . . . | From. |
| STRAWBOSS -- . . . . | Call sign of sending station. |
| MESSAGE FOLLOWS— | A message that requires recording is about to follow. |
| ROUTINE . . . . . . . | Precedence. |
| TIME . . . . . . . . . | Time of origin is -----. |
| ONE TWO ONE SIX FIVE NINE ZULU-- | 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."

THIS IS FOXFIRE--ROGER--OUT
THIS IS SATAN--ROGER--OUT

## TRANSMITTING INITIALS OF NAMES

The proword INITIAL is authorized for use on radiotelephone circuits within the U.S. Navy. Presently, however, this proword is not authorized for communicating with the Army or Air Force (joint communications), or with the allied forces (combined communications).

When transmitting names containing initials, the name for which the initial stands, if known, should be spoken instead of the phonetic equivalent. Example:

USS F. D. ROOSEVELT is transmitted as UNIFORM SIERRA SIERRA FRANKLIN DELANO ROOSEVELT.

If the name for which the initial stands is not known, each initial is spoken by the phonetic equivalent preceded by the proword INITIAL. Example:

LT H. J. SAYER is transmitted as LIEUTENANT INITIAL HOTEL INITIAL JULIETT SAYER.

The proword INITIAL applies only to initials of names. The proword I SPELL must be used when transmitting phonetic equivalents of other single letters.

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 following "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.

You may give repetitions in plain language messages by natural phrases or by individual words. In encoded or encrypted messages, make them by individual characters.

CORRECTING AN ERROR

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--UNCLASS--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 portion 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 A 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. (A message already transmitted can be cancelled only by another message.) For example, during the transmission of a message, STRAWBOSS discovers he is giving it to the wrong station:

FOXFIRE--THIS IS STRAWBOSS--ROUTINE--TIME ZERO SIX ZERO TWO ZULU-- UNCLASS--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 following call or the proword MESSAGE FOLLOWS, 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 MESSAGE--TIME ONE ZERO ZERO EIGHT ZERO ONE ZULU--ALL BEFORE BREAK--OVER

STRAWBOSS transmits:

THIS IS STRAWBOSS--ROGER--OUT

STRAWBOSS, after checking with the originating officer, finds the heading correct as transmitted previously. STRAWBOSS then sends:

ADAM--THIS IS STRAWBOSS--I VERIFY --MESSAGE--TIME ONE ZERO ZERO EIGHT ZERO ONE ZULU-- ALL BEFORE BREAK-- PRIORITY-- TIME ONE ZERO ZERO EIGHT ZERO ONE ZULU-- FROM-- STRAWBOSS--TO-- ADAM-- INFO-- DITTYBAG--GROUPS ONE SEVEN--BREAK--OVER

ADAM receipts for the transmission:

THIS IS ADAM--ROGER--OUT

Example 2:

STRAWBOSS-- THIS IS SATAN--VERIFY MESSAGE--TIME ZERO EIGHT FOUR FIVE ZULU--WORD AFTER PROCEED--OVER

STRAWBOSS transmits:

THIS IS STRAWBOSS--ROGER--OUT

STRAWBOSS, after checking with the originating officer, finds that he means HONGKONG instead of SHANGHAI as the word after PROCEED. STRAWBOSS transmits:

SATAN--THIS IS STRAWBOSS--CORRECTION--MESSAGE--TIME 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 be made by the prowords READ BACK and WORDS TWICE. Send READ BACK when you want your message (or a portion of it) repeated back to you as received. Remember to identify the message or portion you want read back. Transmit the READ BACK proword immediately after the call or the proword MESSAGE FOLLOWS, is 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 the message back.

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 your intention by transmitting WORDS TWICE after the call or the proword MESSAGE FOLLOWS, 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 -- ROUTINE-- ROUTINE-- TIME ONE SIX THREE ZERO ZULU--TIME ONE SIX THREE ZERO ZULU--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 is employed to execute tactical signals when two or more units are to take action at the same time. Executive method messages are usually in abbreviated form and contain the proword EXECUTE TO FOLLOW or IMMEDIATE EXECUTE, whichever is applicable, immediately following 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.

1. In our first example the OTC sends a message to the task groupby the normal executive method.

SKIDROW -- THIS IS STRAWBOSS--SIGNALS FOLLOW - - EXECUTIVE 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 FIXFIRE--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 STANDBY--EXECUTE is given. 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 before the message is executed. Example:

SKIDROW -- THIS IS STRAWBOSS--SIGNALS FOLLOW - - 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 you to send an acknowledgment.

The 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.

1. STRAWBOSS--THIS IS FOXFIRE--WILCO--YOUR LAST TRANSMISSION--OUT
2. 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 FOLLOWS--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 FOLLOWS--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 our final example, NOLT (FOXFIRE) received a radiotelegraph message from NAAT (STRAWBOSS) for relay to NRTK (DITTYBAG):

NOLT DE NAAT-T-P-241632Z-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 FOLLOWS--PRIORITY--TIME TWO FOUR ONE SIX THREE TWO ZULU--FROM--STRAWBOSS--TO--DITTYBAG--GROUPS FOUR--BREAK--UNCLAS--RETURN TO BASE--BREAK--OVER

## OPENING A NET

The 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)

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

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 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 FOLLOWS--(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 it is 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," "Four by four," and the like, which are derivatives of the numerals used with operating signals QSA and QRK, are forbidden.

The following prowords are for 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. |
| CLEAR | Excellent quality (readability). |
| READABLE | Quality good--no difficulty reading 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 IS 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

The specific instances when a radiotelephone message must be authenticated are the same as those for a radiotelegraph message. In general, this is when there is any possibility that the message is of enemy origin. Be alert! Sometimes (but not always) you can spot an enemy deceptive message by the operator's mistakes in procedure or by his mistakes in English grammer or pronunciation. The 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 the shore. Stations are established at most of the seaports on the Atlantic, Pacific, and Gulf coasts, and also at Honolulu, Hawaii.

### 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 service depends upon the location of the ship as well as the land telephone, and, of course, upon 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. You will find the land and ocean rate areas, the station call signs, and the operating frequencies 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 RT 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. It is best to tune the transmitter before coming into range to prevent the calling device from becoming actuated unintentionally.

The recommended type of microphone is the push-to-talk (release to listen) type. Remember that most users know nothing about radio equipment, so the Radioman should demonstrate operation of the microphone to the user before he goes on the air.

## PLACING A CALL

Assume that your ship is an authorized radiotelephone subscriber and the 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 (she) is given the name of the ship, the coastal rate area in which the ship is located, the city and telephone number desired, and, if the call is person-to-person, the name of the individual called. 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 to not 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. You must ever be alert to avoid disclosure of classified information when transmitting on radiotelephone circuits. This applies to military voice circuits as well as to the commercial circuits just discussed.

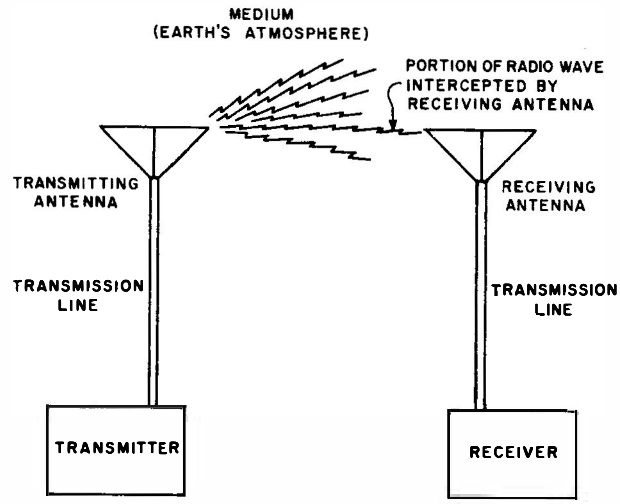
# CHAPTER 8

# 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 the traveling radio wave, absorb part of the radiated energy and send it through a transmission line to a receiver. Thus, the 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 the 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.

Successful communication by means of radio waves depends chiefly on the power of the transmitter, the distance between the transmitter and receiver, and the sensitivity (ability to amplify weak signals) of the receiver. The ability of the earth's atmosphere to conduct the energy to its destination, together with the nature of the terrain between the sending and the receiving points, may, however, be responsible for the frequency selected. Interfering signals can make reception impossible at a desired time. Also, the amount of noise present and transmission line losses may combine to make an otherwise good signal unintelligible. To understand the proper importance of all these factors, it first is necessary to investigate the nature of the radio wave and the conditions affecting its successful propagation.




31.6

Figure 8-1.—Simple radio communication network.

## 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 get back 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 the analogy is not exact, it serves a useful purpose because it makes comparison 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 fails to compare with that of electromagnetic radiation in 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.

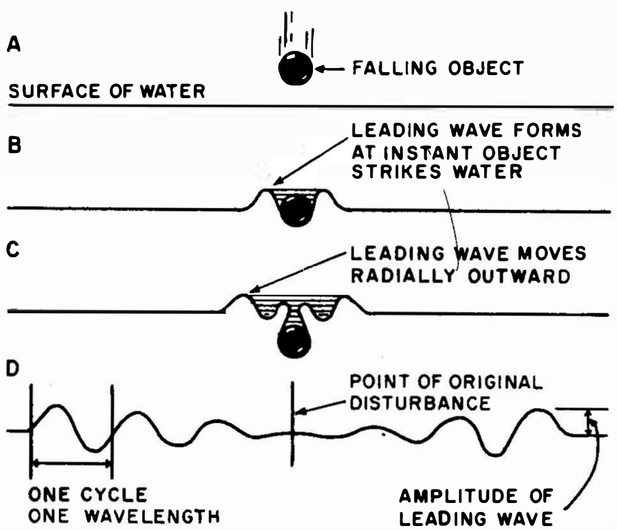



Figure 8-2.—How a falling stone imparts wave motion to a water surface. 31.7

The 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, the amplitude is the measure of the energy level of the wave. 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, and usually 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 then returns to the first direction to begin the next cycle (fig. 8-2, part D).

The 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 larger unit 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, but you are required to know them. The kilocycle is 1 thousand cycles and is abbreviated kc; the megacycle is 1 million cycles (or 1000 kc) and is abbreviated mc; the gigacycle is 1 billion cycles (or 1000 mc) and is 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. By the same token, 500,000 cycles is expressed as 500 kc. When the number of kilocycles becomes too large, megacycles are used instead to simplify the figure. Thus, 82,000 kc is expressed as 82 mc, and so on.

The characteristics of low-frequency propagation are different from those of high-frequency propagation. Hence, for ease of identification, the frequencies usually are classed in bands, as in table 8-1.

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 |

The choice of a given frequency as the point of division between bands, such as between the very high frequencies and the ultrahigh frequencies, is more or less arbitrary and is agreed upon for convenience.

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 radio frequency 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 and inches. (A meter is 39.37 inches.)

Finding the wavelength of any frequency is a relatively simple process. We know that a radio wave travels at a constant speed of 300,000,000 meters (or 186,000 miles) per second. From this, we can determine the length of 1 cycle (wavelength) simply by dividing the velocity of the wave by the frequency of the wave. The foregoing statement is condensed into the following formulas.

1. If the frequency is expressed in cycles per second, use either a or b.

a. Wavelength (in meters)

$$= \frac{300,000,000}{\text{Frequency (in cycles)}}.$$

b. Wavelength (in feet)

$$= \frac{984,000,000}{\text{Frequency (in cycles)}}.$$

2. When the frequency is expressed in kilocycles, the formulas become either of these:

a. Wavelength (in meters)

$$= \frac{300,000}{\text{Frequency (in kc)}}.$$

b. Wavelength (in feet)

$$= \frac{984,000}{\text{Frequency (in kc)}}$$

3. If the frequency is expressed in megacycles, the formulas become one of the following:

a. Wavelength (in meters)

$$= \frac{300}{\text{Frequency (in mc)}}$$

b. Wavelength (in feet)

$$= \frac{984}{\text{Frequency (in mc)}}$$

## RADIATION

When radio frequency 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 to a receiving antenna, the concept of a moving wave becomes important. The moving wave actually consists of moving electric and magnetic fields. The moving electric field always creates a magnetic field, and a moving magnetic field creates an electric field. The 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 shows the components of the radio wave. From the point of view of the 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. The intensities of both the electric and the magnetic fields are maximum at the same instant the crest of the wave passes the antenna. Conversely, the 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.

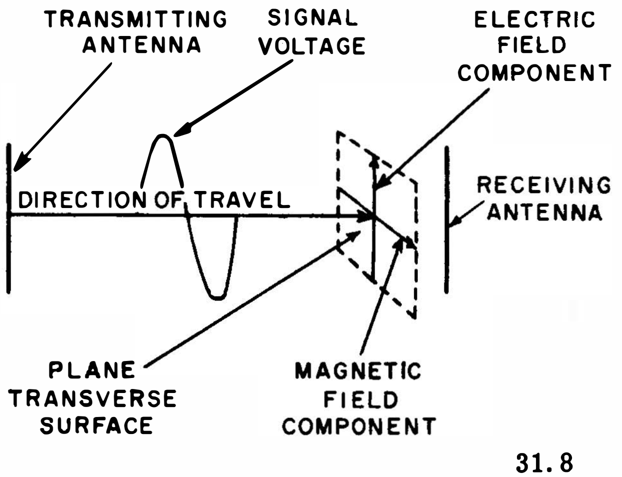



Figure 8-3. —Components of radio wave.

Figure 8-4 illustrates the instantaneous cross section of a radio wave moving in a direction away from the reader. The electric lines of force are perpendicular to the earth, whereas the magnetic lines are horizontal. A change in direction of either the electric or magnetic lines would result in a change in direction of travel of the wave.

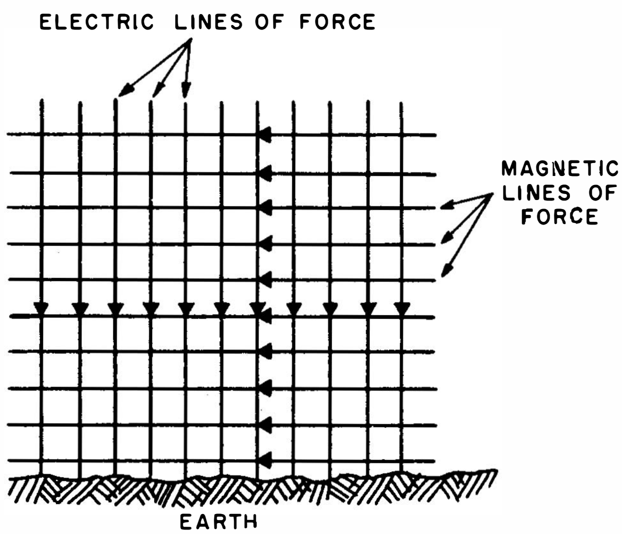



Figure 8-4.—Instantaneous cross section of a radio wave. 20.241

POLARIZATION

The lines of force of the electric field are propagated perpendicular to the earth when the transmitting antenna is oriented perpendicular to the earth. In this instance, the radio wave is said to be polarized vertically. If the transmitting antenna is horizontal, the electric lines of force will be horizontal, and the wave is then said to be polarized horizontally. Actually, the polarization of the wave may be altered somewhat during travel. But the electric and magnetic lines of force are always perpendicular to each other and to the direction of travel, regardless of polarization.

The polarization of the wave is an important consideration in the 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 the efficient reception of vertically polarized waves (those transmitted from a vertical antenna). Also, a horizontal antenna should be used for the 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 the transmitting to the receiving antennas. Such a condition does not always prevail, however, as we shall see when we consider the effects of the atmosphere on the behavior of radio waves.

## RADIO WAVE PROPAGATION

The study of radio wave propagation is concerned chiefly with the properties and effects of the medium through which radio waves must travel in their journey between transmitting and receiving antennas. Because the atmosphere is the common medium for the propagation of radio waves, it is discussed here in some detail.

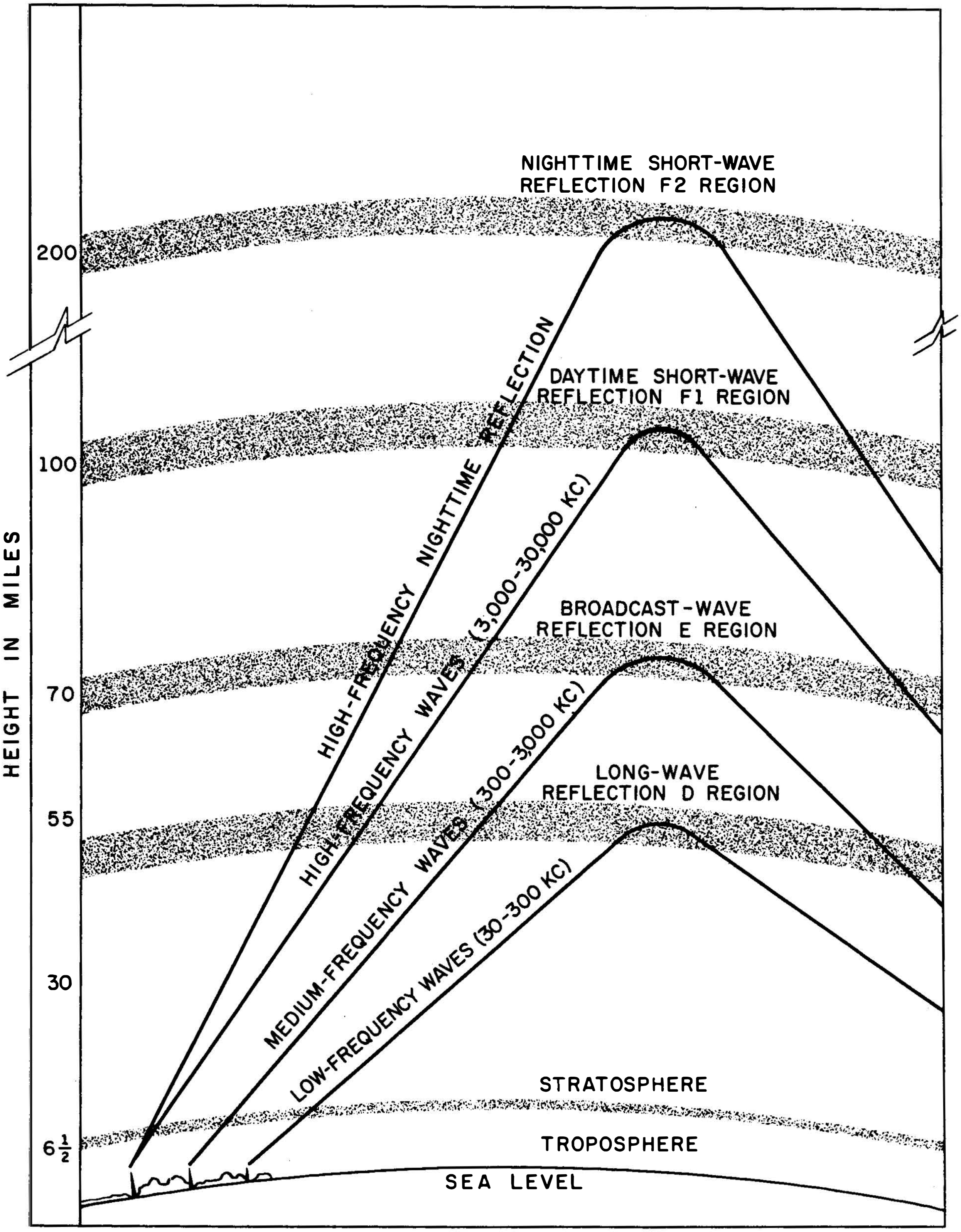
### ATMOSPHERE

The atmosphere about the earth is not uniform. It changes with a change in height or geographical location, or even with a change of time (day, night, season, year). To assist us in understanding the effect these changes have on radio waves, the various layers of the atmosphere have been distinguished. These layers are the troposphere, the stratosphere, and the 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 6 1/2 miles. The temperature in this region varies appreciably with altitude.

The stratosphere lies between the troposphere and the ionosphere. It extends from about 6 1/2 miles to approximately 30 miles above the surface of the earth. The temperature in this region is almost constant.

Besides the usual variations in moisture content and temperature, and the variations in density associated with a change in elevation, the atmosphere is distinguished mainly by the variation in amount of ionization present. The ionization is believed to result from ultraviolet radiation from the sun and is explained in greater detail later, when we discuss the ionosphere as a separate topic. 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. The ionization of this layer is large compared with that near the surface of the earth. It extends from about 30 miles to 250 miles above the earth. The ionosphere itself is composed of several layers (fig.




31.9

Figure 8-5. —Layers of the earth's atmosphere.

8-5), where ionization occurs at different levels and intensities.

## PROPAGATION IN THE ATMOSPHERE

Radio waves travel in two principal ways from a transmitter to a receiver: by means of groundwaves, which pass directly from the transmitter to the receiver; or by skywaves, which travel up to the electrically conducting layers of the atmosphere (ionosphere) and are reflected by them back to earth. Long-distance radio transmission takes place chiefly by skywaves. But short-distance transmission and all ultrahigh-frequency transmission occur by means of groundwaves. Some forms of transmission consist of combinations of both.

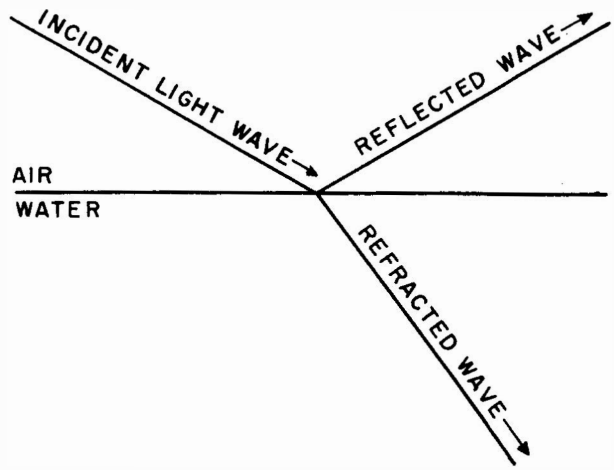
Like other forms of electromagnetic radiation (such as light), radio waves can be reflected, refracted, and diffracted. The propagation of the groundwave is affected partially by the electrical characteristics of the earth (soil or sea) and by diffraction, or bending, of the wave with the curvature of 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 this consequently affects the reflection or the refraction of the waves.

### Reflection

The reflection of a radio wave is like that of any other type of wave. For instance, 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.) 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, and the ionosphere, even though it is not a surface such as a mirror, is also a good reflector of radio waves.

### Refraction

If a beam of light shines on a smooth surface of water, some of the light is reflected and the remainder penetrates the water, as diagramed in figure 8-6. The phenomenon by which light waves penetrate the water in the manner shown




31.1D

Figure 8-6. —Reflection and refraction of a light beam.

is called refraction, and 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 is that the light waves travel at a slower speed through water than through air. Thus, the direction of travel of the 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.

### 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 8-7 illustrates this phenomenon and helps to explain why radio waves of the 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 an important 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 the transmitter to the receiver.

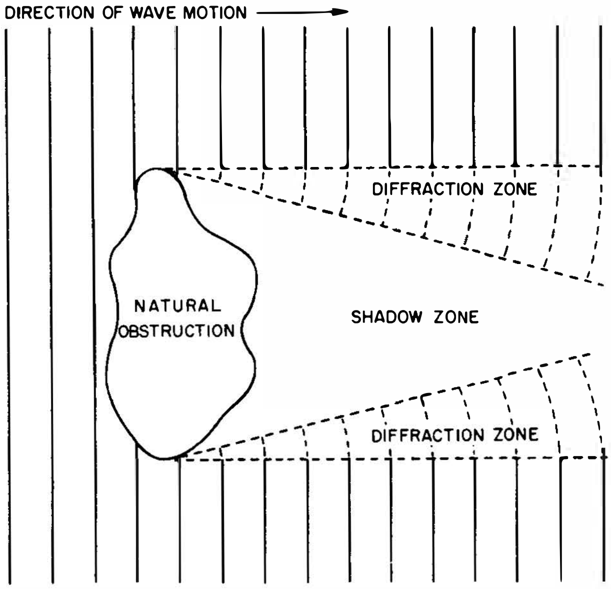



Figure 8-7. —Diffraction of waves around solid object. 31.11

## 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 the waves, (3) diffraction of the waves around the curvature of the earth, (4) electrical conductivity of the local terrain, (5) nature of the transmission path, and (6) weather conditions, such as the distribution of the 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 the 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 8-8 shows how groundwaves take a direct or reflected course from the transmitter to the receiver. They also may be conducted by the surface of the earth, or may be reflected in the troposphere. Accordingly, the resulting groundwave can be considered as composed of one or more of the following components: the direct wave, the ground-reflected wave, the surface wave, and the tropospheric wave.

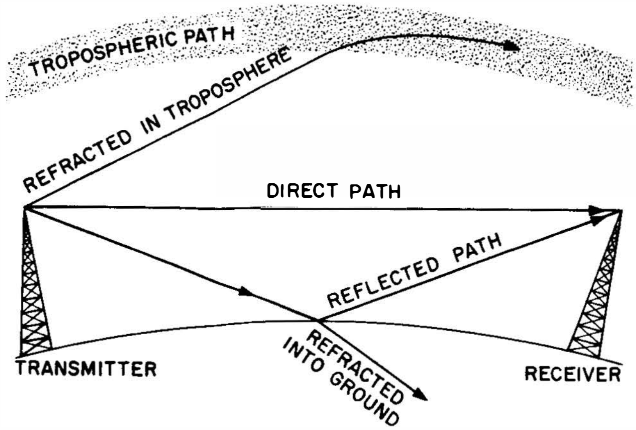



Figure 8-8. —Possible routes for groundwaves. 31.12

### Direct Wave

The direct wave is that part of the entire wave that travels directly from the transmitting antenna to the 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. The 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 or by the earth's surface, but is subject to refraction in the tropospheric air between the transmitter and receiver. Refraction becomes particularly important at very high frequencies.

### Ground-Reflected Wave

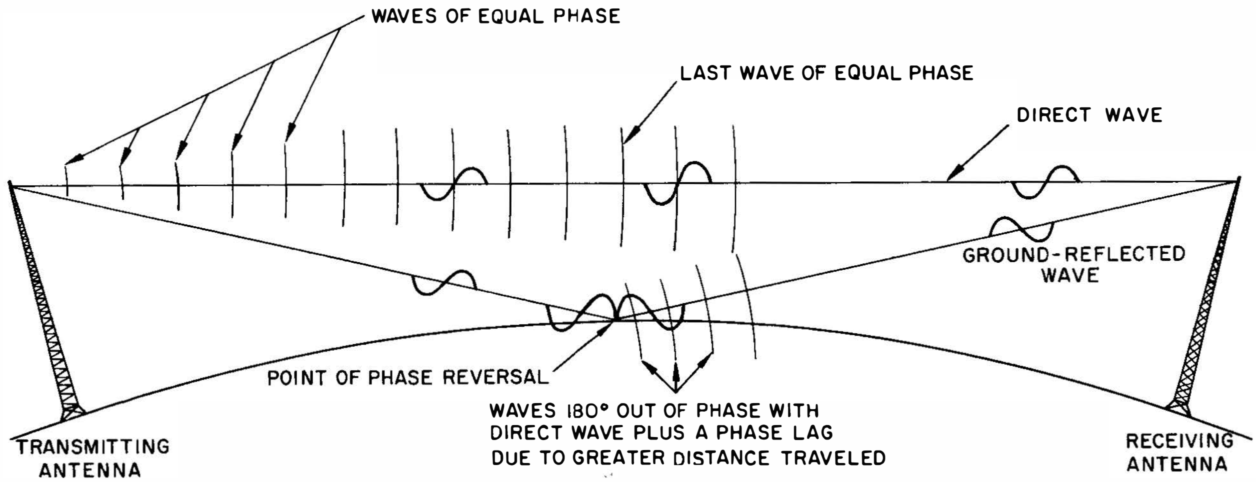
The ground-reflected wave, as its name indicates, is the part of the radiated wave that reaches the receiving antenna after it is reflected from the ground or from the sea. Upon reflection from the earth's surface, the reflected wave undergoes a phase reversal of $180^{\circ}$ (fig. 8-9). This phase 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 $180^{\circ}$ shift caused by reflection results. In figure 8-9 it may be seen that the 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 of the reflected wave. Thus, the reflected wave arrives at the receiving antenna nearly 180° out of phase with the direct wave, and an undesirable cancellation of signal energy results.

Surface Wave

The 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, the 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 |




31.13

Figure 8-9. —Comparison of direct and ground-reflected waves.

The best type of surface for surface-wave transmission is sea water. Sea water accounts for the long-distance coverage attainable by the fleet broadcasts when using surface-wave transmission of the very low frequencies. The most reliable frequency band for one-way broadcasts is VLF, which can be received by submarines when completely submerged (with no part—not even the antenna—projecting above the surface of the water).

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 the conductivity of the earth is high and the frequency of the wave is below 30 mc, the surface wave is the principal component, except in plane-to-plane or plane-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 of the 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

The 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 a 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 the frequency increases, tropospheric refraction is more effective at the higher frequencies, particularly above 50 mc. Temperature inversion is a common cause of tropospheric refraction. This means that 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, the sinking of an air mass heated by compression, the rapid cooling of surface air after sunset, and the heating of air above a cloud layer by reflection of the sunlight from the upper surface of the clouds. Tropospheric wave propagation depends on weather conditions and, because weather conditions do vary from minute to minute, they can cause fading of the radio signal. The receiving and transmitting antennas should have the same type of polarization, inasmuch as the tropospheric wave maintains essentially the same polarization throughout its travel. Temperature inversions in the tropics and over the oceans are present almost continuously at heights up to 3000 feet. When the boundary of the inversion is defined sharply, waves traveling horizontally become trapped by the refracting layer of air and continue to be sent back toward the earth. Figure 8-10 shows how such a trapped wave follows a duct, the upper and lower walls of which are formed by the temperature inversion boundary and the surface of the earth. Thus, the waves follow the curvature of the earth for distances far beyond the normal horizon of the transmitter and, in some localities, may consistently reach distances of many thousands of miles. Duct transmission usually is effective at only UHF and VHF frequencies. A necessary feature of duct transmission, if communication is to be established by this means, is that both the transmitting and the receiving antennas must be inside the duct. A transmitting antenna above the duct, as on a tower or mast, does not operate into the duct, and no signals by this means are received at the receiving antenna. Moreover, a receiving antenna below a duct receives no signals from an airplane flying in or above the duct, even though line-of-sight conditions prevail.

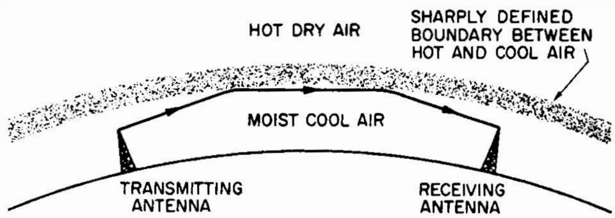



Figure 8-10. —Transmission by means of tropospheric duct. 31.14

## IONOSPHERE

Now let's consider the ionosphere in detail and see how the different levels of ionization affect the propagation of radio waves. Although the earth's atmosphere extends to a distance of over 250 miles, the air particles beyond this height are so rare that they are practically nonexistent. Our atmosphere is under constant bombardment by radiation and particle showers from the sun and by cosmic rays whose source is not yet known. Not only does the radiation from the sun include the light rays that we see, but also the entire spectrum (series of wavelengths), ranging from infrared rays to ultraviolet rays. As these forms of radiation approach the atmosphere of the earth, they reach certain critical levels where the gases are of such density that they are particularly susceptible to ionization by their action. This means that the radiation from the sun is capable of dislodging some of the loosely bound electrons from the gas atoms, and the gas then is said to be 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. The predominant source of ionization is ultraviolet radiation from the sun.

The ionosphere consists of four distinct layers. They are called, in order of increasing heights and intensities, the D, E, F1, and F2 layers. The relative distribution of these layers about the earth is indicated in figure 8-11. 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. During the 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.

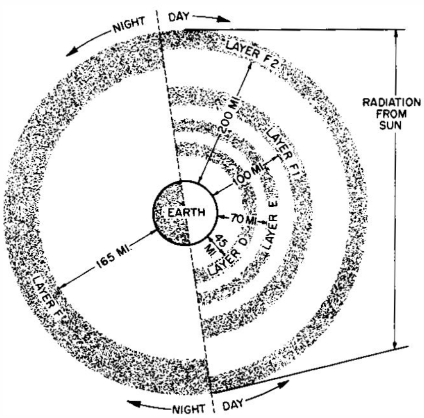



Figure 8-11. —Ionosphere layers 31.15

## D Layer

Between heights of 30 to 55 miles above the surface of the earth is the first region 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 through this region, and at times 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 region in order of height, called the E layer, lies at heights between 55 and 90 miles. Its height varies somewhat with the season. 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 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 less than 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 90 and 240 miles above the earth's surface is another region of ionization, known as the F layer. Ionization exists at all hours, usually with two well-defined layers during the daytime and one during the night. In this region, at night, the single F layer lies at a height of about 170 miles, and 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 region splits into two distinct layers—the F1 and F2. Depending on the seasons and the time of day, the F1 has a lower limit at a height of approximately 90 miles, and the F2 has a lower limit at a height of about 160 to 220 miles. The F2 layer is the most highly ionized of all the layers and is the most useful for long-distance radio communication. The intensity of ionization reaches a maximum in the afternoon and gradually decreases throughout the night, with a rapid rise in ion density in the morning.

### Other Layers

In addition to the regions 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 the excessive absorption of the radio wave.

## VARIATIONS OF IONOSPHERE

Because the existence of the ionosphere depends on radiations from the sun, it is obvious that variations in the ionosphere 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 the abnormal behavior of the sun. Regular variations are divided into four classes: daily, seasonal, 11-year, and 27-day variations.

Table 8-3 lists the regular variations, together with the effects upon the ionosphere and on radio communications. It also gives suggestions that may be followed in compensating for the various effects.

### Daily Variations

In table 8-3 you will note that higher frequencies are suggested for daytime use, and lower frequencies at night, to compensate for daily variations. The reason for this 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. The higher frequency waves suffer less absorption in passing through the D region, whereas the disappearance of the D region 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, which is quite 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 less 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 affect the ionization of the atmosphere. During periods of high sunspot activity, the ionization of the various layers is greater than usual, resulting in higher critical frequencies for the E, F1, and F2 layers, and higher absorption in the D region. Consequently, higher frequencies are permitted for communication over long distances at times of greatest sunspot activity. Increased absorption in the D region, which has the greatest effect on the lower frequencies, requires the use of 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 the rotation of the sun on its axis. As the number of sunspots changes from day to day with rotation of the sun, the formation of new spots, or the disappearance of old ones, absorption by the D region 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.

Table 8-3 — Regular Variations of Ionosphere

| Type of variation | Effect on ionosphere | Effect on communications | Method of compensation |
|---|---|---|---|
| Daily | F layer: Height and density decrease at night, increase after dawn. During day, layer splits into (1) F 1 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. | |
| 27-day sunspot cycle. | Recurrence of sudden ionospheric disturbances 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. |

## Irregular Variations

In addition to the regular variations of the ionosphere, a number of transient effects, though unpredictable, have an important bearing on propagation of the skywave. Some of the more prevalent of these effects are sporadic E, sudden ionospheric disturbance, ionospheric storms, and scattered reflections.

The 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 the other layers of the ionosphere are blanked out completely. The sporadic E may be so thin at other times that reflections from the upper layers can be received through it easily. Although the sporadic E layer is more prevalent in the tropics than in the 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 the sudden type of ionospheric disturbance (SID) causing a radio fadeout. 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, and, at the onset of the disturbance, receiving operators are inclined to believe that their radio sets are dead. The solar eruption causes a sudden increase in the ionization of the D region, frequently accompanied also by disturbances in the earth's magnetic field. The increased ionization of the D region 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 and 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 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, and usually no compensation by the radio operator is required.

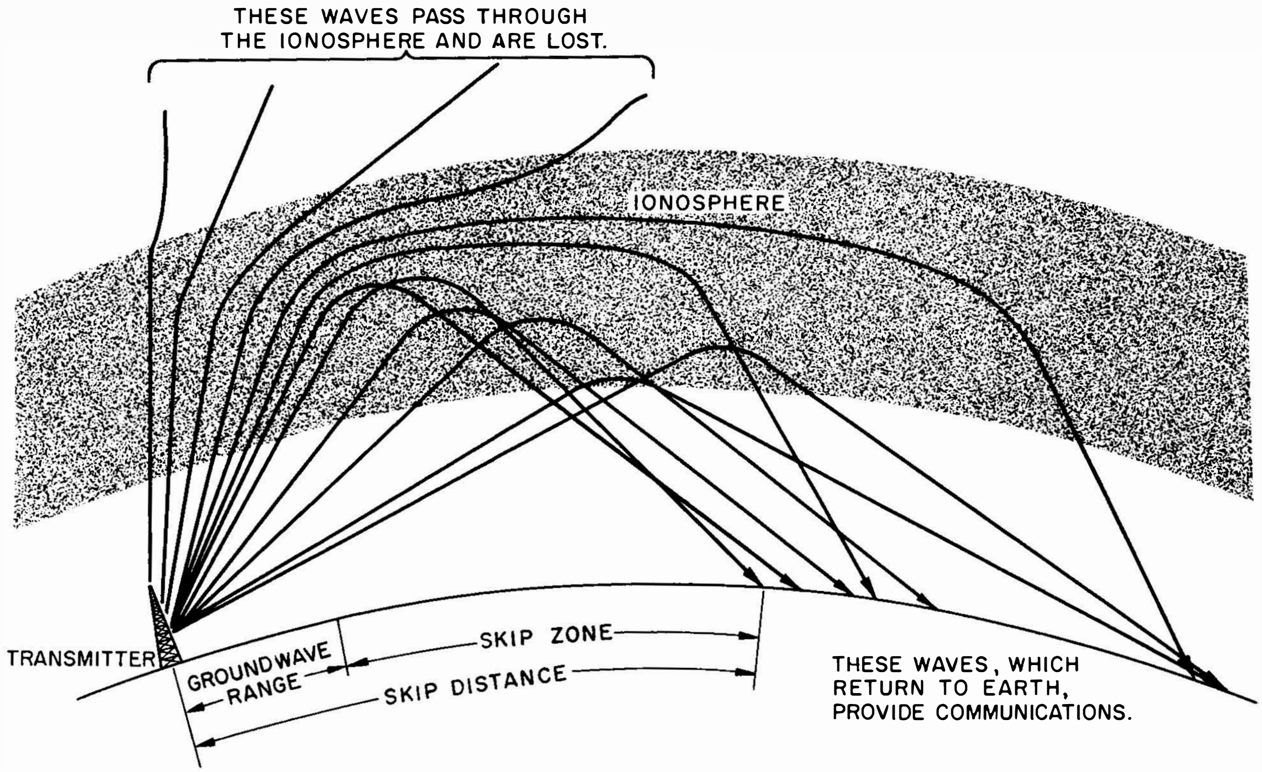
## SKYWAVE

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. But it presents many problems that can be solved adequately only through an understanding of the principles of skywave composition.

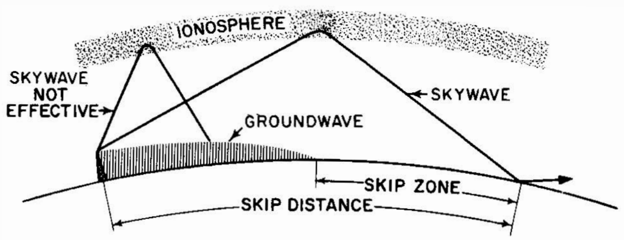
Figure 8-12 illustrates some of the many possible paths of radio waves from a transmitter to a receiver by reflection from the ionosphere. Note that some of the waves are assumed to be too high in frequency for reflection by the ionized layer, and pass on through and are lost in outside space unless 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 are the ones that provide communications. Figure 8-12 also shows that the skip distance extends from the transmitting antenna to the nearest point at which the reflected waves return to earth. The skip zone and its relation to the ground wave are shown in figure 8-13. 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 the phases difference between groundwaves 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 ionization 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 the earth, part of the energy enters the earth and is dissipated rapidly, but part is reflected back into the ionosphere, where it




31.16
Figure 8-12. —Skywave transmission paths.



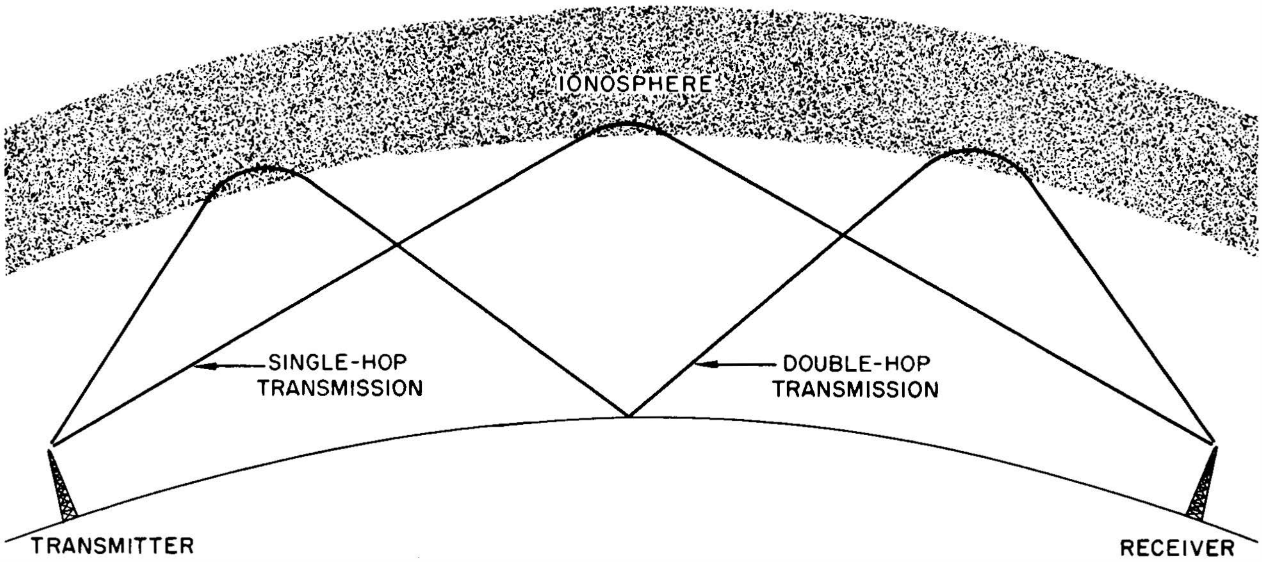

31.17
Figure 8-13. —Relation of skip zone and groundwave.

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, and enables transmissions to be received at great distances from the transmitter. Figure 8-14 illustrates the hop means of travel for paths involving one and two reflections from the ionosphere (called single- and double-hop).

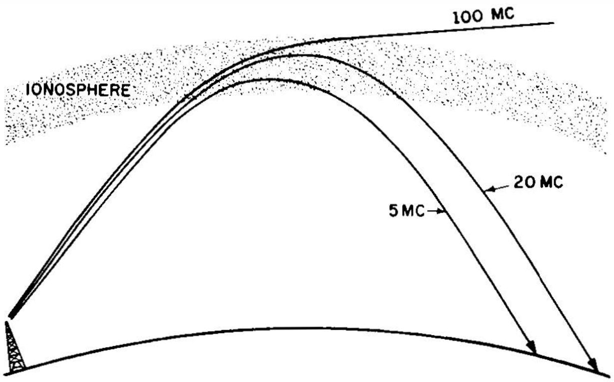
As mentioned earlier, in the discussion of the ionosphere, the higher the frequency of a wave, the less it is refracted by a given degree of ionization. Figure 8-15 shows three separate waves of different frequencies entering an ionospheric layer at the same angle. Here, the 100-mc wave is not refracted 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 the daytime than at night, and greater on a winter day than on a summer day. The existence of this upper-limit frequency depends on the ionization in the ionosphere reflecting only waves of frequencies less than a certain critical value. This value is called the maximum usable frequency, abbreviated MUF. At frequencies above the MUF for a given distance, the wave is said to skip, be-




31.18
Figure 8-14. —Single- and double-hop transmissions.




31.19
Figure 8-15. —Frequency versus distance for returned waves.

cause it then returns to earth at a greater distance from the transmitter.

It is important to know the MUF for any transmission path at any particular time. If the operating frequency is above the MUF, the wave skips, because it is not reflected from the ionosphere at the desired distance. If the 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. Hence, it usually is desirable to transmit on a frequency as near the MUF as possible. Inasmuch as a direct relationship exists between the MUF, the condition of the ionosphere, and time, it is possible to predict the MUF for any transmission path months in advance.

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 others. 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 date. The publication contains tables of frequency bands recommended for use under normal conditions for communication to and from the principal shore stations. Included also are graphs, called nomograms, that are a rough guide for radio operators in the choice of suitable frequencies for communication over distances up to 2200 miles. In most instances, you will find that the exact frequency recommended in DNC 14 is not available for your use. You then should select an available frequency as near as possible, but not exceeding, the MUF. If a frequency higher than the MUF is used, it is improbable that reliable communications will result.

## ANTENNAS

An antenna is a conductor or a system of conductors for radiating (transmitting) or intercepting (receiving) radio waves.

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 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. Perhaps you have noticed the interference in 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 the radio wave radiated by an antenna depends upon 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 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. These methods are adjusting the frequency to suit a given antenna length or, as usually is more practical, adjusting the length of the antenna wire to suit a given frequency. It is, of course, impractical 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 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. We learned that radio waves travel 186,000 miles per second in free space. The radiofrequency energy on an antenna, however, moves at a speed considerably less than that of the 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 somewhat shorter physically.

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 you prefer to 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 the differences between the actual and electrical antenna lengths. A dipole for that frequency would be half the length, that is, 164 feet (or 50 meters).

The formulas, correct for finding wavelength, 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. The circumference of the wire itself, and the capacitance introduced by insulators and nearby objects combine to change the velocity ofthe wave in the antenna. This is called END EFFECT, because the 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. The following formula can be used for finding the correct length, in feet, of half-wave antennas:

$$\text{Antenna length (in feet)} = \frac{468}{\text{Frequency (in mc)}}.$$

By substituting, we find that the correct antenna length for 3 mc is:

$$\frac{468}{3} = 156 \text{ feet.}$$

The formula is accurate for all practical purposes in calculating the actual or physical length of a half-wave antenna for frequencies up to 30 mc.

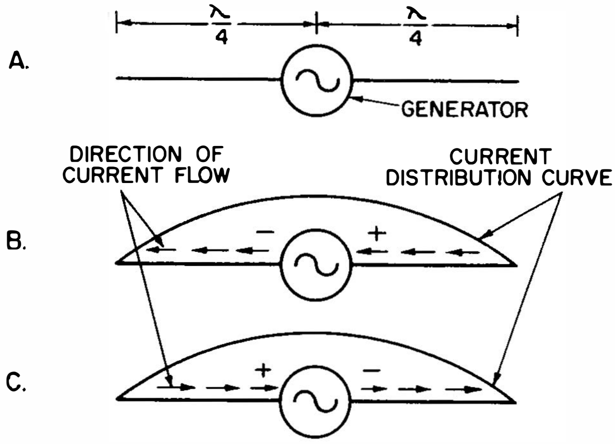
## HALF-WAVE DIPOLE

The 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 8-16. During one-half the generator's alternation, electrons in the antenna flow from right to left (fig. 8-16, view B). During the next half alternation, electrons flow in the opposite direction (fig. 8-16, part C).

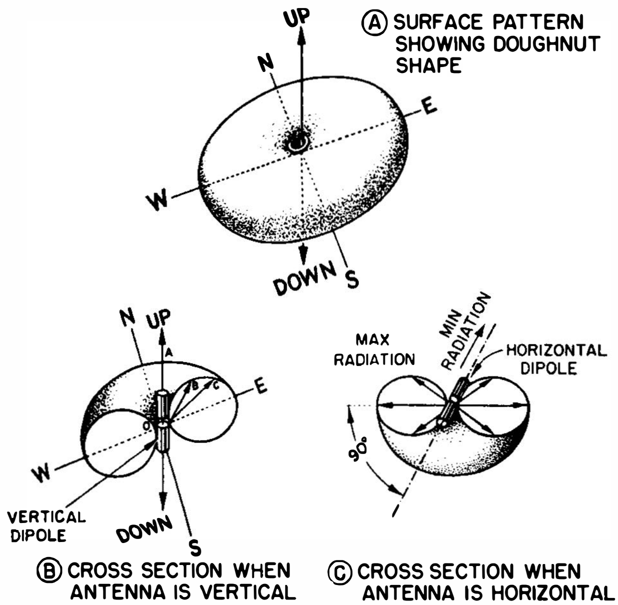
The dipole is the basis for many complex antennas. When used for transmitting medium and high frequencies, it usually is constructed of wire. At very high and ultrahigh frequencies, the shorter wavelength permits construction using metal rods or tubing. Depending upon the wave polarization desired, the 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 8-17, 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 the 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.




20.242
Figure 8-16. —Instantaneous direction and distribution of current in a dipole.




1.255
Figure 8-17. —Electromagnetic field surrounding a dipole.

Figure 8-17, part C, shows half of the doughnut pattern for a horizontal dipole. Again, the maximum radiation takes place in a plane perpendicular to the axis of the antenna.

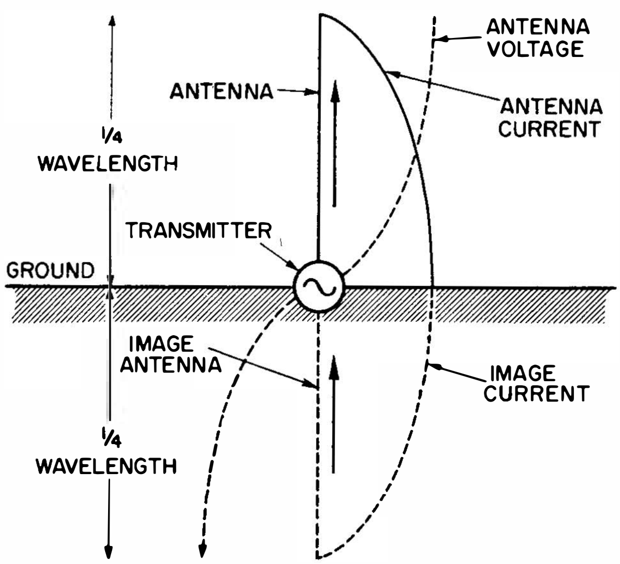
At the low and medium frequencies, half-wave antennas are rather long and have little use in the Navy except at shore stations where there is room for them. A dipole for 500 kc, for example, would have to be about 936 feet long. At lower frequencies another basic type of antenna affords a solution to the problem of undue length. It is the quarter-wave antenna.

## QUARTER-WAVE ANTENNA

The 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.

The earth is a fairly good conductor for medium and low frequencies, and acts as a large mirror for the radiated energy. The result is that 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. 8-18), 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 lower half of an ungrounded half-wave antenna.

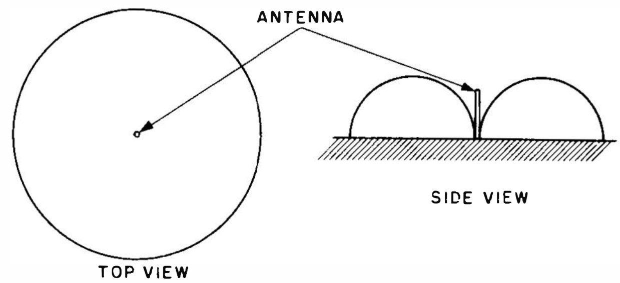



13.35(76)

Figure 8-18. —Grounded quarter-wave antenna, showing image current.

The relationship of current and voltage in a quarter-wave antenna is similar to that 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 8-19 shows the radiation pattern produced by a grounded quarter-wave antenna. One bad feature of these shorter antennas is that the radiation is less than that of a half-wave antenna. The radiation decreases with the length of antenna wire used, because less wire is carrying the high current that produces radiation.



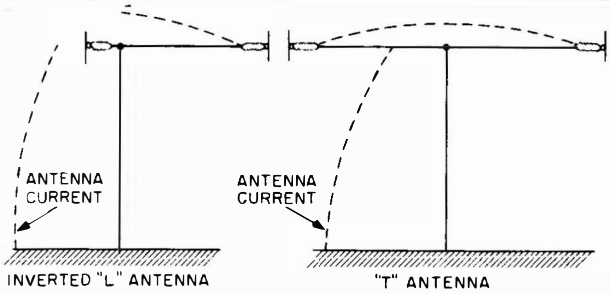

76.12

Figure 8-19. —Radiation pattern of a grounded quarter-wave antenna.

Space limitations aboard ship usually prohibit the installation of vertical antennas that are long enough to be resonant at the low and medium frequencies. Two principal methods have been found for improving shipboard antennas that are electrically short at the lower frequencies.

One method of increasing the 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. 8-20). In this way the current in the vertical section is made more nearly constant, thus increasing the effective height of the antenna. 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 a loading coil) at the base of the antenna. Inductance has the effect of increasing the antenna length. If the antenna must be used over a wide frequency range, a large variable capacitor is




76.13
Figure 8-20. —Flattop antennas and their current distribution.

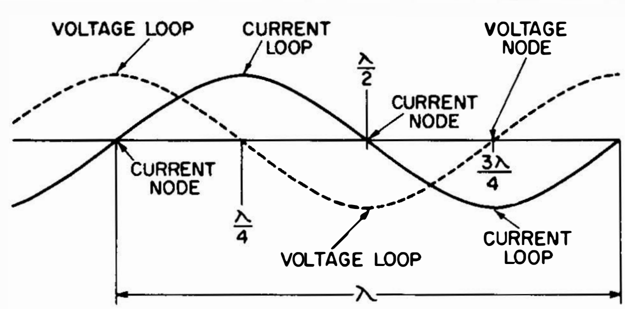



Figure 8-21. —Standing waves along full-wave antenna. 76.14

placed in series with the loading coil. The capacitor has the effect of shortening the antenna. The combination of the loading coil and the 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 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, the current and voltage values vary along the length of the wire, and always are $90^{\circ}$ out of phase. Figure 8-21 shows the relationship of current and voltage in a full-wave antenna. The 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. You will notice that 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 upon the length of the antenna, and hence upon the 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 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 of the 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 you will encounter.

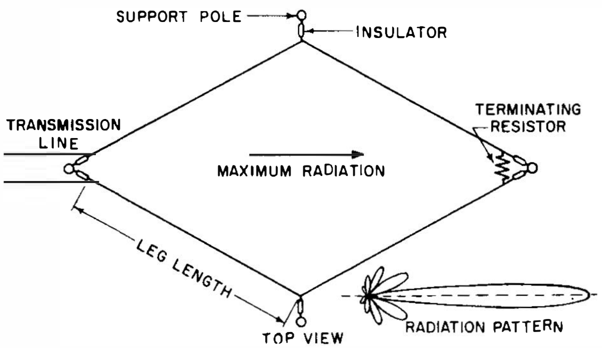
Rhombic Antenna

A type of antenna used widely for long-distance transmission and reception is the rhombic, so named because of its diamond shape. Figure 8-22 shows a typical rhombic antenna.

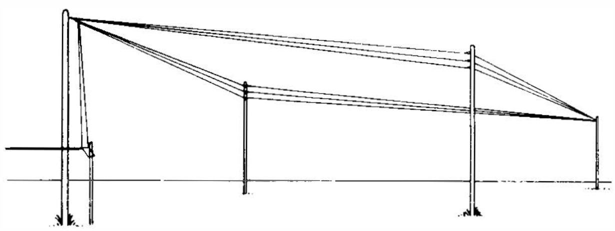
The rhombic antenna requires so much space that its use is confined to shore stations. Because of its directive radiation pattern (fig. 8-22), it is very useful in point-to-point communications. The basic rhombic antenna has four straight wires joined to form the diamond, and it is suspended horizontally 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 of the advantages of the 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 more than a single wire is used to form each leg. The most common of the multiwire rhombics is the three-wire type (fig. 8-23). 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 and, when used for receiving, greatly reduces the noise caused by precipitation static. For these reasons it is the only type of rhombic presently installed at both transmitting and receiving stations.



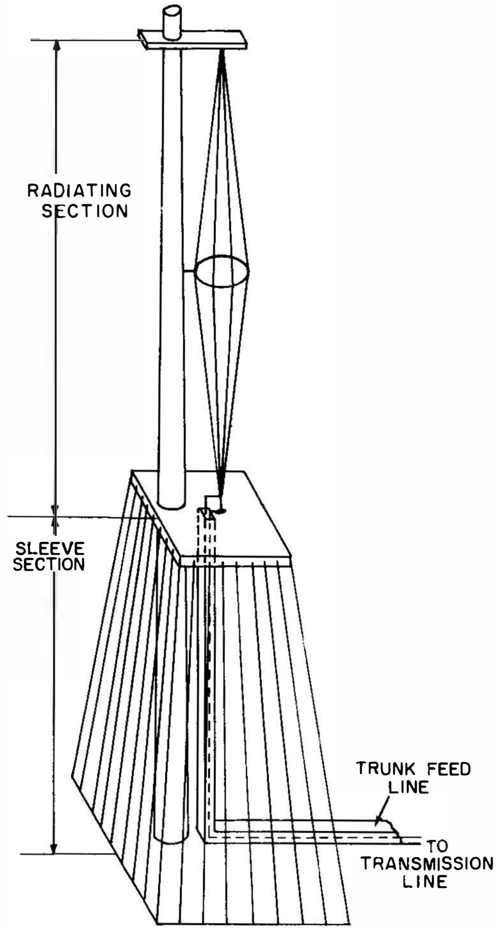

13.37(76)A
Figure 8-22. —Typical rhombic antenna.



13.37(76)B
Figure 8-23. —Three-wire rhombic.

Sleeve Antenna

The sleeve antenna, a high-frequency antenna, is capable of operating over a wide range of frequencies, and is known as a broad-band 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 8-24 is a shore station version of a sleeve antenna. The shipboard sleeve antenna is shown in figure 8-25.



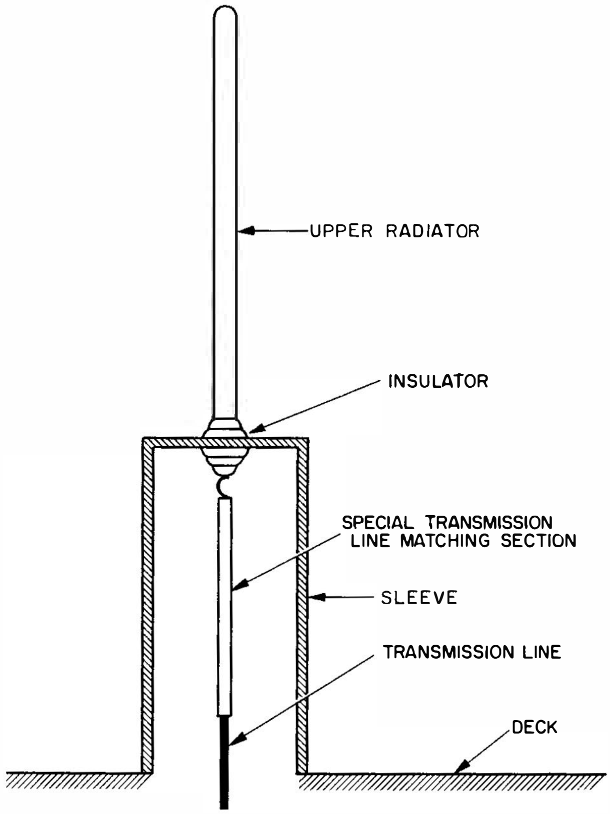

13.40
Figure 8-24. —Sleeve antenna (shore station).

Sleeve antennas are especially helpful in reducing the total number of conventional narrowband antennas that otherwise would be required to meet the 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 broad-band antenna that is used extensively is the conical monopole shown in figure 8-26. Like the sleeve antenna, it is used both ashore and aboard ship.

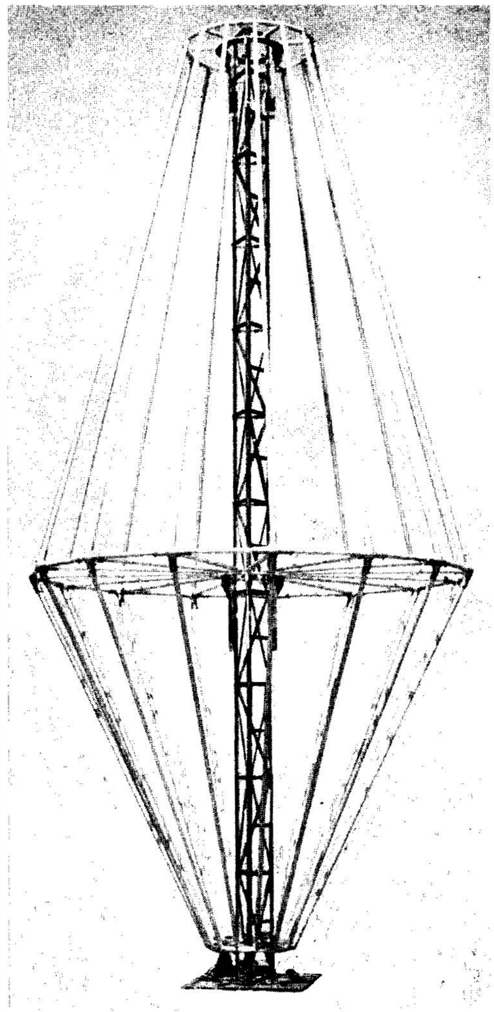
When operating at frequencies near the lower limit of the high-frequency band, the conical radiates in much the same manner as a regular vertical antenna. At the higher frequencies the lower cone section radiates, and the effect of the top section is to push the signal out at a low angle. The low angle 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.




25.217
Figure 8-25. —Sleeve antenna (shipboard).

## TYPICAL SHIPBOARD ANTENNAS

Problems not usually present in land installations arise when antennas are installed on board 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.



25.214
Figure 8-26. —Conical monopole antenna.

### Wire Antennas

Wire antennas (fig. 8-27) are installed on board 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 and, in addition, 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 resists corrosion and is nonmagnetic. Wire of receiving antennas ordinarily is covered with a plastic insulation, but the wire of transmitting antennas is uninsulated.

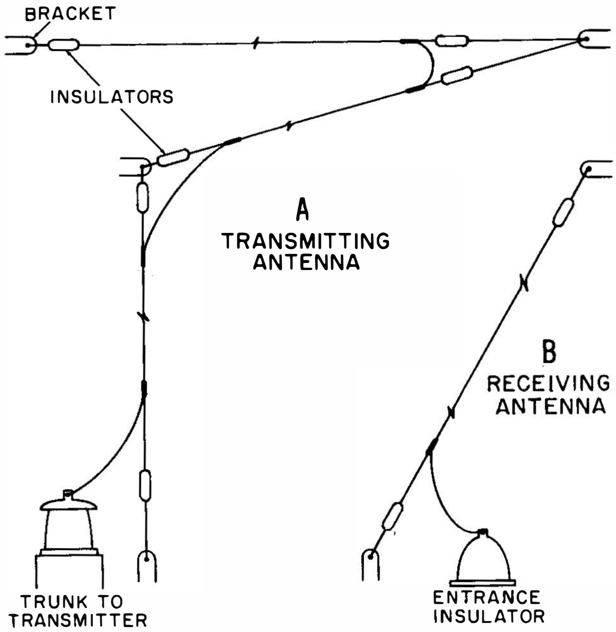



Figure 8-27. —Shipboard wire antennas.

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 the transmitting antennas so that a minimum of energy is picked up from the local transmitters. The transmission line (lead-in) for each receiving antenna terminates in antenna transfer panels in the 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.

The metal rings, antenna knife switches, antenna hardware, and accessories associated with transmitting antennas are painted red. Hardware and accessories used with receiving antennas are painted blue. This color scheme is a safety precaution that indicates, at a glance, whether an antenna is used for radiating or receiving.

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 may be deck-mounted, or they may be mounted on brackets on the stacks or superstructure (fig. 8-28). Whip antennas commonly used aboard ship are 25, 28, or 35 feet in length, and are made up of several sections.

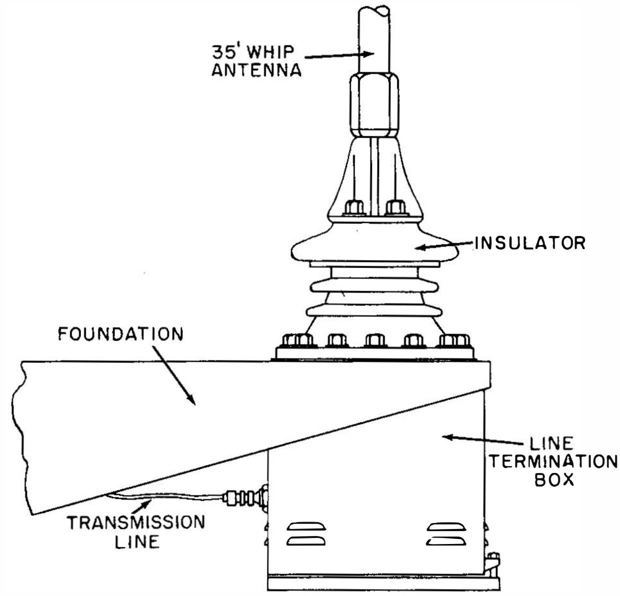



Figure 8-28. —Whip antenna.

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 the submarine. In some installations, as the 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 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.

A UHF antenna of the half-wave (dipole) type is the AT-150/SRF (fig. 8-29). 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 mounted horizontally.

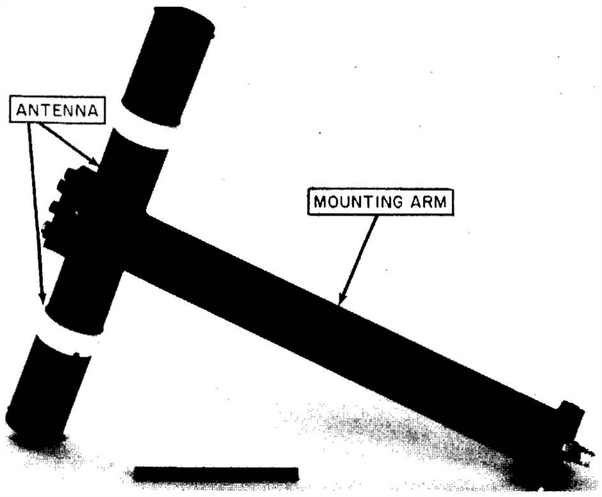
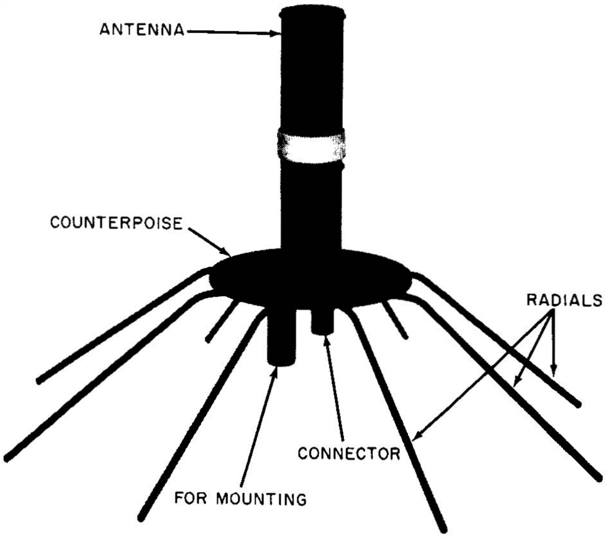



Figure 8-29. —UHF antenna AT-150/SRC.
25.219

The AS-390/SRC (fig. 8-30) 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). The antenna is mounted vertically.




25.220
Figure 8-30. —UHF antenna AS-390/SRC.

### EMERGENCY ANTENNAS

Loss or damage to an antenna from heavy seas, violent winds, or enemy action may cause serious disruption of communications. Sections of a whip antenna may be carried away, insulators may be damaged, or a shell burst may cause a wire antenna to snap in half. If loss or damage should happen when all available equipment is needed, you will have to rig an emergency antenna (or at least assist the ETs) to restore communications on a temporary basis until the regular antenna can be repaired.

Emergency antennas vary considerably in design. Among the influences affecting their design are the type of ship, the location of transmitting or receiving equipment, the availability of space, and the suitability of nearby structures for rigging the antenna quickly.

The simplest emergency antenna consists of a length of wire rope to which a high-voltage insulator is attached to one end and a heavy alligator clip or lug is soldered to the other. 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 and insulators and other necessary hardware installed. They are then stowed in the radio spaces so that they are readily accessible.

Be sure you know how and where to rig your ship's emergency antennas!

ANTENNA TUNING

As you learned earlier, shipboard antennas used for communications at medium and high frequencies are not usually of the proper length to give optimum performance at the operating frequency. This condition exists because all the antennas are of a standard size and shape, or they are installed in whatever space may be available for them, or 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 effective length of the antenna must be made electrically. This process, called antenna tuning, is accomplished by increasing or decreasing the inductance and/or the capacitance in the antenna system at the point where the antenna is fed from the transmitter or transmission line. Added inductance, as explained earlier, 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 as though it has a number of quarter waves along its length. By tuning the antenna properly, the standing waves are increased and the radiated energy is increased.

In our study of transmitters in chapter 9, we will learn more 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 Navy Training Courses Basic Electricity, NavPers 10086-A, and Basic Electronics, NavPers 10087-A. You will find the chapters applicable to Radiomen in the reading list at the front of this manual.

In the descriptions of representative communication equipments, only the fundamental features are given. The circuits are represented largely by block diagram, and the emphasis is on the types and purposes of the stages on which the performance capabilities and limitations of the 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, let us first review the subject of electrical units, and the schematic symbols used in electronic circuit drawings.

## ELECTRICAL UNITS

A thorough knowledge of the electrical units presented in Ohm's law is a necessity for the Radioman. The coverage given these units in the following paragraphs is intended as a review only. Unless you are familiar with their application in Ohm's law, you are advised again to study the Navy Training Courses entitled Basic Electricity and Basic Electronics.

### CURRENT

An electrical current is often compared to the flow of water through a main. To gage the rate of flow we must have a measure of quantity (pints, quarts, gallons, barrels, etc.) and a measure of time (seconds, minutes, hours, etc.).

In an electrical circuit the 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, and a larger unit, the COULOMB—6.3 billion billion electrons—is used instead. 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

At this point it would be profitable for you to become familiar with the various schematic symbols you will encounter in both your study and your work 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. Consequently, you will find many textbooks and equipment technical manuals, prepared before adoption of the standard, in which some symbols are not quite identical with those shown in this manual. However, in most instances, familiarity with the modern standard enables you to recognize easily the intent of the older symbols.

The list of symbols shown in figure 9-1, while not all-inclusive, illustrates most of the basic symbols of interest to the Radioman, and also includes many typical combinations, called buildup symbols. It can be truthfully said that a complete listing of all possible buildup examples has never been compiled. A reasonably comprehensive knowledge of the basic symbols, however, will enable you to understand the more complex buildups. You should know particularly, in your study of electronic circuits, that schematic symbols may be drawn to any proportional size that suits a particular drawing, and may be oriented in any direction without altering the meaning of the symbols. Explanatory details are often added, when necessary, adjacent to the symbols.

Your work as a Radioman requires that you know the meanings of these schematic symbols and 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, NavPers 10087-A.

As you advance in rating beyond RM2, you will find increased uses for your 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 upon 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 Joint Electronics Type Designation System.

### JOINT ELECTRONICS TYPE DESIGNATION SYSTEM

The first two letters of the Joint Electronics Type Designation System are AN. This is the system indicator. It does not mean that all the services use the equipment, but only that the type number was assigned under the AN system. The AN is followed by a slant sign and three identifying letters. The letters to the right of the slant sign are very important, for they give a brief description of the equipment:

FIRST LETTER—Where installed; 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 the equipment; communications, direction-finding, receiving, transmitting, etc.

The three equipment indicator letters are followed by the model number, and the model number may be followed by additional letters to indicate a modification of the original equipment.

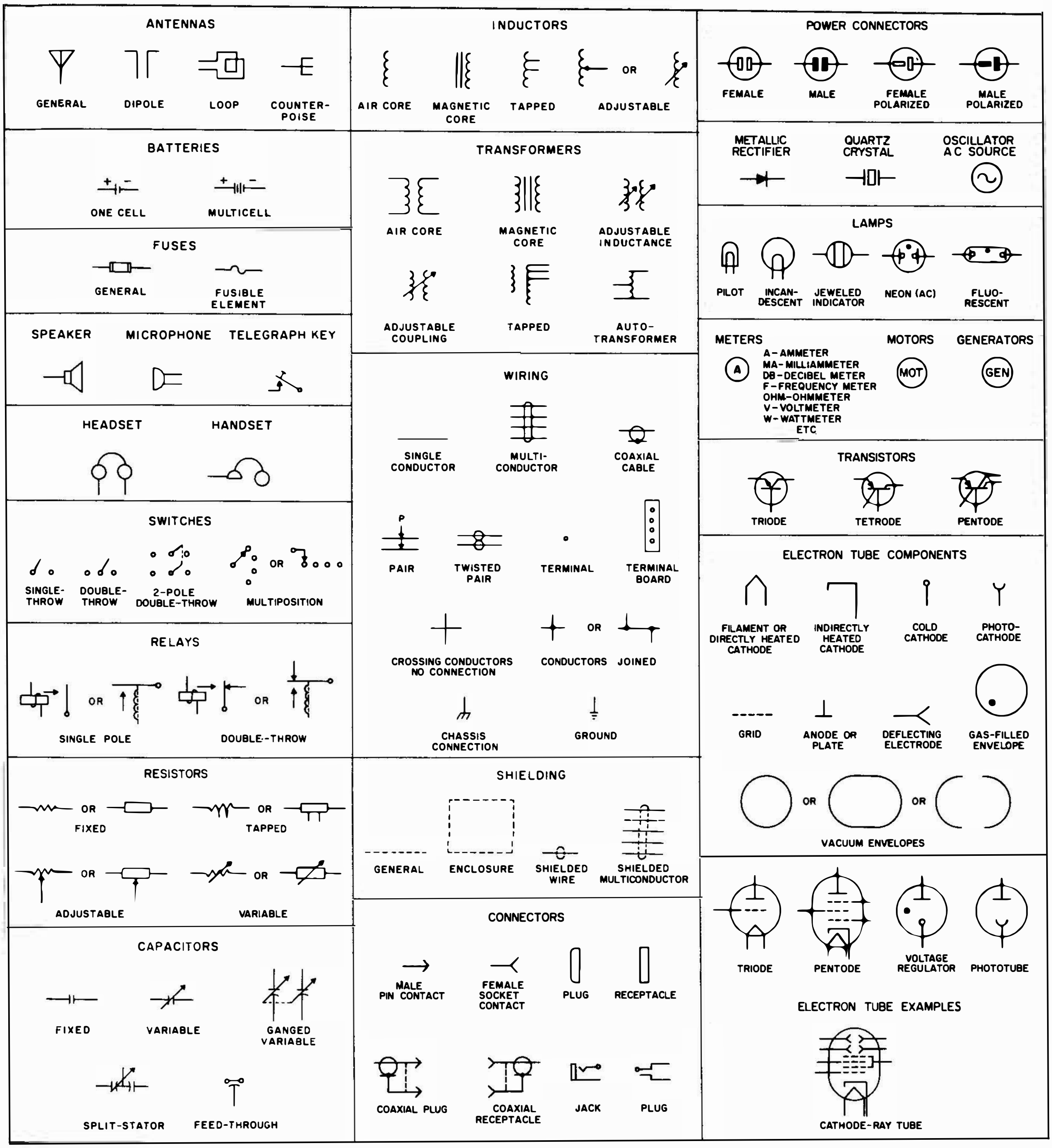
For an example, take the equipment designation AN/SRT-15. The AN is the system indicator. A glance at table 9-1 gives us the meaning of the equipment indicator letters:

S—Water surface craft.
R—Radio.
T—Transmitting.

The figure 15 is the model number.

### NAVY MODEL SYSTEM

The AN nomenclature system was adopted by the Navy in 1946, but you still find a considerable amount of equipment marked and identified by the older Navy Model System.




13. 5A
Figure 9-1. —Schematic symbols.

Table 9-1.—Equipment Indicator Letters, a 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 |
| 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 functions other 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. | |

The 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. The remaining letters were assigned in alphabetical sequence as newer equipments were designed. Some first letters you will find 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).

In the list you can see that the 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 followed RAA; RAZ was followed by RBA, and so on.

Numbers following the model letters indicate a modification of the equipment or the award of a new manufacturer's contract.

Although the Navy model letter system of equipment identification no longer is in primary use, you will find some equipments under this system of comparatively recent design and manufacture — for example, the model TED transmitter.

## CLASSIFICATION OF EMISSIONS

Radio wave emissions (transmissions) have been classified by international agreement, depending on the type of modulation used. The classifications devised by the International Telecommunication and Radio Conference in 1938 included:

A1—CW telegraphy.
A2—Modulated telegraphy (MCW).
A3—Telephony.
A4—Facsimile.
A5—Television.

The foregoing classification of emissions still is widely used, but is inadequate because there is no provision 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. This system classified emissions according to type of modulation, type of transmission, bandwidth, and supplementary characteristics. Following are typical examples of the designators that are of interest to Radiomen:

| | |
|---|---|
| 0.1A1 | CW telegraph, 25 wpm. |
| 2.04A2 | CW telegraph, tone-modulated, 1020 cycle tone. |
| 6A3 | AM telephony. |
| 36F3 | FM telephony |
| 1.5A2 | Tone-modulated RATT, 60 wpm. |
| 1.08F1 | Single-channel RATT, 60 wpm. |
| 1.24F1 | Two-channel RATT, 100 wpm (2—30 mc). |
| 2.85F1 | Four-channel multiplex. |
| 4F4 | Facsimile. |

## TRANSMITTERS

The largest and most powerful transmitter used by the Navy (and 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 to be built in the Pacific area and the VLF station at Jim Creek, Washington State, 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, for, as we learned in our study of wave propagation, the 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.

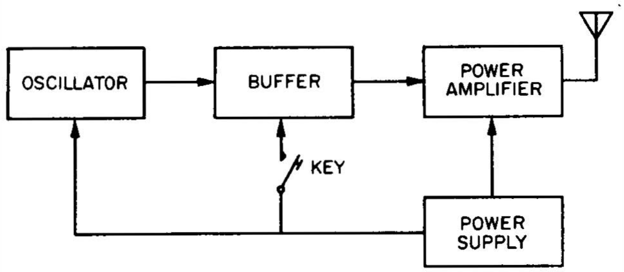
In the VLF range there are no standard shipboard radio transmitters. The shore transmitters for this band are all of special design and are of tremendous size, with power ranging from 300 kw to 2 million watts.

The types of shipboard transmitters used in the LF through UHF bands are many and varied. Specific equipment models are treated later in this chapter following a discussion of the theory of operation of radio transmitters.

## PURPOSE OF TRANSMITTER

The purpose of a radiotransmitter is to produce radiofrequency energy, and, with its amplifiers and antenna, to radiate a useful signal.

The general plan for all transmitters can be seen in figure 9-2.




20.201
Figure 9-2. —Stages of a typical transmitter.

Every transmitter has an oscillator that generates a steady flow of radiofrequency energy. The oscillator may be the self-excited type, which originates the signal in electron tubes and associated circuits. Or it may be of the crystal type, which uses, in conjunction with an electron tube, a quartz crystal cut to vibrate at a certain frequency when electrically energized. In either type, voltage and current delivered by the oscillator are very feeble, and both must be amplified many times to be radiated any distance.

The buffer stage is a voltage amplifier that increases the amplitude of the oscillator signal to a level that will drive the power amplifier. Voltage delivered by the buffer varies with the type of transmitter, but it may be hundreds or thousands of volts.

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. It may also be a frequency multiplier, as we will see later.

The final stage of a transmitter is the power amplifier. Power is the product of current times voltage, and in the power amplifier a large amount of r-f current is made available for radiation by the antenna.

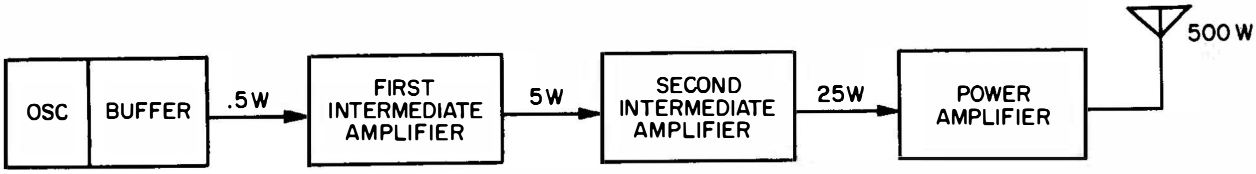
The power amplifier of a high-power transmitter may require far more driving power than can be supplied by an oscillator and its buffer stage. One or more low-power intermediate amplifiers may be required between the buffer and the final amplifier that feeds the antenna. The main difference between many low- and high-power transmitters is in the number of intermediate power-amplifying stages that are 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 is sometimes loosely used to designate unwanted radiations caused by imperfections in the transmitting equipment, but this is not entirely accurate. True harmonics are always exact multiples of the basic or fundamental frequency generated by the oscillator, and are created in the vacuum tubes and their associated circuits. Even harmonics are two, four, six, eight, etc., times the fundamental; odd harmonics are three, five, seven, nine, etc., times the fundamental. If an oscillator has a fundamental frequency of 2500 kc, harmonically related frequencies are—

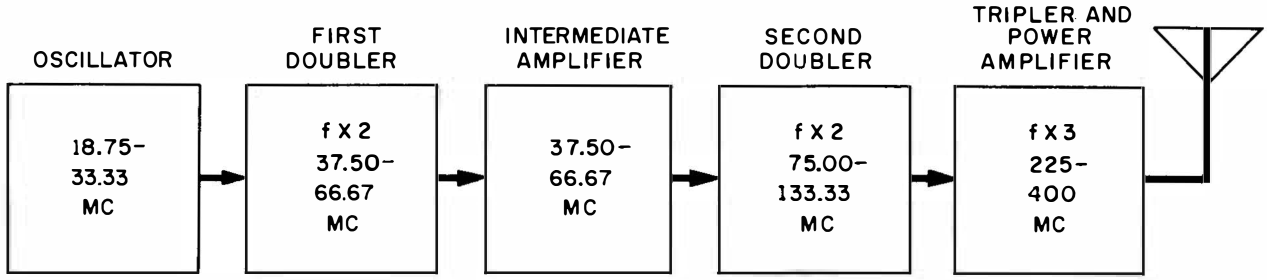
5000 . . . . . . 2d harmonic
7500 . . . . . . 3d harmonic
10,000 . . . . . . 4th harmonic
12,500 . . . . . . 5th harmonic




76.15
Figure 9-3. —Intermediate amplifiers increase transmitter power.

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; and, 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. The 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. The stages that multiply the frequency by two are called doublers; those that multiply by three are triplers; and those multiplying by four are quadruplers.




76.16

Figure 9-4. —Frequency-multiplying stages of typical VHF/UHF transmitter.

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 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 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.

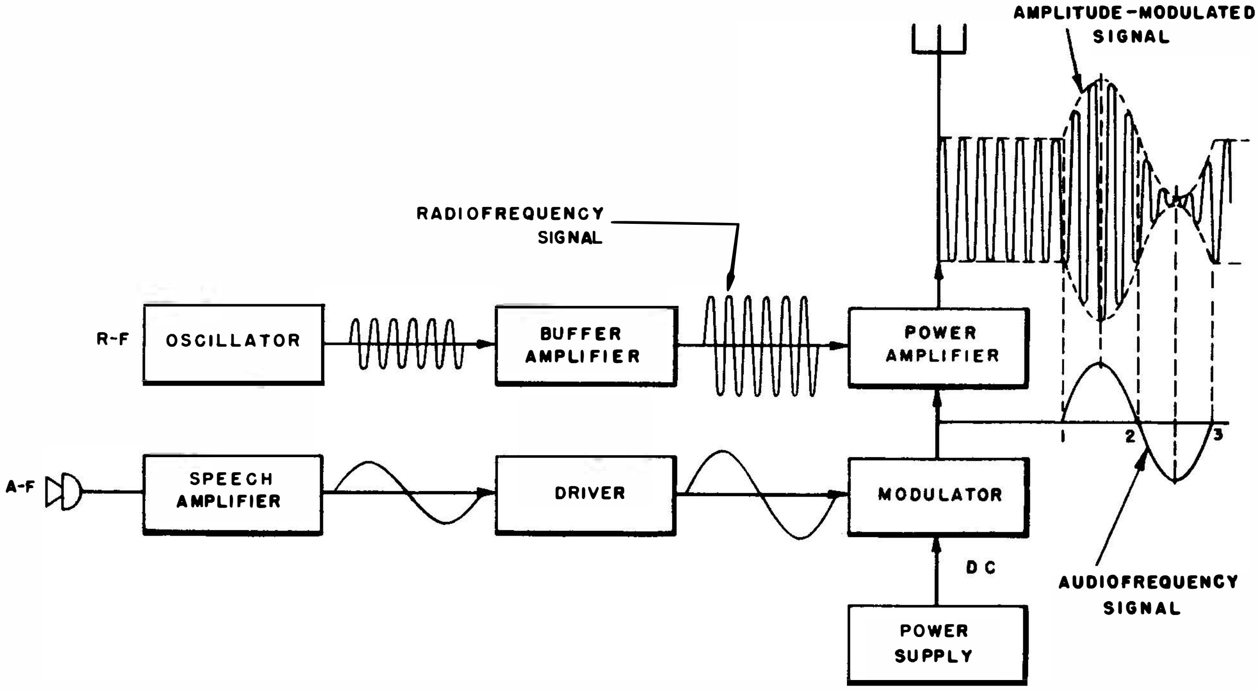
## AMPLITUDE MODULATION

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 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.




13.53
Figure 9-5. —An a-m radiotelephone transmitter.

The result of the modulation is that the 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 and 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), the amplitude of the r-f output wave is increased, and during the negative alternation (between point 2 and point 3) it is decreased. Amplitude modulation consists of varying the 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, but the two most important to you 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 the 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 are its frequency and its phase. The process of varying the frequency in accordance with the audiofrequencies of voice or music is called frequency modulation (f-m), and the process of varying the phase is phase modulation (p-m). 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, it is of considerable use in commercial broadcasting, but its shortcomings—frequency extravagance, short range on available frequencies, and 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.

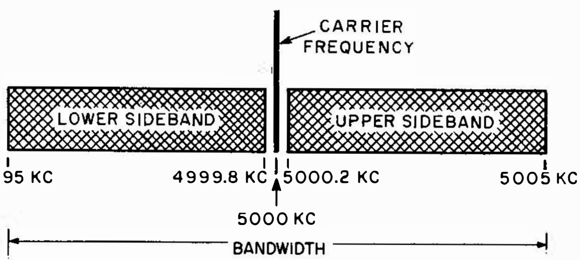
Another mode of operation provided by many medium- and high-frequency transmitters and nearly all VHF-UHF equipments is modulated continuous-wave (MCW) telegraph transmission.

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 the 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 of the carrier and the frequency 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. The 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). The space a carrier and its associated sidebands occupy in a frequency spectrum is called a channel. The width of the channel (called BANDWIDTH) is equal to twice the highest modulating frequency. For example, if a 5000-kc carrier is modulated by a band of frequencies ranging from 200 to 5000 cycles (0. 2 to 5 kc), 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 is illustrated 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. The congestion in the medium- and high-frequency bands and recent developments that have reduced the physical sizes of equipments have given a new impetus to the advantages of using SSB in fleet communications.

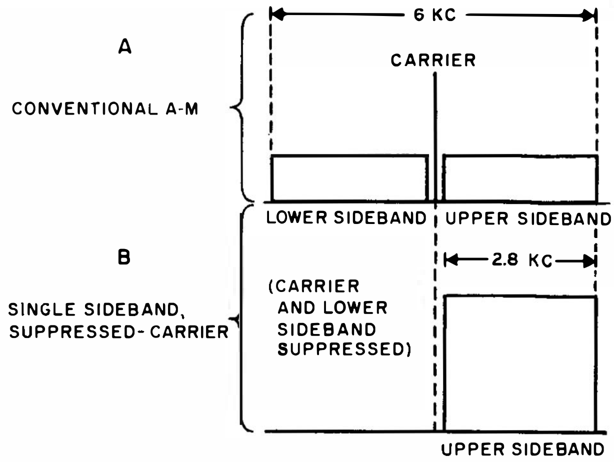
Following is a brief introduction to the technique of SSB.

In our study of sidebands, we 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. Naturally, this appears to be an uneconomical means of transmission. By eliminating the carrier and one of the sidebands, the same intelligence can be transmitted at a saving in 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 is usually 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 the 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, however, one of the two sidebands is filtered out before it reaches the power amplifier stage of the transmitter, the same intelligence can be transmitted on the remaining sideband. All the power is then transmitted in one sideband, instead of being divided between the carrier and both sidebands as in conventional a-m. This 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.)




59.51
Figure 9-7. —Comparison of bandwidths of conventional a-m and SSB voice channels.

SSB Advantages

The 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 "Loud but distorted.") This occurs because 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.

INCREASED EFFECTIVE POWER. —In a conventional a-m system, approximately one-half of the transmitter's power goes into the carrier, and the remaining one-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 THE 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 the 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 is an important advantage in fleet communications.

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 result. They are caused by the heterodyning of two or more signals transmitting at the same time. In SSB, as soon as the 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 we are able to listen to more than one conversation at the same time around the mess table.

## 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 used also for SSB, RATT, and FAX transmissions. They must be of rugged construction for long service life. Transmitters that meet these requirements are quite complex, and, because of the limited space available for radio installations in naval vessels, are of compact construction.

One method of obtaining equipment compactness is to combine a transmitter and a receiver into one unit called a 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. You will find both terms used in the equipment descriptions that follow.

## RADIO SET AN/URC-32

Radio Set AN/URC-32 (fig. 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 transmitter is designed for single-sideband transmission, and for reception on upper sideband, lower sideband, or the two independent sidebands simultaneously, with separate audio and intermediate frequency (i-f) channels for each sideband. In addition to single-sideband operation, provisions are included for compatible a-m (carrier plus upper sideband), CW, or fsk operation.

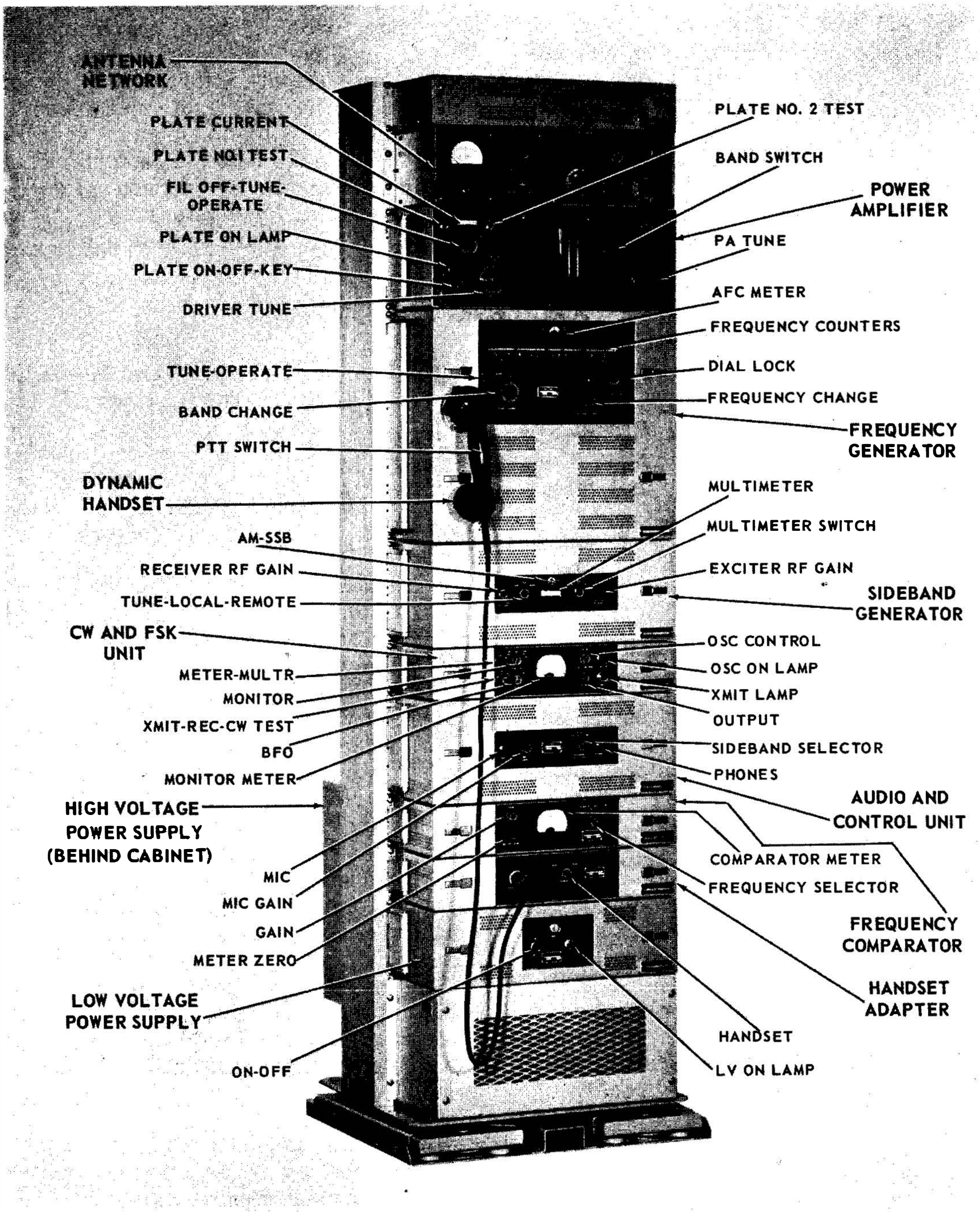
### General Description

The 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.

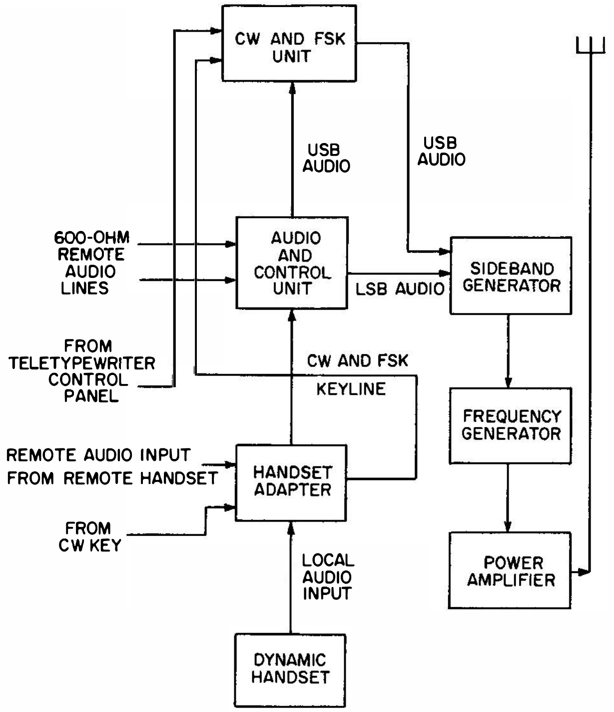
During transmission (fig. 9-9) voice input signals from the handset are fed to the handset adapter. Input signals (CW or remote audio) from a remote control unit (when used) are also applied to the handset adapter input terminals. A local-remote switch permits the operator to select either the local 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 audiofrequencies are converted later to the required frequency-shift signals for the 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 it 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,

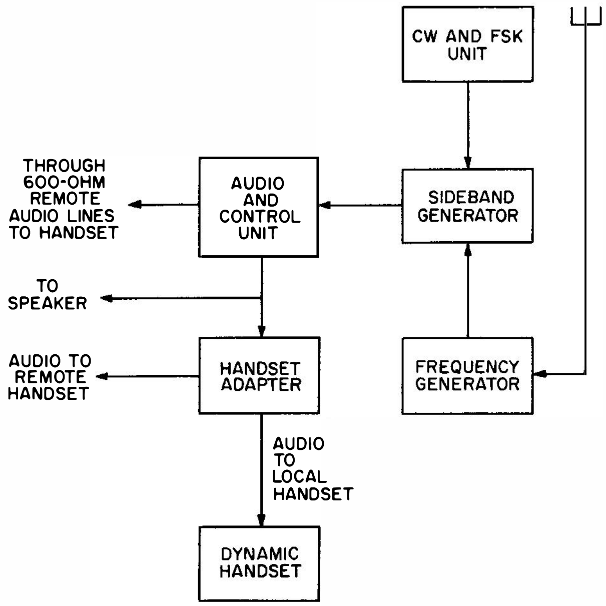



32.135
Figure 9-8.—Radio Set AN/URC-32, relationship of units and operating controls.




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.

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 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 30 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 amplified in the sideband generator, further amplified in the audio and control unit, and 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 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 kilocycle.

## Operating Procedure

The following preliminary settings must be performed before turning on the equipment (refer to figure 9-8 for location of controls).

| | |
|---|---|
| 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 used to apply power to the equipment. If the 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 the ON position. The indicator lamp on low-voltage power supply will light when air pressure is present in the cooling system.

2. Set the meter selector switch on sideband generator to the -90, +130, and +250 positions and check that the meter reads between 35 and 50 db in each position.

3. Turn the FIL OFF-TUNE-OPERATE switch on power amplifier to the OPERATE position. Wait 30 seconds before performing step 4.

4. Depress the PLATE switch on the 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 the switch is depressed.

5. Depress PLATE switch to KAY and alternately depress PLATE NO. 1 TEST switch and PL NO. 2 TEST switch on the power amplifier, checking that the 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 the 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 is as follows:

1. Set PLATE switch on power amplifier to OFF.

2. Set BAND CHANGE switch on the 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 the frequency generator. Set the desired operating frequency on the lighted frequency counter usingthe 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 the frequency counter to the next lower frequency on the counter and set the BAND CHANGE switch to ADD 1, ADD 2, or ADD 3. With the BAND CHANGE switch in the ADD 1 position, 1 kc is added to the frequency indicated on the 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 the BAND CHANGE switch to ADD 0.

EXAMPLE: To select an operating frequency of 23.699 mc, set the BAND CHANGE switch to BAND 4, set the 15.7- to 30.0-mc frequency counter to 23.696 mc using the FREQUENCY CHANGE control, and reset the 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 and should not be expected to read 0 unless the master oscillator is exactly on frequency and no correction is required.

5. Adjust RECEIVER RF GAIN control so that the automatic gain control (AGC) does not increase the 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 the sideband generator meter (AGC) "kicks up" about 15 db with the meter switch in the 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.

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 the ANT-LOAD switch on the antenna tuner control to LOAD. Set the FIL OFF-TUNE-OPERATE switch on power amplifier to TUNE. Set the meter selector switch on the sideband generator to RF OUT. Set TUNE-LOCAL-REMOTE switch on the sideband generator to TUNE.

In the following steps, key to transmit by depressing the PLATE switch on the power amplifier to KEY.

7. With the EXCITER RF GAIN control in the maximum counterclockwise position, key to transmit and turn EXCITER RF GAIN control clockwise until meter on the sideband generator reads approximately 40 db.

8. Key to transmit and adjust DRIVER TUNE control on the power amplifier within the desired band limits to peak the PLATE CURRENT meter reading, and adjust the EXCITER RF GAIN control as necessary to maintain a PLATE CURRENT meter reading of approximately 200 milliamperes. The red index on the DRIVER TUNE control must fall within the proper band limits marked on the panel. If a power output reading is observed on the power output meter of the antenna tuner, detune the P. A. TUNE control until no power output is indicated. This effectively disables the r-f feedback so that optimum adjustment of the 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.

After completing step 8, make no further adjustments on the DRIVER TUNE control for the remainder of the tuning procedure.

9. Set the P. A. TUNE control on the power amplifier within the desired frequency band limits. Key to transmit and adjust P. A. TUNE control for a dip in the PLATE CURRENT meter reading.

10. Set EXCITER RF GAIN control maximum counterclockwise. Set FIL OFF-TUNE-OPERATE switch on the 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 the P. A. TUNE control. The PLATE CURRENT meter reading should not exceed 500 milliamperes. 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 the operating procedures in the 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. The reflected power meter reading should be less than 10 watts. The PLATE CURRENT meter reading should be between 450 and 550 milliamperes.

14. Key to transmit and adjust the EXCITER RF GAIN control for a forward power output of 125 watts.

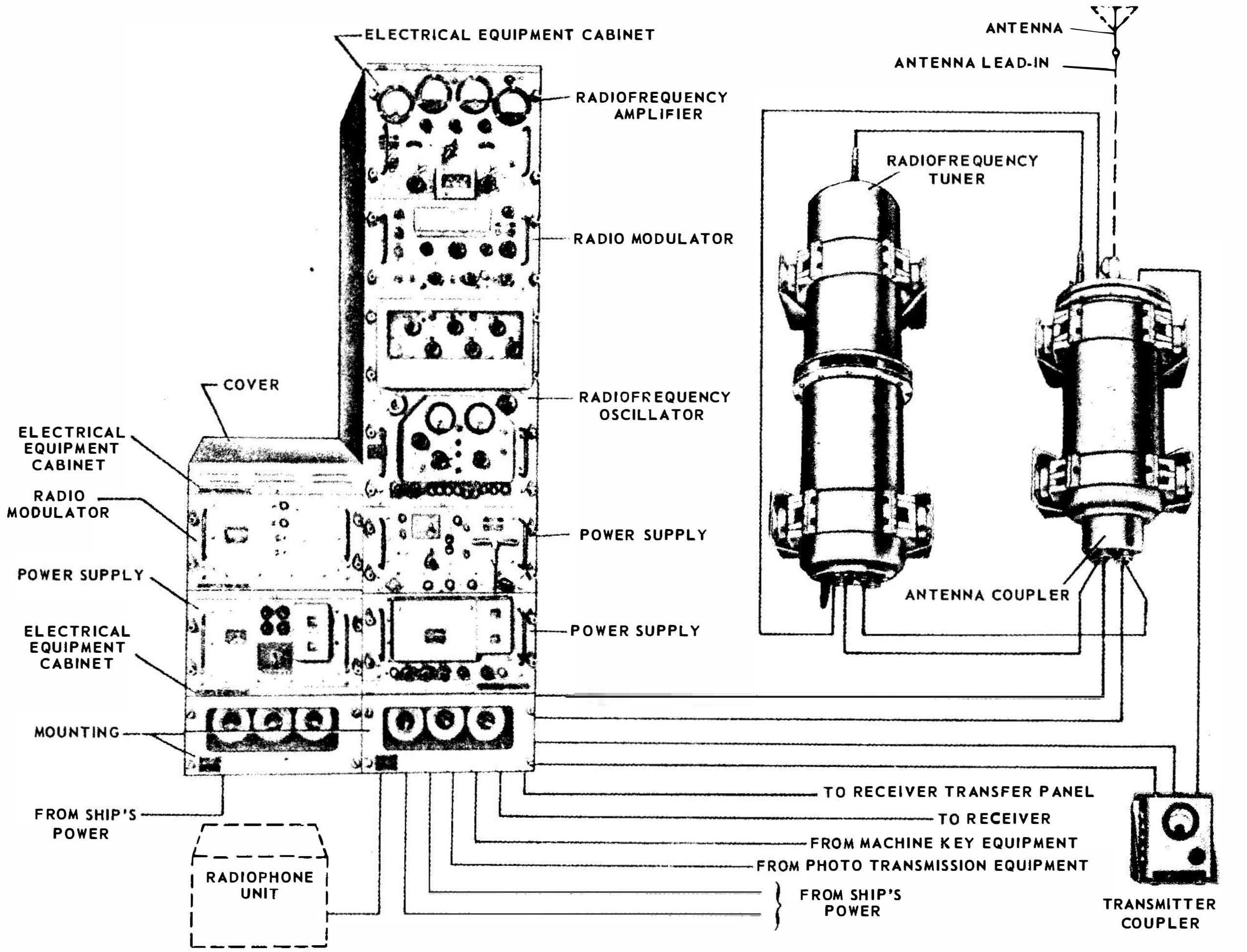
15. Key to transmit and check the following meter readings:

| | |
|---|---|
| PLATE CURRENT meter | Approx. 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 the sideband generator to LOCAL. On AM transmit operation, readjust EXCITER RF GAIN control for 125 watts forward power. Set PLATE switch on the power amplifier to ON. This completes the tuning procedures.

## AN/SRT-15 TRANSMITTER

The AN/SRT-15 (fig. 9-11) is one model of a series of radio transmitters. This transmitter replaced older equipments such as Navy models TAJ, TBL, TBK, and TBM. It is capable of performing the operations that heretofore have required several separate transmitters, and the space needed is considerably less than that of the older models.




1.144
Figure 9-11. —Radio transmitter AN/SRT-15.

The three transmitters in the series are known as the AN/SRT-14, -15, and -16. The AN/SRT-14 is the basic transmitter, and has a power output of 100 watts. The AN/SRT-15 is the same,with the addition of a 500-watt booster amplifier and its associated power supply, thus providing optional output power of either 100 or 500 watts over the frequency range 2 to 26 mc; output is limited to 100 watts in the MF band from 0. 3 to 2 mc. The AN/SRT-16 consists of two AN/SRT-14 equipments plus the booster amplifier, furnishing two entirely independent transmitting channels of 100-watt output, with the 500-watt booster amplifier available for use with either channel when desired.

All three transmitters cover the frequency range 0. 3 to 26 mc, and may be used for CW, radiotelephone, radioteletypewriter, and FAX transmissions.

AN/WRT-1

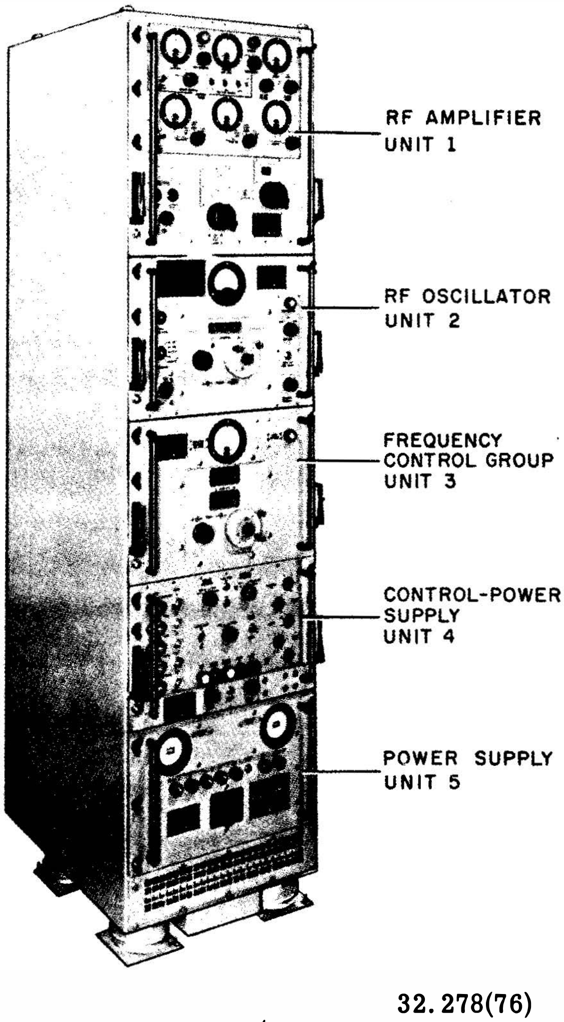
The AN/WRT-1 (fig. 9-12) is a modern MF transmitter installed in surface vessels. It covers the frequency range 300 to 1500 kc, with an output power of 500 watts, and can be used for CW, teletypewriter, and radiotelephone. This transmitter has a built-in dummy load for use in tuning the transmitter under radio silence conditions.

AN/WRT-2

The AN/WRT-2 is a modern HF transmitter used in surface ships and submarines. It covers the range of 2 to 30 mc in 12 frequency bands. The r-f oscillator produces fundamental frequencies from 2 to 8 mc; frequency multiplication is used to produce 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 AM radiotelephone. It has an output power of 1000 watts when transmitting single sideband. It may also be used for transmitting separate intelligence on each independent sideband. A built-in dummy load permits off-the-air tuning under radio silence conditions.

The AN/WRT-2 (not illustrated) is similar in size and constructional appearance to model AN/WRT-1 (fig. 9-12).



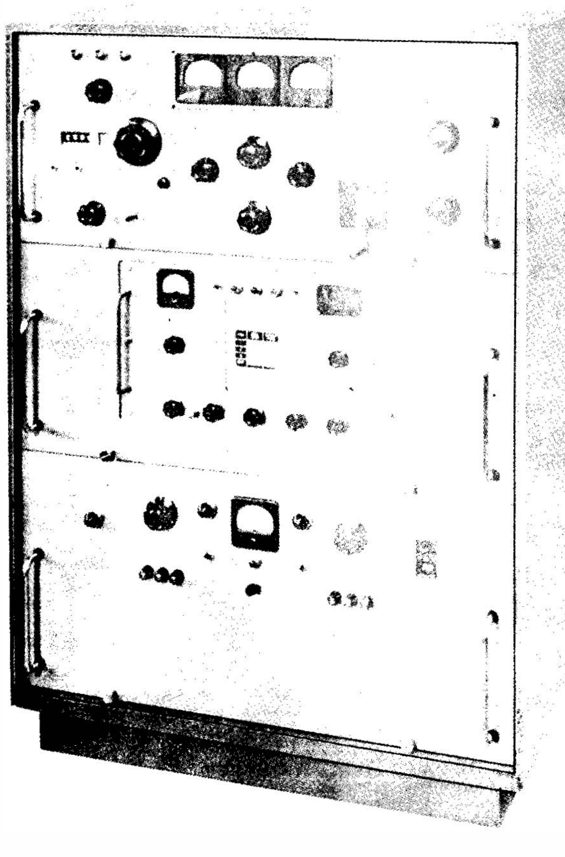

32.278(76)
Figure 9-12. —AN/WRT-1 transmitter.

AN/URT-17

The AN/URT-17 transmitter (fig. 9-13), with its extended range and higher power, has many features not found in the older transmitters. It can be used for radiotelephone, CW, RATT, and FAX operation on all frequencies from 2 to 32 mc. It provides output power of 1000 watts for CW or RATT, and 750 watts for radiotelephone. The most outstanding feature is its SSB capabilities. The SSB exciter provides choices of single sideband with suppressed carrier, two independent sidebands with suppressed carrier, double sideband with full carrier, or CW operation. It presently is installed in major flagships and headquarters of fleet commanders.

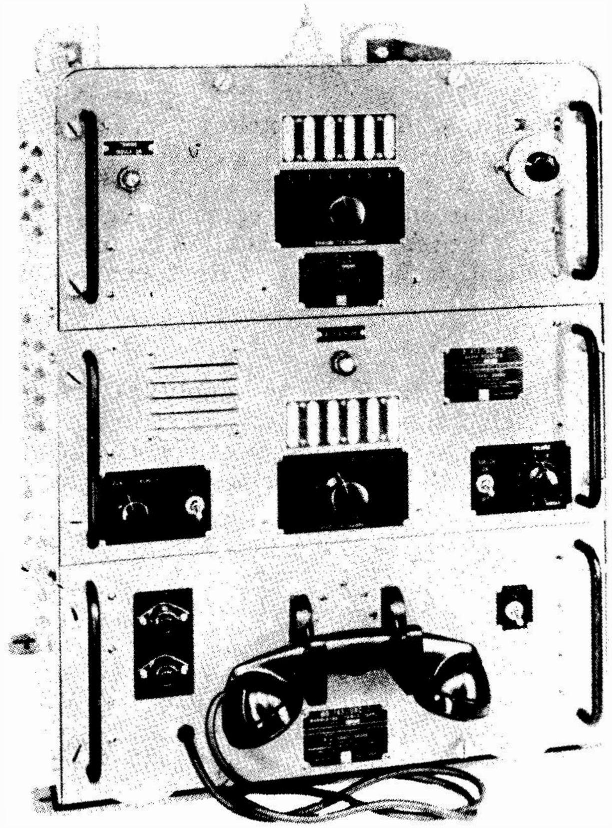
AN/URC-7

The AN/URC-7 is an amplitude-modulated radiotelephone transmitter-receiver for short- and medium-distance radiotelephone communication. Both transmitter and receiver have six



76.18
Figure 9-13. —AN/URT-17 transmitter.

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 (fig. 9-14).

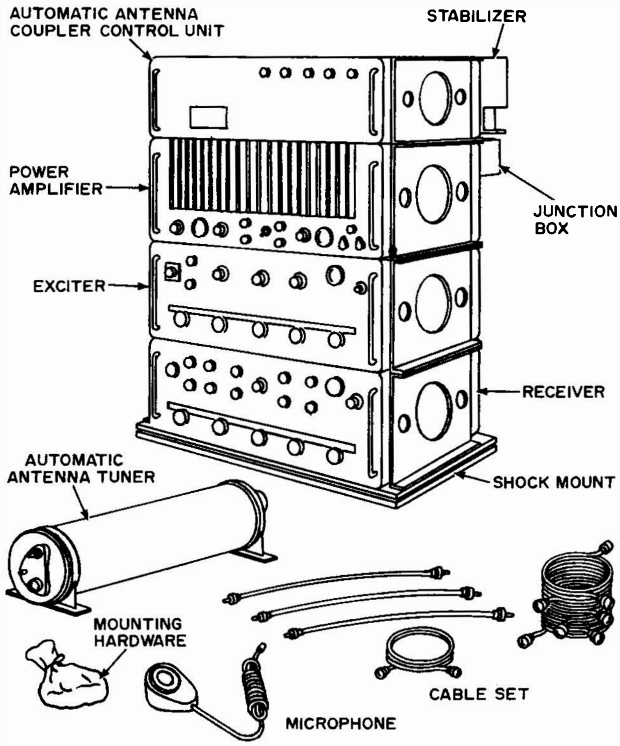


76.19
Figure 9-14. —AN/URC-7 transmitter.

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

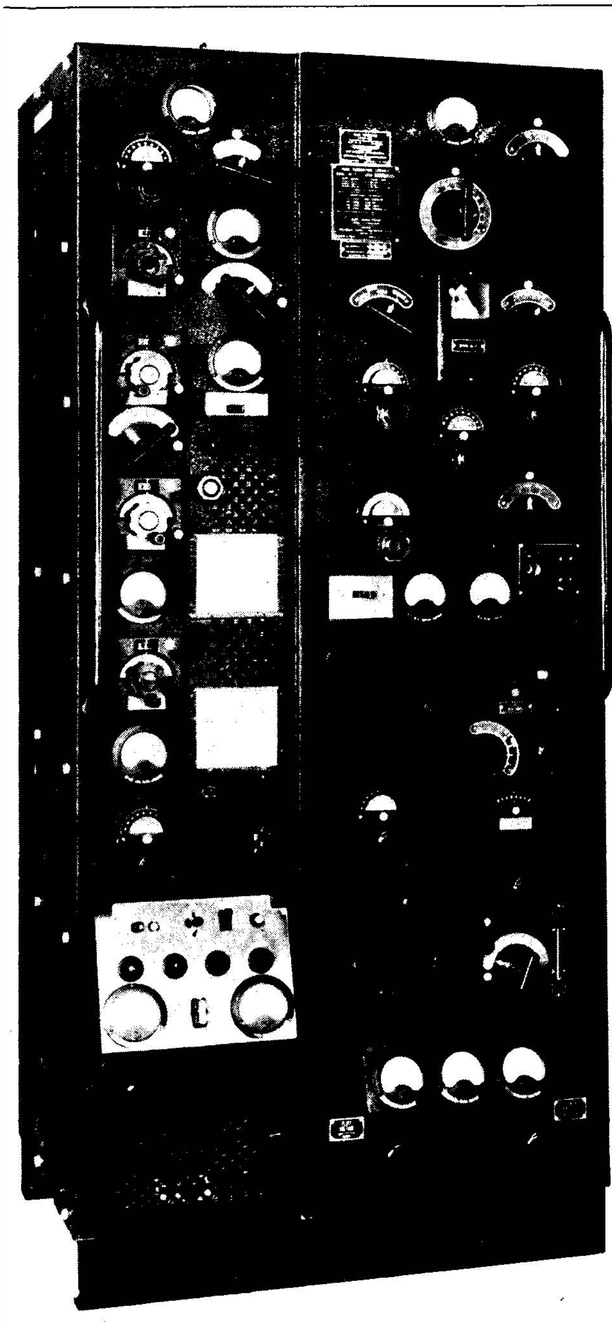
Radio Set AN/WRC-1 (fig. 9-15) is a transmitter-receiver that covers the frequency range of 2 to 30 megacycles in 1-kilocycle steps. It has a power output of 100 watts, and is capable of transmission and reception on upper sideband, lower sideband, continuous wave, amplitude modulation, frequency shift keying, and independent sideband modes of operation. The independent sideband mode of operation allows the transmission and reception of different information on USB and LSB simultaneously.




76.20
Figure 9-15. —Radio Set AN/WRC-1.

## TBL

The TBL transmitter (fig. 9-16) is a low-power equipment used extensively for many years. It operates in two frequency ranges and has an output of 200 watts on CW and 100 watts on MCW. The low-frequency side covers the range 175 to 600 kc, and the high side from 2 to 18 mc. This means that the TBL can be used to cover two frequency ranges, resulting in important space saving. Both sides of this transmitter cannot be keyed simultaneously; however, to shift from one frequency range to the other is merely a matter of throwing a switch. This transmitter requires a separate speech amplifier (not illustrated) when used for voice transmission. The most recent improvement to the TBL is field change AN/WRA-1, which permits use of this transmitter for single-sideband operation.



76.21
Figure 9-16. — TBL transmitter.

TCS

The model TCS (fig. 9-17) is a small transmitter-receiver that has been in use for many years for short-range voice communications. 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. 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 is most commonly used. This 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. Two VHF transmitters still in use are described here.

### AN/URT-7

The AN/URT-7 is a crystal-controlledradiotelephone 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. 9-19).

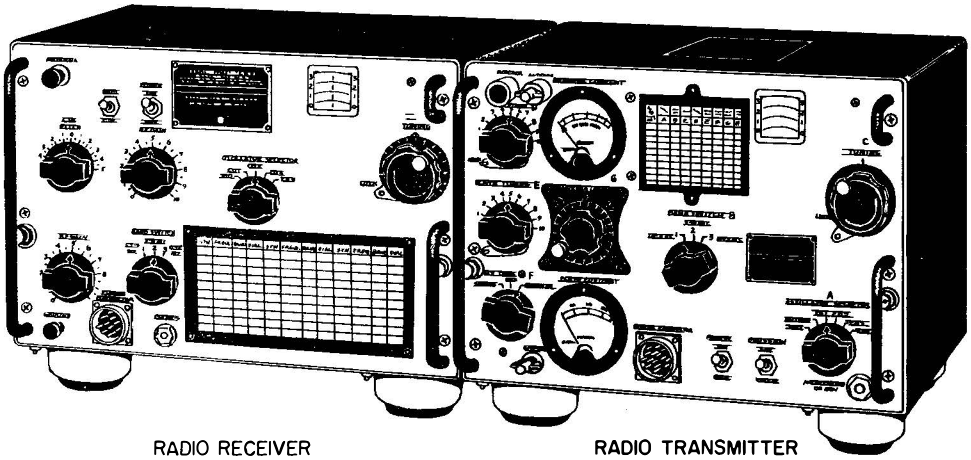
### TDQ

The TDQ transmitter (fig. 9-18) operates radiotelephone and MCW in the frequency range 115 to 156 mc. It is crystal-controlled and has a 45-watt power output. This transmitter is being replaced by AN/URT-7.

## UHF TRANSMITTERS

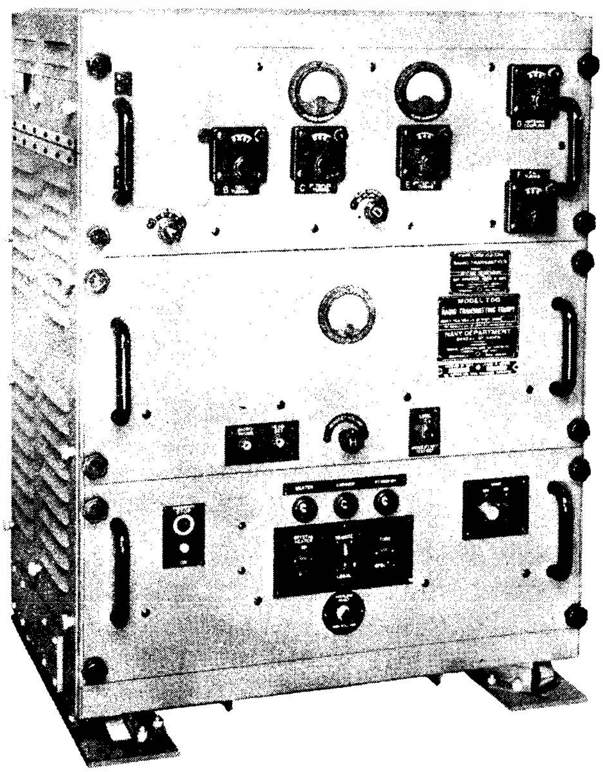
The UHF transmitters are used throughout the Navy. They operate in the 225- to 400-mc frequency range, and their primary uses are for tactical surface and air radiotelephonecommunications.

Power output requirements are relatively low because the effective range of UHF is normally limited to line-of-sight distances. Although UHF transmitters are designed also for MCW emission, radiotelephone is most commonly used.




76.22

Figure 9-17. — TCS transmitter-receiver.



50.71

Figure 9-18. — TDQ transmitter.

NAVY MODEL TED

The TED (fig. 9-19) 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.

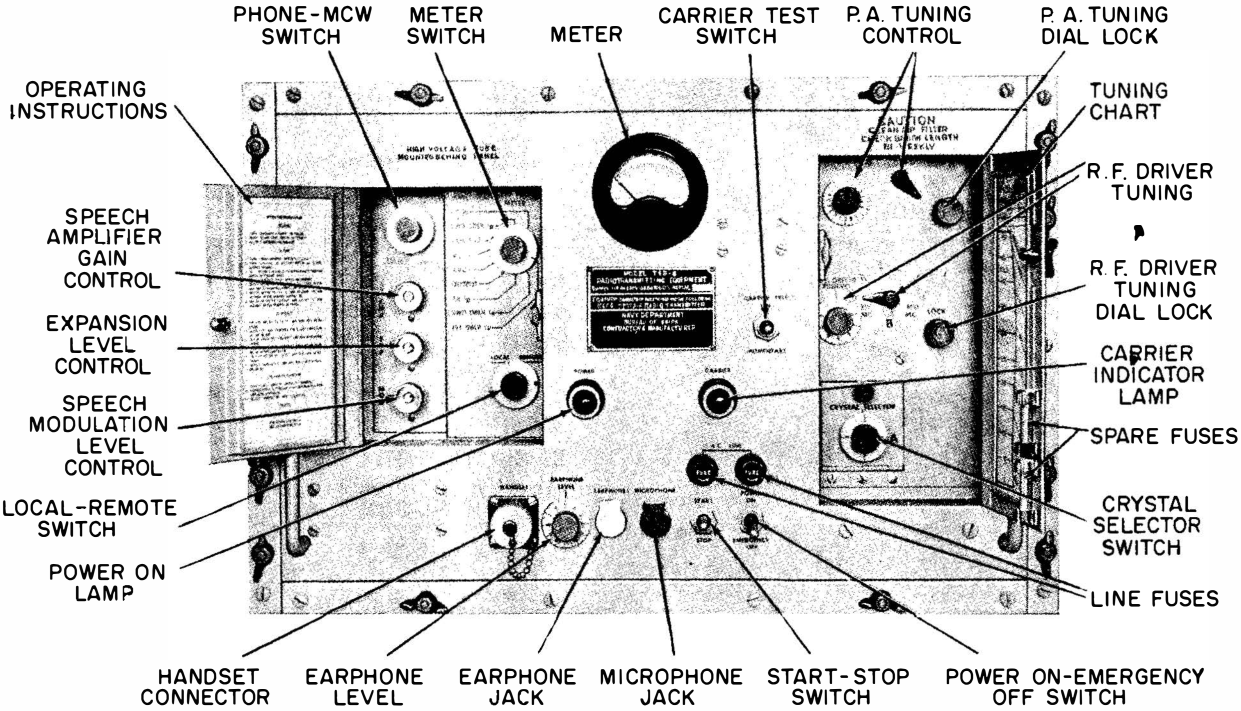
Although mountings for four crystals are provided, permitting rapid selection of any one of four frequencies, the transmitter must be retuned each time the frequency is changed.

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, and currently is being installed in the fleet. This amplifier boosts the output power to 100 watts.

AN/GRC-27

The AN/GRC-27 and AN/GRC-27A are UHF transmitter-receiver sets covering frequencies from 225 to 400 mc. The AN/GRC-27A, the shipboard installation, is shown in figure 9-20. This equipment is used for UHF radio telephone 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 transmitters 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




32.38

Figure 9-19. — UHF radio transmitter, model TED.

transmitter's frequency range. Any 10 of these 1750 frequencies can be preset manually with selector switch dials. Any one 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. It takes only 2 to 7 seconds 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 done in about 2 to 7 seconds. The receiver has AVC (automatic volume control), automatic noise limiter, and a squelch circuit.

The AN/GRC-27A is installed principally in carriers and radar picket vessels, whose primary missions involve the control of aircraft.

## 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

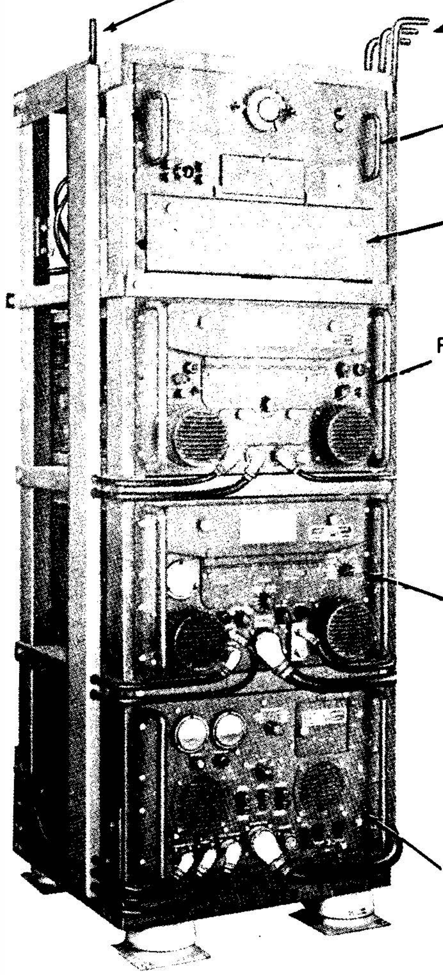
Radio receivers must perform the following six functions (fig. 9-21):

1. Signal interception.
2. Signal selection.
3. Radiofrequency amplification.
4. Detection.
5. Audiofrequency amplification.
6. Sound reproduction

These six functions are sufficient for a-m reception, but for CW reception an additional circuit (shown by dotted lines, fig. 9-21), called a beat-frequency oscillator, is required.

#### Signal Interception

The receiving antenna intercepts a small portion of the passing radio waves. The signal




32.109.2
Figure 9-20. —UHF transmitter-receiver AN/GRC-27A.

voltage extracted by receiving antennas is only a few microvolts, sufficient for subsequent amplification as long as the noise energy intercepted by the antenna is substantially less than this.

## SIGNAL SELECTION

Some means must be provided to select the desired signal from all r-f carriers intercepted by the antenna. This 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

The weak signals intercepted by the antenna usually must be amplifier 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 makes sure that only the desired signal is amplified.

## 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, and this is one of the reasons why r-f amplification is required ahead of the detector.

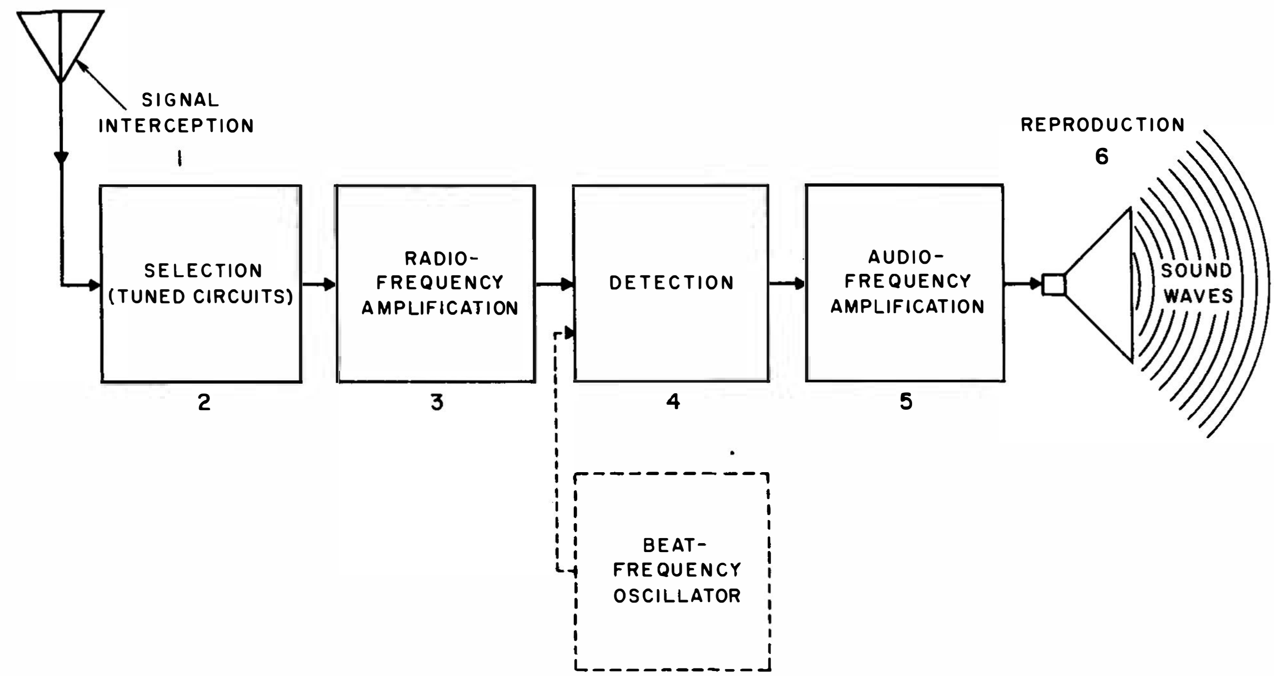
In CW (radiotelegraphy) reception, a beat-frequency oscillator (bfo) is used in the receiver circuit. The bfo provides an r-f signal that beats or heterodynes against the frequency injected into the detector. The resultant frequency is an audiofrequency that can be heard in the headset or loudspeaker.

## AUDIOFREQUENCY AMPLIFICATION

The signal frequency in the output of the detector generally is too weak to operate a headset or loudspeaker. One or more stages of a-f amplification are therefore 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 the 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




76.23
Figure 9-21. — Essentials of radio reception.

depressed at the transmitter, and, consequently, it reproduces the interruptions of the r-f carrier in accordance with the Morse code.

## FIELD STRENGTH

The amount of voltage induced in an antenna depends upon the length of the antenna and the 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. The amount of voltage induced in an antenna depends on the length of the antenna as well as upon the field strength of the signal.

## SENSITIVITY

The sensitivity of a receiver 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.

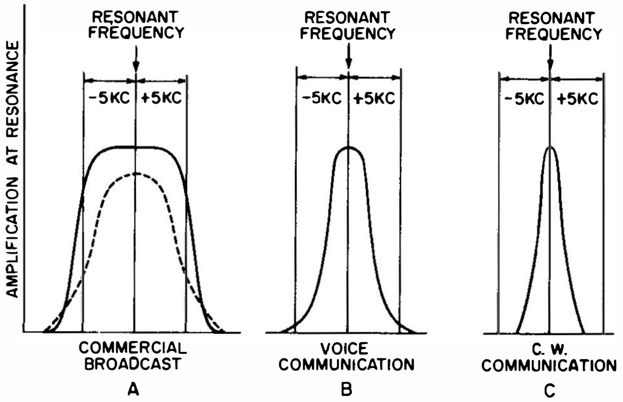
In an area of strong local interference, a receiver needs a strong signal to give good reception. If the local interference has a field strength of 100 microvolts per meter, a signal strength of from 500 to 1000 microvolts per meter is required to drown the noise. The same receiver, free of local interference, may give good reception on a signal strength of 10 microvolts per meter. It is hard 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 microvolts 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 very 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, and a CW communication receiver is even more selective. You can compare the three tuning curves in figure 9-22.

You will remember the analysis of amplitude modulation treated earlier in this chapter. It showed how the intelligence transmitted was contained in the sideband frequencies.




76.24

Figure 9-22. — Tuning curves of three types of radio receivers.

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. 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 9-22 is OPTIMUM— "at its best." The top is broad and flat and the sides are steep. Actually, most a-m broadcast receivers have tuning curves resembling the broken line, and many frequency components of voice and music contained in the signal are not reproduced by the set.

Although sharp tuning in a home radio would make for poor listening, it is desirable for military sets for the sake of frequency economy and 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, like 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.

## TYPES OF RECEIVERS

The two major types of communication receivers are the TUNED RADIOFREQUENCY (TRF) and the SUPERHETERODYNE.

### TUNED RADIOFREQUENCY RECEIVER

In the TRF receiver, all radiofrequency amplification takes place at the frequency of the incoming signal, and all tuned circuits must be adjusted to this frequency. For this reason, the TRF receiver has several disadvantages. It is difficult to get uniform amplification of the r-f stages over the entire frequency range of the receiver. At the higher frequencies, the sensitivity of the receiver is reduced. The most serious drawback of the TRF receiver is that the selectivity of the tuned circuits cannot be kept uniform over the frequency range, the selectivity decreasing at the high end of the frequency band. The TRF receiver is rarely used any more. The Navy models RAK/RAL and RBA receivers, although obsolete and scheduled for early replacement, still are installed and in use in some ships and stations. These models are the only TRF receivers you are likely to encounter.

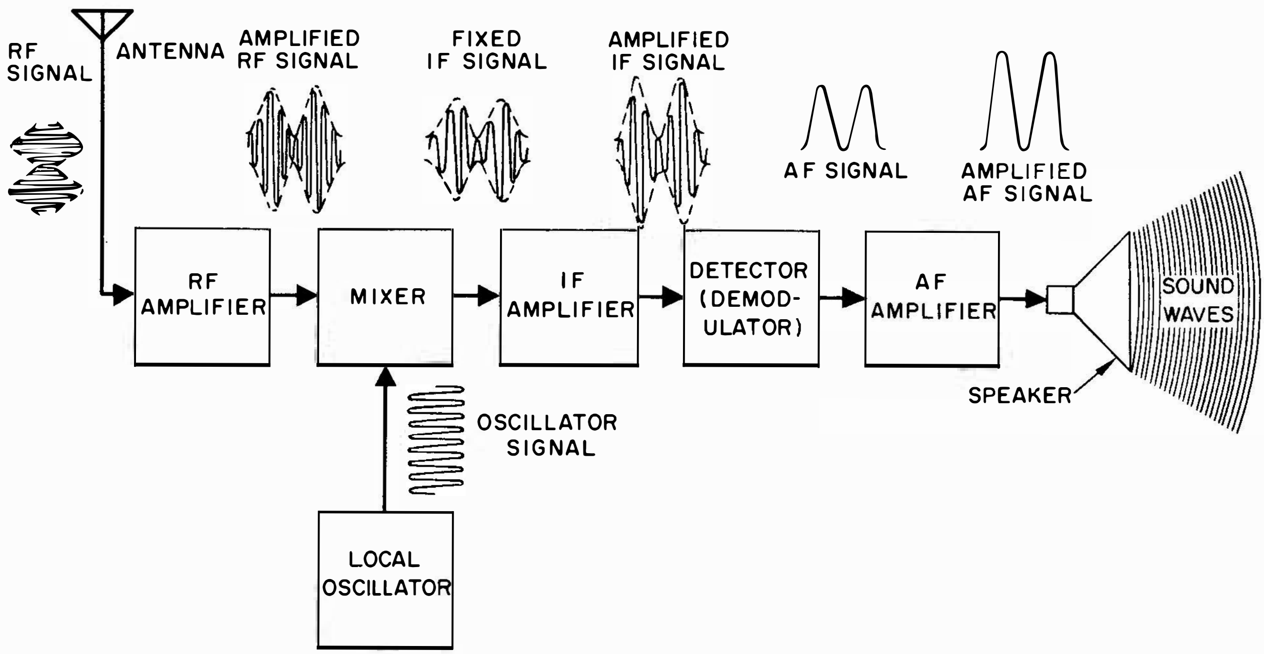
### SUPERHETERODYNE RECEIVER

The difficulties of the TRF receiver are overcome to a large degree in the superheterodyne receiver by conversion of the signal frequency to a lower intermediate frequency (i-f). Regardless of the frequency of the received signal, the signal with its audio modulation is always converted to this fixed intermediate frequency. Then it can be amplified in a fixed-frequency i-f amplifier. This amplifier has much higher and more uniform amplification and selectivity over the tuning range of the re- receiver than is possible with the TRF amplifier. Summing up, the superheterodyne receiver is superior to the TRF receiver, because it is more selective, has higher amplification, and more uniform selectivity and sensitivity. In addition to these advantages, it has fewer variable-tuned circuits, and the receiver can more easily be made to cover more frequency bands. For these reasons, superheterodynes have replaced TRF receivers for practically all uses.

## BASIC SUPERHETERODYNE RECEIVER

The basic stages for a-m superheterodyne reception are shown in figure 9-23 in the order in which a signal passes through the receiver. The illustration also shows the changes in waveshape of the signal as it passes through the receiver. The operation of the superheterodyne receiver for the reception of a-m signals is as follows:

1. Modulated r-f signals from many transmitters are intercepted by the antenna.




76.25
Figure 9-23. — Superheterodyne receiver, showing signal waveshape.

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, and 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 is equal to the sum of the incoming signal and the local oscillator; 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. The electrical audio variations are converted into the corresponding sound waves by the loudspeaker (or headphones).

## FREQUENCY CONVERSION

The oscillator and mixer circuits together achieve the frequency conversion of an r-f signal to an intermediate frequency. Two methods are used to produce this frequency conversion. In one, a separate oscillator tube provides the 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. The 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 is known as 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 make use of 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. You can find the i-f for a particular model in the equipment technical manual.

CW Detection

Because CW code signals are not modulated, the intelligence contained in them cannot be receovered by the ordinary detection process. The addition of a beat-frequency oscillator (bfo), shown in figure 9-21, is all that is required to make an a-m superheterodyne receiver suitable for the reception of CW signals. 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. The receiver can be made ready again instantly for a-m reception by simply turning off the bfo. All Navy communication receivers in the VLF through HF ranges have a bfo.

Volume Control

Volume or gain controls are provided in receivers to permit changing the receiver sensitivity. This identical device is found on home radios and televisions and is familiar to everyone. It is necessary in order to compensate for differences in the strength of incoming signals.

Volume control can be manual or automatic. Automatic volume control (AVC)—sometimes called automatic gain control (AGC)—is used in all superheterodyne receivers and is desirable for several reasons. 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. The 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 the amplitude of a received signal increases. It affects weak as well as strong signals. 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, provided the signal is not too weak.

In some receivers a special type of AVC, called delayed automatic volume control (DAVC), is used. 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 further weakened.

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.

The 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.

The output limiter prevents sudden crashes of static from injuring the operators eardrums. There are 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.

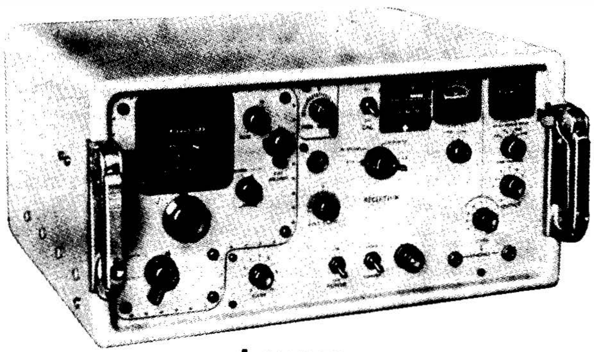
Some receivers have silencer circuits that keep the set quiet when no signal is coming in. This is a convenience when standing by for a message, and also saves you the discomfort of spending a slack watch listening to static.

Most output limiters and silencers have OFF-ON switches and an output level adjustment. The 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 you attempt to tune any particular receiver for the first time.

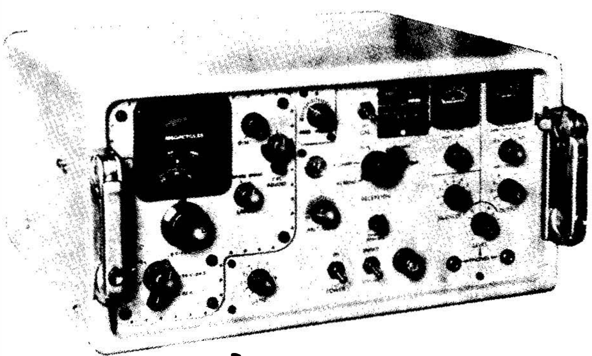
## REPRESENTATIVE RECEIVERS

Radio receivers AN/SRR-11, -12, -13, and -13A (fig. 9-24) are representative modern communication receivers used in all types of Navy vessels. They are companion receivers to the previously described transmitters AN/SRT-14, -15, and -16, and cover frequencies between 14 kc and 32 mc. A general description of these receivers is followed by an explanation of the common operating adjustments, and this is concluded with a summary of the tuning procedures.

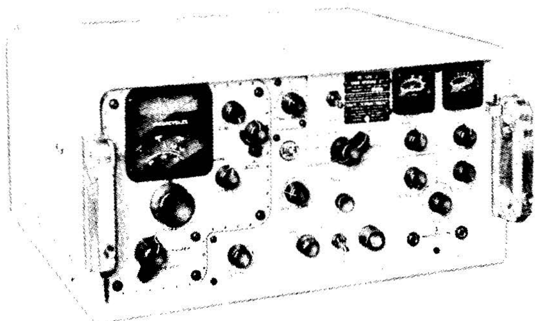
A number of other receivers also are briefly described and illustrated in this section.



A AN/SRR-11



B AN/SRR-12 AND 13



C AN/SRR-13A

Figure 9-24.—AN/SRR-11, -12, -13, and -13A receivers. 1.157

### AN/SRR-11, -12, -13 RECEIVERS

The 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 the range of the AN/SRR-13 and -13A is from 2 to 32 mc.

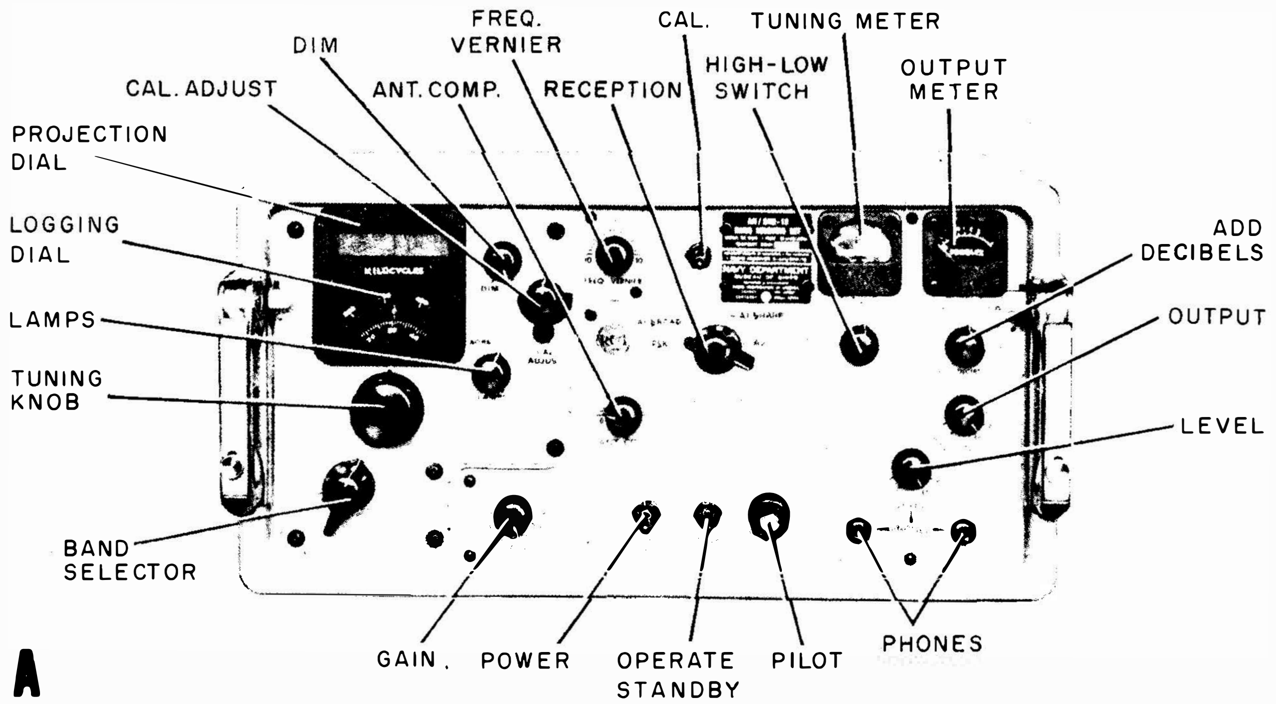
You may have noticed that the frequency range of AN/SRR-12 includes the standard broadcast band, and overlaps part of the frequencies covered by the other models. The Navy procured very few AN/SRR-12 receivers, and it is unlikely that you will encounter this model in the fleet. Although the tuning procedures for AN/SRR-12 and 13 are the same, further discussion will mention only models AN/SRR-11 and -13. AN/SRR-13A differs only slightly and 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 the 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, and, 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 and 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 tuning procedures.

The frequency to which the receiver is tuned appears 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.



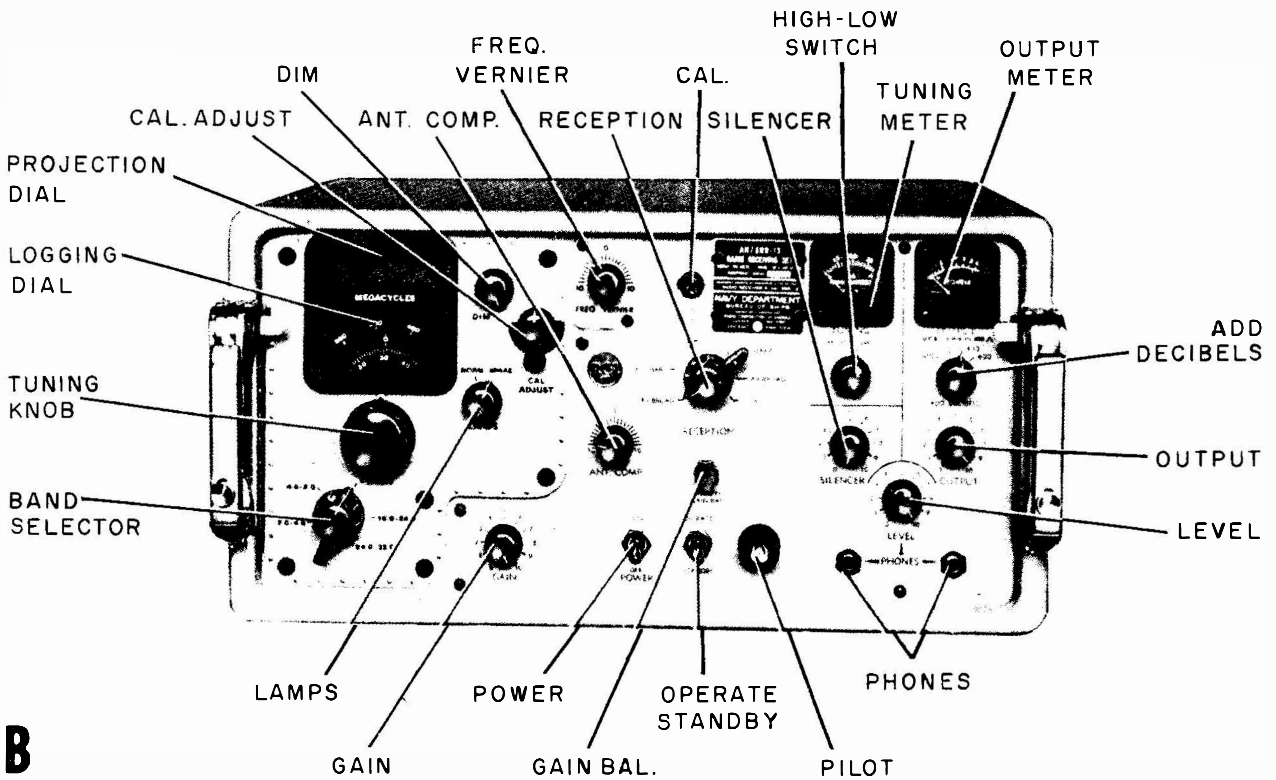




Figure 9-25.— (A) AN/SRR-11 receiver. (B) AN/SRR-13 receiver.

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Operating Adjustments

The name of each control is marked on the front panel, as illustrated in figure 9-25.

The on-off POWER switch turns the receiver on. The OPERATE-STANDBY switch (not included in model AN/SRR-13A) must also be turned on to apply plate voltage to the tubes.

The GAIN control operates in both the r-f and i-f stages of the receiver. Maximum gain is obtained with the control knob turned fully clockwise.

The ANT COMP (antenna compensating) control provides a tuning adjustment for the antenna preamplifier, to compensate for variations in antenna length.

The BAND SELECTOR provides selection of the tuning range in any one of five bands. The TUNING KNOB is used to tune the receiver to the desired frequency. The indication of this frequency appears on the translucent screen above the tuning knob, as previously described.

The DIM control varies the brightness of the dial light. The LAMPS switch connects a spare dial light in the event of burnout of the first one.

The OUTPUT control varies the volume of the audio amplifier. The LEVEL control is used to vary the volume in the headphones.

The RECEPTION control on the AN/SRR-11 receiver is a four-position switch used to select the proper circuits for the type of signal being received. The FSK position is used for receiving frequency-shift signals, either RATT or FAX, when a converter is connected to the receiver; a beat note is furnished. The A1 BROAD setting is the normal setting for CW signals; a beat note is also provided. The A1 SHARP setting is used to separate CW signals by narrowing the frequency response; a beat note is also provided. The A2 position is used for receiving MCW signals. In addition to the four signal positions on the AN/SRR-11 reception control, the corresponding switch on the AN/SRR-13 receiver has two additional settings. These are designated A3 SHARP and A3 BROAD. Both settings provide circuits for reception of radiotelephone signals.

The SILENCER reduces background noise when the RECEPTION control is set at A3 SHARP or A3 BROAD, and the desired station is not transmitting.

The FREQ VERNIER varies the pitch of the beat-frequency oscillator when the RECEPTION control is in the A1 BROAD, A1 SHARP, and FSK positions.

When CAL (calibrate) switch is turned on, frequency checkpoints are provided. The CAL ADJUST control is used to reset the projection dial after the desired checkpoint frequency has been zeroed.

The TUNING METER reads up scale (to the right) when the desired signal is tuned to maximum. The meter reads down scale (toward the left) when the desired station is detuned. The tuning meter is used in conjunction with the HIGH-LOW switch. It normally is in the LOW position. When the tuning meters reads on the lower part (left side) of the scale in the LOW position of the switch, use the HIGH position and tune the receiver for an up-scale reading on the meter. The HIGH position of the switch is spring-loaded; when released, the switch returns to the LOW position.

The OUTPUT METER reads the output power level when used in conjunction with the ADD DECIBELS switch.

The ADD DECIBELS switch is used to protect the output meter circuit against overload. Use the +10 position for checking strong output levels. The Ø position is used to measure weak levels, and the -10 position is used for a momemtary reading of weak levels. The ADD DECIBEL switch should be in the +20 position when not using the output meter.

Summary of Operation

When starting the equipment: (1) turn POWER switch ON, (2) turn OPERATE-STANDBY switch to OPERATE, (3) adjust dial illumination with DIM control (turn clockwise to brighten; should the dial light burn out, switch LAMPS knob to SPARE position), (4) turn ADD DECIBELS switch to +20 position, (5) make sure the CAL switch is OFF, and (6) plug a headset into either of the two PHONES jacks. The LEVEL control adjusts the volume in the headphones.

To tune a signal:

1. Turn the GAIN and OUTPUT controls clockwise until background noise is heard.

2. Turn the SILENCER control fully counterclockwise. This control is effective only when the RECEPTION control is set at A3 SHARP or A3 BROAD. (The AN/SRR-11 is not designed for radiotelephone reception, hence does not have the SILENCER control.)

3. Set BAND SELECTOR switch to the appropriate frequency band.

4. Calibrate the receiver at the nearest frequency checkpoint. To calibrate the receiver,

turn CAL switch ON. Set the tuning dial at the nearest calibration marker (marked by an inverted V on the frequency scale). Rock the tuning knob slightly on both sides of the chosen frequency until a beat note is heard. Zero beat should occur at the calibration marker chosen. If zero beat does not occur at this marker, adjust the tuning knob until zero beat is heard. Then, loosen the thumbscrew holding the CAL ADJUST knob, and turn the knob until the nearest calibration marker is under the hairline on the projection screen. Tighten the thumbscrew over the CAL ADJUST knob. Turn the CAL switch OFF. The dial reading will now be very accurate for frequencies near the calibration marker.

5. Tune in the desired station by setting the frequency under the hairline index on the dial projection screen by means of the TUNING KNOB.

6. If the station is not heard at this setting of the dial, rock the dial a short distance about this point to search for it. After you find the desired station, turn ANT COMP (antenna compensating) control until the signal is the loudest. Adjust the signal to maximum indication on the TUNING METER.

Other tuning procedures vary, depending on the class of emission and consequent setting of the RECEPTION control.

CW RECEPTION.—Set RECEPTION control to A1 BROAD. Adjust GAIN to point of loudest signal and lowest background noise. Then adjust OUTPUT to a comfortable listening level. Use the LEVEL control to adjust headphone volume. Adjust FREQ VERNIER to a pleasant audio pitch. (A pleasant audio note varies with the individual operator's preference, so adjust it to suit yourself.)

The A1 BROAD position of the RECEPTION control should be used for receiving CW signals whenever possible. However, the A1 MEDIUM (on AN/SRR-13A only) and A1 SHARP settings should be used when necessary to eliminate adjacent signals that crowd the desired station's signal.

RADIOTELEPHONE RECEPTION.—Set RECEPTION control at A3 BROAD or A3 SHARP (these positions are not included in AN/SRR-11). In these positions, the GAIN is automatically maximum and operating the GAIN control has no effect. Tune the signal to maximum reading of the TUNING METER. Adjust OUTPUT control to proper listening level. To eliminate background noise, start with the SILENCER control fully counterclockwise, then rotate the SILENCER until background noise is eliminated with the desired signal remaining undistorted.

RATT AND FAX RECEPTION.—For receiving frequency-shift RATT and FAX, the RECEPTION control is set at FSK. Normal tuning procedures are followed, except that adjustment of the OUTPUT and FREQ VERNIER controls vary for different types of converters used for RATT and FAX reception.

## RBA, RBB, AND RBC RECEIVERS

The RBA, RBB, and RBC receivers (fig. 9-26) have been used for many years aboard ship and at shore stations. Although they are being replaced by the AN/SRR-11, 12, and 13 series, you are likely to be working with them on your ship or station.

The total frequency coverage of these receivers is 15 kc to 27 mc—the RBA from 15 to 600 kc, the RBB from 0.5 to 4 mc, and the RBC from 4 to 27 mc.

The RBA is a TRF (tuned radiofrequency) receiver, whereas the RBB and RBC are superheterodynes. All three receivers may be used for CW, MCW, and voice signals, but the RBA is not recommended for radiotelephone use because of its high selectivity. Most RBA and RBC receivers have been adapted to receive frequency-shift RATT and FAX signals also. All three receivers have high sensitivity and good selectivity. As shown in figure 9-26, the power supplies are separate units from the receivers.

## R-390A/URR

Radio receiver R-390A/URR (fig. 9-27) is a modern, high-performance, exceptionally stable receiver for both shipboard and shore station use. It will receive CW, MCW, a-m radiotelephone, frequency-shift RATT and FAX, and SSB signals within the frequency range from 500 kc to 32 mc.

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 used in the range from 8 to 32 mc.

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 counter-type indicator that resembles the mileage counter on an automobile dashboard.

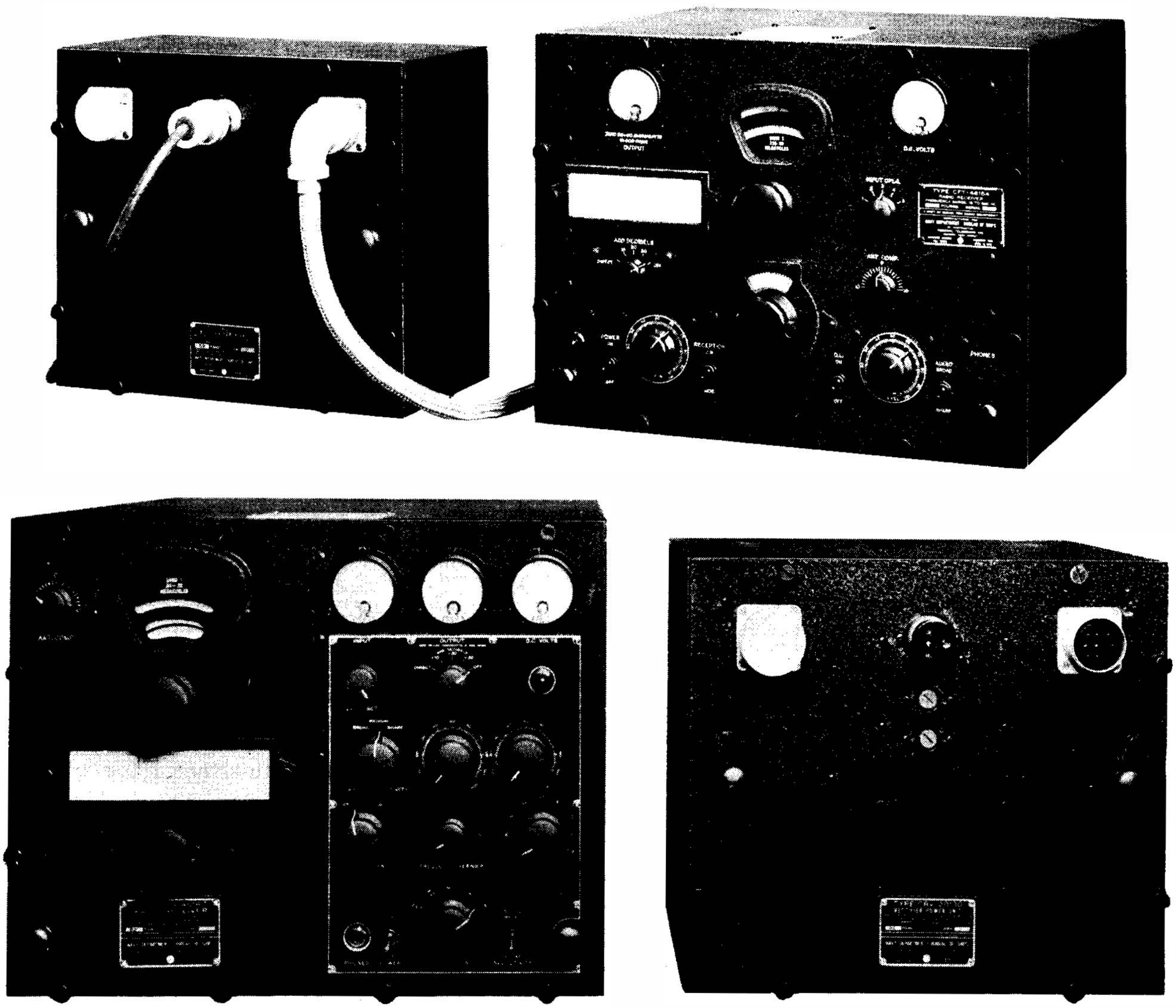

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Figure 9-26.—Top: RBA receiver with power supply; bottom: RBB/RBC receivers with power supply.

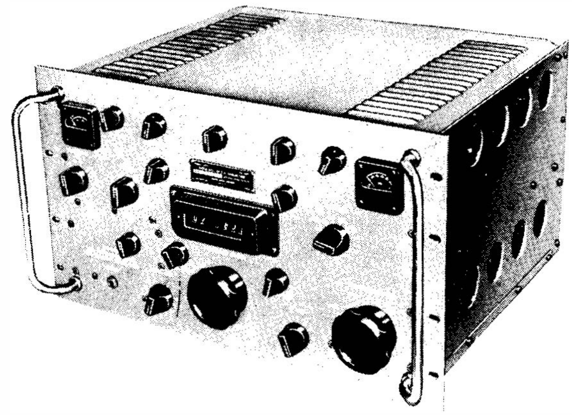
The dial is calibrated in kilocycles, and the frequency-reading accuracy of this tuning dial permits use of the receiver as an accurate frequency meter.

AN/WRR-2

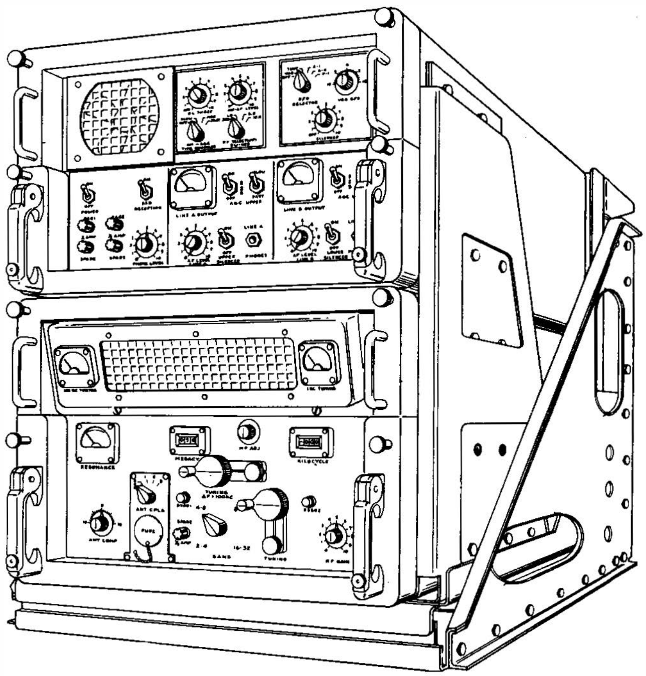
One of the latest shipboard radio receivers for the medium- and high-frequency bands is the AN/WRR-2, shown in figure 9-28. (The same receiver with rack mounting for shore station use, is called AN/FRR-59.)

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



34.15
Figure 9-27.—Radio receiver R-390A/URR.

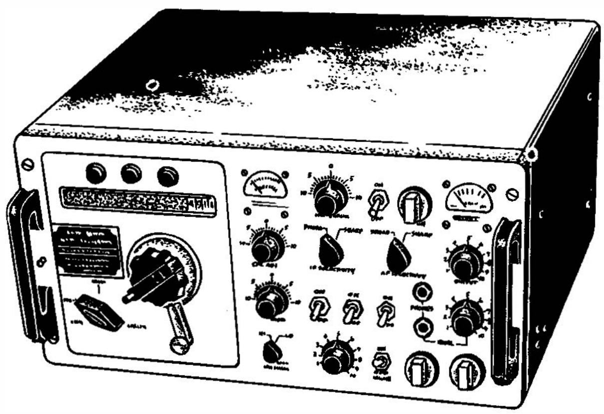


50.40
Figure 9-28.—Radio receiving set AN/WRR-2.

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 arm signals cannot be received at the same time.

AN/WRR-3

Radio receiver AN/WRR-3 (fig. 9-29) is a dual conversion superheterodyne receiver for surface craft and submarine installations. It receives CW, MCW, and frequency-shift keying signals.



76.26
Figure 9-29.—Radio receiver AN/WRR-3.

The receiver covers the frequency range of 14 to 600 kilocycles in five bands. The bands are—

Band 1 - 14 to 30 kc.
Band 2 - 30 to 63 kc.
Band 3 - 63 to 133 kc.
Band 4 - 133 to 283 kc.
Band 5 - 283 to 600 kc.

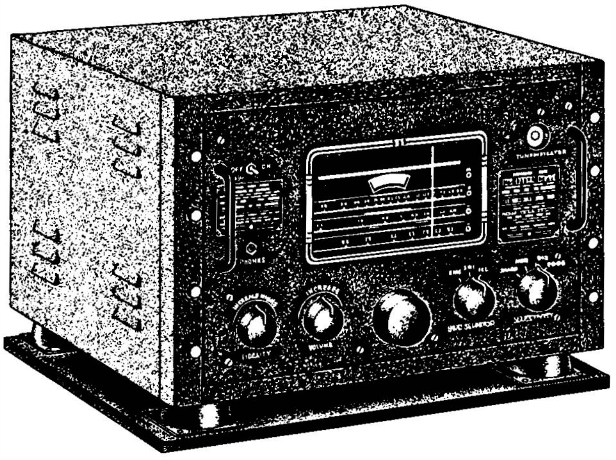
The frequency to which the receiver is tuned is read directly on drum-type dials.

An internal calibration circuit provides calibration points at each 10-kc tuning point within the tuning range of the receiver.

RBO

The model RBO receiver (fig. 9-30) has been the standard shipboard entertainment receiver for many years. It is installed in ships of all types.

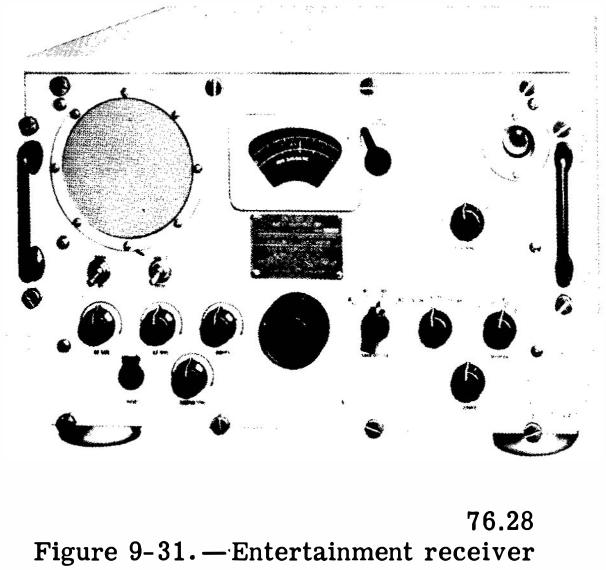
The RBO is a superheterodyne receiver. It provides high-quality reception of voice and music. There are three frequency bands: (1) the standard broadcast band, 530 to 1600 kc; (2) a shortwave band from 5. 55 to 9. 55 mc; and (3) another shortwave band from 9. 20 to 15. 60 mc.



76.27
Figure 9-30.—Model RBO entertainment receiver.

AN/URR-22

Radio receiver AN/URR-22 (fig. 9-31) is designed primarily for reception of voice transmissions on the standard broadcast and international shortwave broadcast bands. It can be used, additionally, as an emergency communication receiver for CW and MCW signals.

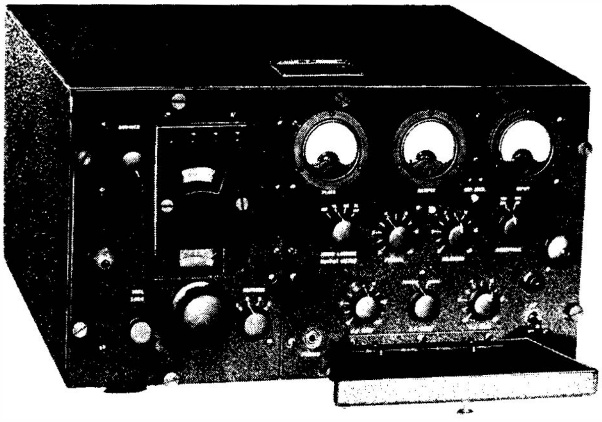


76.28
Figure 9-31.—Entertainment receiver AN/URR-22.

It is a superheterodyne receiver covering the frequency range of 540 kc to 18.6 mc in four frequency bands.

VHF RECEIVERS

The AN/URR-21 receiver (fig. 9-32) 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.



32.56
Figure 9-32.—VHF receiver AN/URR-21.

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

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. There is a single tuning control for tuning to any frequency within its range, for either crystal-controlled or manual tuning. Only one crystal at a time can be 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, shown in figure 9-33.

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 are commonly 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. 9-33). Both receivers are used aboard ship and at naval air and shore radio stations.

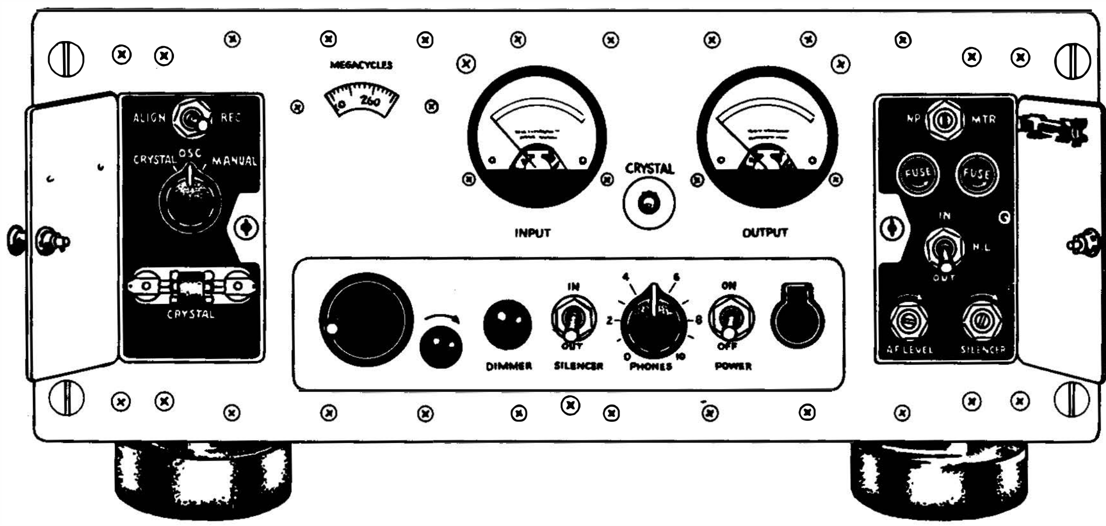
## AN/GRC-27

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 and 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. Should you be required to operate facsimile equipment, consult the equipment technical manual for complete operating instructions.




32.45
Figure 9-33.—UHF receiver AN/URR-35.

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, it is reflected into a photoelectric cell, and variations in intensity of reflected light due to the character of the picture creates 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.

## FACSIMILE TRANSCEIVER

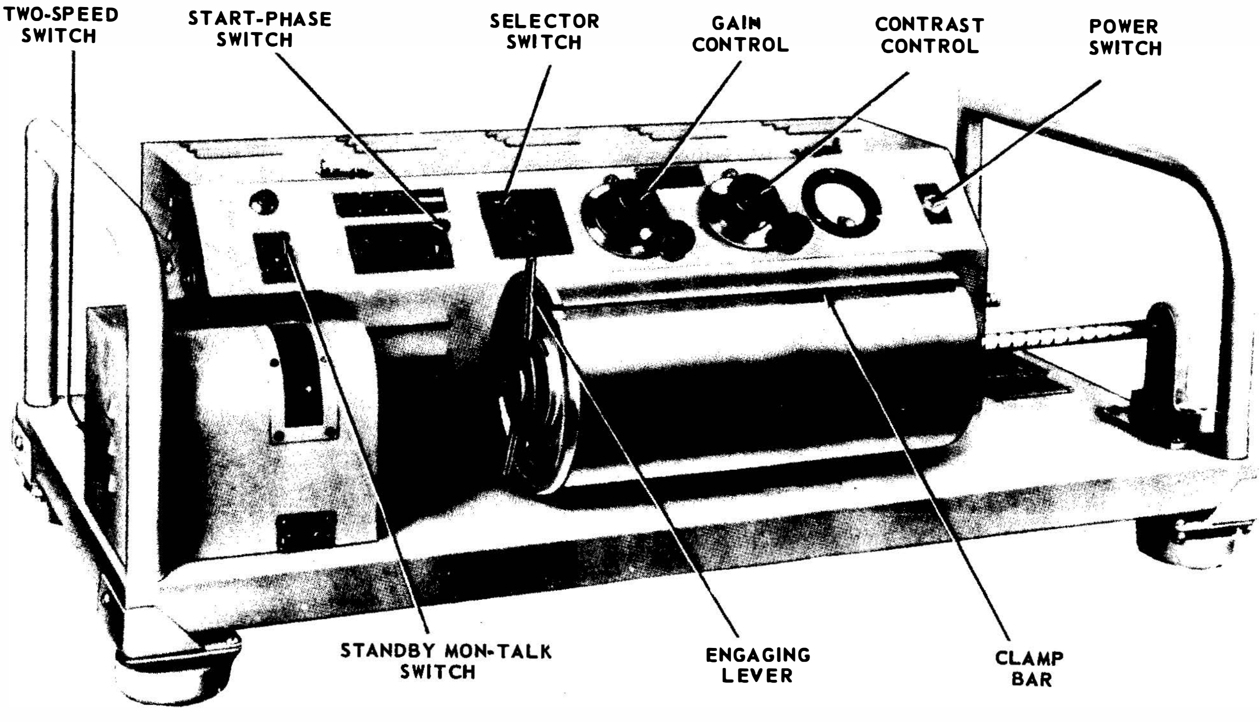
Facsimile Transceiver TT-41B/TXC-1B, shown in figure 9-34, is an electromechanical optical facsimile set of the revolving-drum type for both transmission and reception of page copy. Colored copy may be transmitted, but all reproduction is in black, white, and intermediate shades of gray. Received copy is recorded either directly on chemically treated paper, or photographically in either negative 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 located on the sloping front panel (fig. 9-34). The motor speed control switch is located 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 located on the right end of the transceiver.

## FACSIMILE RECORDER

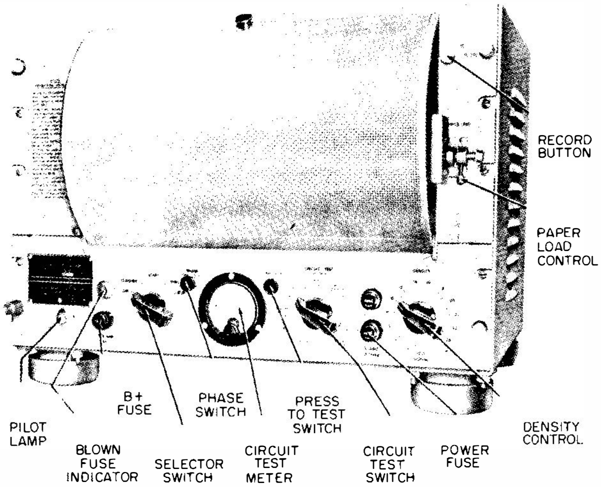
Facsimile Recorder RD-92A/UX, shown in figure 9-35, is used for direct stylus recording only. It cannot be used for transmitting FAX, nor can it be used to receive on photographic film, like the transceiver described earlier.

The recorder drum rotates at a speed of 60 rpm while feeding a stylus needle along the




13.70
Figure 9-34.— Facsimile transceiver TT-41B/TXC-1B.

drum, one scanning line for each revolution until the complete drum has been covered.




13.71
Figure 9-35.—Facsimile recorder RD-92A/UX.

When the record button (fig. 9-35) 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, which 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.

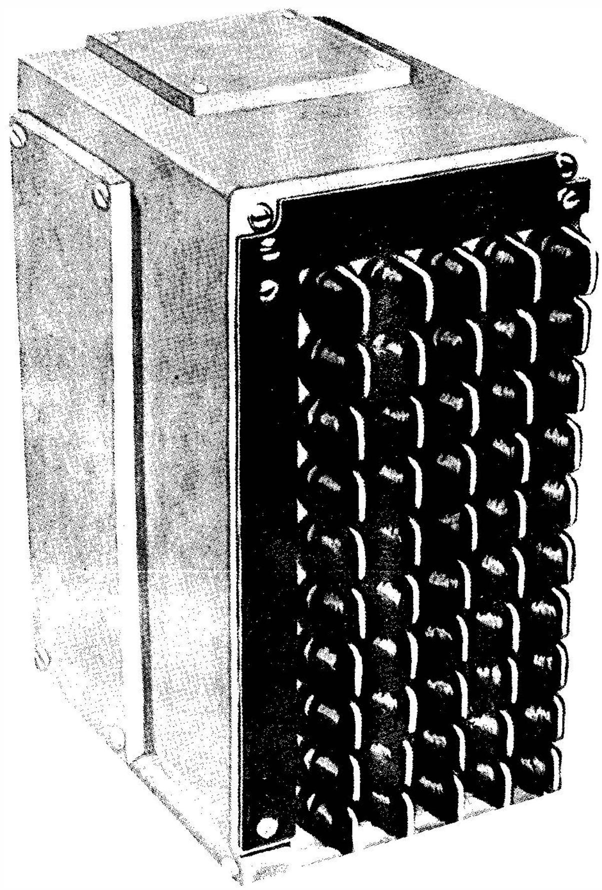
## RECEIVER AND TRANSMITTER TRANSFER SWITCHBOARDS

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. Two unit-constructed panels (one for receivers and one for transmitters) now provide all the facilities that were available in three types of plug panels formerly used, and in addition afford greater flexibility in the remote-control system.

Receiver Transfer Switchboard, type SB-82/SRR, and Transmitter Transfer Switchboard, type SB-83/SRT, are both highly flexible in their method of operation. These two types are described here.

## RECEIVER TRANSFER SWITCHBOARD

Receiver Transfer Switchboard, type SB-82/SRR, is shown in figure 9-36. The receiver switchboard has five vertical rows of ten double-pole, single-throw (ON-OFF) switches that are 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.



36.69
Figure 9-36. — External view of the Receiver Transfer Switchboard, type SB-83/SRT.

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 are normally mounted in a vertical position (as in fig. 9-36). This arrangement permits the outputs from five receivers to be fed to the five vertical rows and up to ten remote stations to be fedfrom 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.

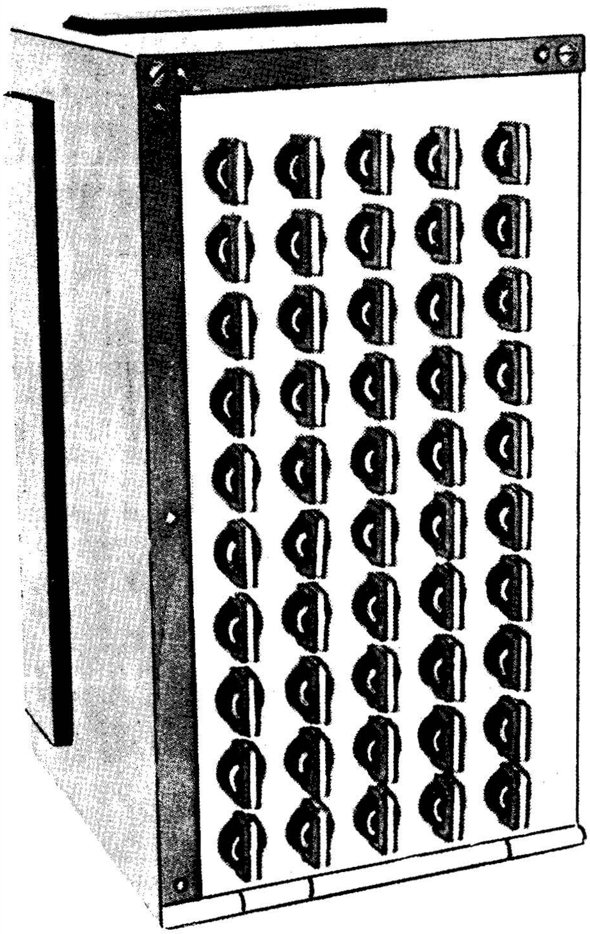
It should be noted that only the receiver audio output circuit is connected to the switchboard. Transmitter transfer switchboards, however, handle several other types of circuits in addition to audio circuits.

## TRANSMITTER TRANSFER SWITCHBOARD

Transmitter Transfer Switchboard, type SB-83/SRT, is shown in figure 9-37. The same parallel wiring of the switches is used as in the receiver switchboard.

The transmitter switchboard has five vertical rows of ten 12-pole, single-throw switches continuously rotatable in either direction. Radio transmitters are wired to the five vertical rows and remote stations are connected to the ten horizontal rows. Switches are OFF 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. In addition, the transmitter switchboard carries the 12-VOLT DC 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).



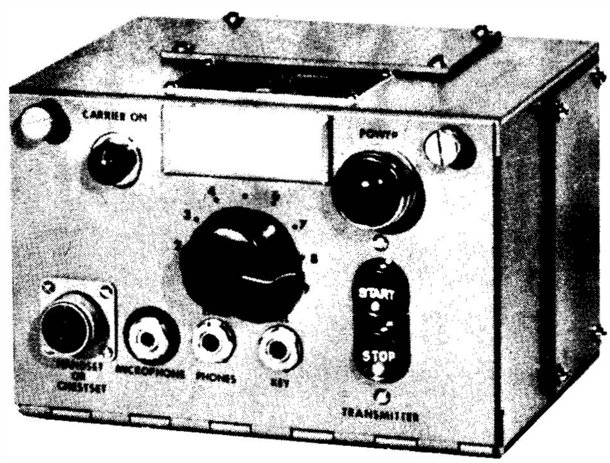
36.70

Figure 9-37. —External view of the 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 has been closed already. This arrangement prevents serious damage that is certain to result from two or more transmitters feeding a single remote station at the same time. 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, you 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.

## 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 9-38. 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.




7.40.2A
Figure 9-38.—Radiophone unit (RPU).

## DUMMY ANTENNAS

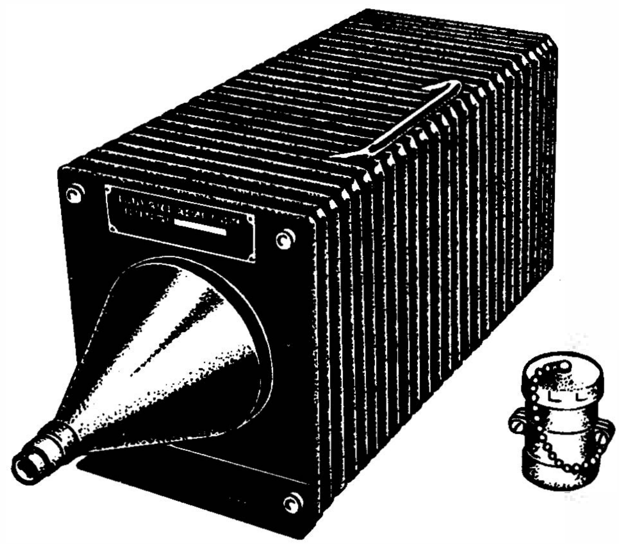
Under radio silence conditions, placing a carrier on the air during transmitter tuning would give an enemy the opportunity to take direction-finding bearings and determine the location of the ship.

Even though radio silence is not imposed, DNC 5 directs that transmitters be tuned by methods that do not require radiation from the antenna, in order 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 the use of 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 operation.

One model, typical of most dummy loads, is the DA-91/U (fig. 9-39), 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.



36.29

Figure 9-39.—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 9-40. This type of distribution system makes possible the multiple operation of a maximum of 28 radio receivers from a single antenna. It is generally 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 9-40. 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, the common crossover frequency of which marks 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 of them may be installed at one time. The six filters installed are selected to cover the most-used frequency bands. The filter subassemblies are sealed units having terminal plugs for easy installation or removal. The filters have numbers stamped on them to indicate their crossover frequencies. These numbers are viewed through windows in the front panel. The six subassemblies that are used are mounted in the order of decreasing frequencies from left to right, as viewed from the front of the panel.

The filter panel (fig. 9-40(B)) 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).

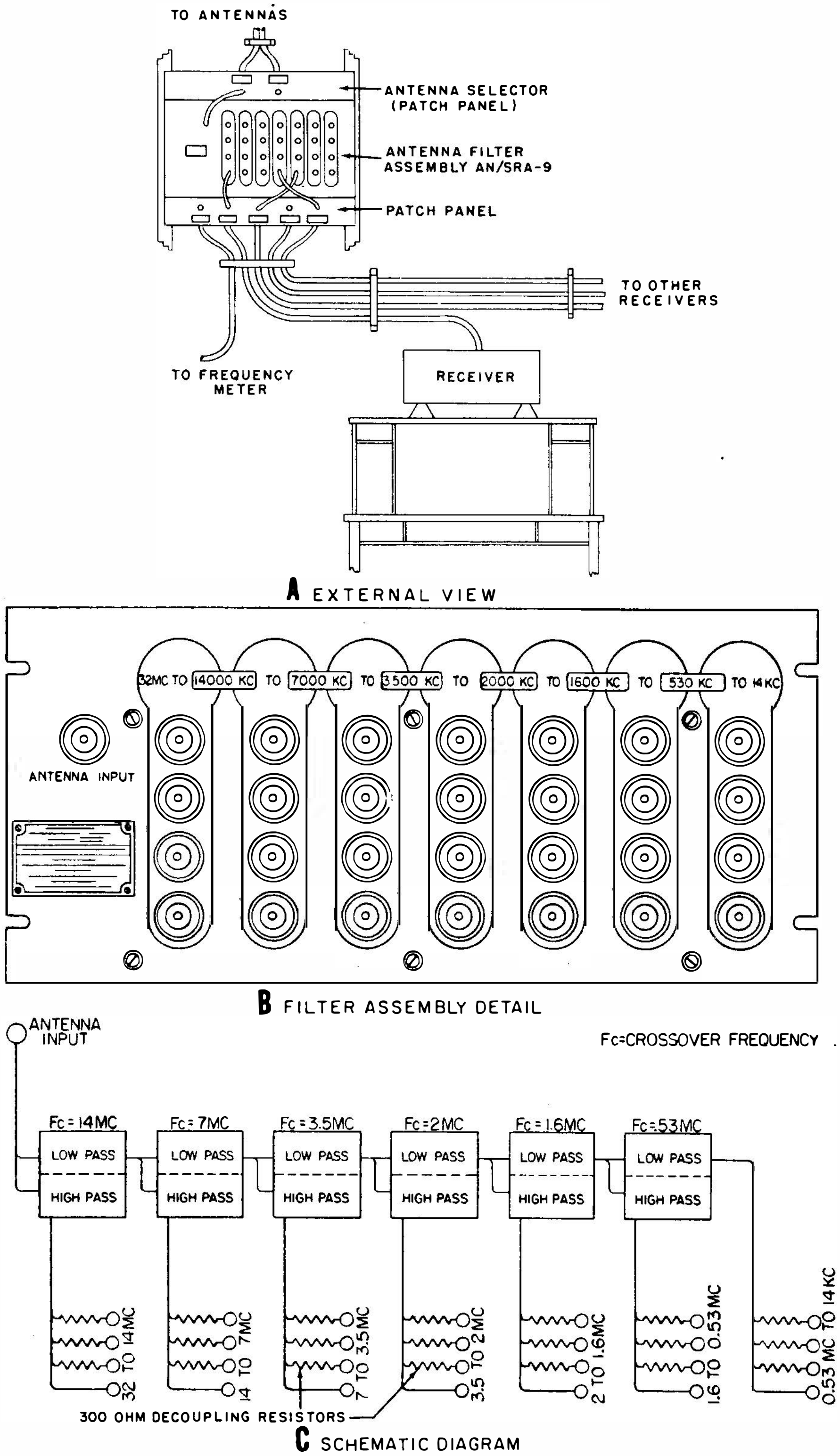
The bottom jack in each vertical row of output jacks is painted red to indicate that it is connected directly to its subassembly. The other three output jacks in each row are unpainted to denote that they are decoupled from their corresponding filters by 300-ohm decoupling resistors (fig. 9-40(C)).

Because Navy communication receivers generally 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 signals 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 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




1.51:.115

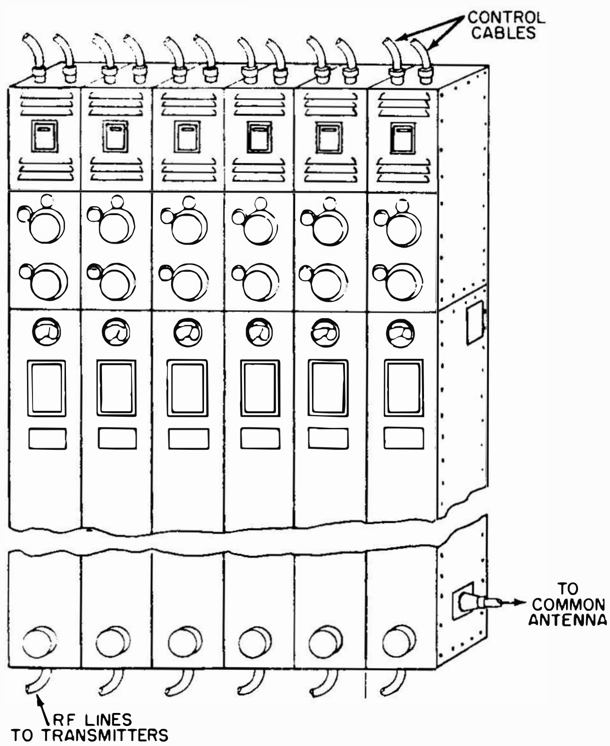
Figure 9-40. —Receiving antenna distribution system, using antenna filter assembly.

channels. This arrangement permits maximum use of the best available antenna locations and reduces the intercoupling between antennas.

Much research and development are being done 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, and the equipments described will eventually become obsolete. This is essentially true of all electronic equipment.

## VHF-UHF MULTICOUPLERS

One type of VHF-UHF multicoupler (CU-255/UR) is shown in figure 9-41. 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.




1.266
Figure 9-41. —VHF-UHF multicoupler CU-255/UR.

These 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 the tuning controls is indicated by the meter on the front panel of the multicoupler. This meter indicates the output from the reflectometer, which is a device for indicating the magnitude of the power reflected back from the coupling circuit. When the controls are adjusted so that the tuning indicator reads zero, 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 except for the drive mechanism. The CU-332A/UR provides for manual tuning only, whereas the other has both automatic and manual tuning.

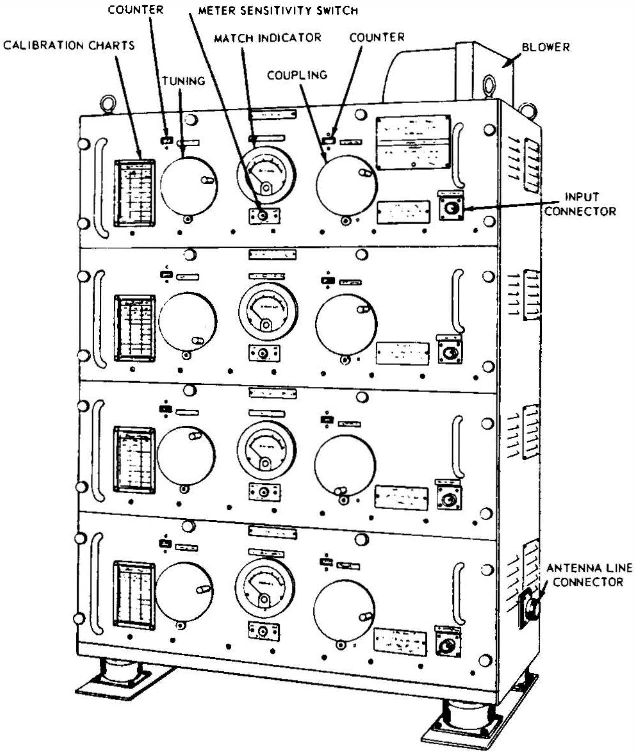
The CU-332A/UR multicoupler is used with manually tuned UHF equipment, such as the model TED transmitter, or any other manually tuned equipment operating in the 230- to 390-mc frequency range.

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 operating 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. The AN/SRA-15 coupler, which is typical of this group, is illustrated in figure 9-42. It provides for the simultaneous operation of four transmitters (each with 500 watts output) into a single broad-band antenna. It 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.




70.28

Figure 9-42. —Antenna multicoupler AN/SRA-15.

## FREQUENCY METERS

Frequency meters are used to tune transmitters and receivers and to determine the frequency of received signals. Two frequency meters used on shipboard for many years are Navy models LM and LR.

### MODEL LM FREQUENCY METER

Several models of this meter have been built. These models are similar except for the power supply and some minor mechanical differences. The LM-18 frequency meter provides a simple, accurate means of adjusting transmitters and receivers to any desired frequency in the range from 125 kc to 20 mc. It is used both as a heterodyne frequency meter for transmitter adjustment, and as a signal source for receiver calibration.

The LM-18 is accurate within .02 percent in the 125- to 2000-kc band, and within .01 percent in the 2000-kc to 20-mc band.

Before any frequency adjustments may be made, the heterodyne oscillator must always be corrected to calibration, through comparison with the crystal oscillator at the crystal checkpoint nearest to the desired frequency. Crystal checkpoints are shown in the equipment calibration book. Comparison between the crystal and heterodyne oscillators may be made at many points over the calibrated range through use of the fundamental or harmonic frequencies of either or both oscillators. Comparison between the two oscillators is made by setting the heterodyne oscillator tuning control to the scale reading for the crystal checkpoint desired, and adjusting the resulting beat note heard in a pair of headphones. As this adjustment is made, one or more beat notes will be heard in the phones. A corrector control is provided to produce zero beat (no sound) at the strongest beat point within its range. (Zero beat is obtained when both oscillators are tuned to the same frequency and their signals are canceling each other.) After the operator has become familiar with the equipment, it will be found that this adjustment can be made precisely to zero beat. Here is a brief listing of the operating instructions.

To tune a transmitter to a desired frequency:

1. Plug phones into the frequency meter jack.
2. Find page in the calibration book showing dial setting for desired frequency.
3. With crystal switch on, turn frequency meter dial to setting for crystal checkpoint printed in red at bottom of page in the calibration book.
4. Adjust corrector control to obtain zero beat in the phones.
5. Turn crystal switch off.
6. Turn frequency meter dial to setting for desired frequency.
7. With transmitter coupled to the frequency meter, tune transmitter to obtain an audible signal in the phones.
8. Adjust radiofrequency coupling control to obtain sufficiently strong signal.
9. Tune transmitter to obtain zero beat in the phones.

To tune a CW receiver to a desired frequency:

1. Adjust frequency meter to nearest crystal checkpoint, as outlined in the preceding steps 1 through 5.

2. Turn the frequency meter dial to setting for desired frequency.

3. Remove the phones from frequency meter, and plug them into the receiver output jack.

4. With the receiver coupled to the frequency meter, tune the receiver to obtain an audible signal in the phones.

5. Adjust the radiofrequency coupling control to obtain sufficient signal.

6. Tune the receiver to obtain zero beat in the phones.

## LR FREQUENCY METER

Model LR frequency meter has greater accuracy and a greater frequency range than the model LM just described. Model LR is used for setting transmitters and receivers to desired frequencies in the range 160 kc to 30 mc. By harmonic extension, frequencies up to 60 mc can be measured. The equipment is accurate within .003 percent.

A newer model, known as model FR-36/U, is similar in all essential details to the earlier LR models.

## 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 in addition to earphones to provide visual as well as aural indications of zero beat settings; a built-in oscilloscope is used to aid in setting the internal oscillator frequency.

The calibration book is fastened to a drawer that slides under the cabinet when not in use.

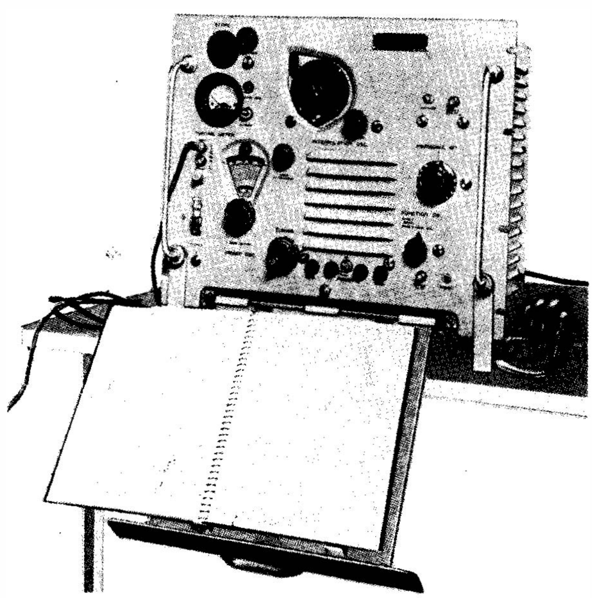
## EMERGENCY AND PORTABLE EQUIPMENT

Several models of portable radio equipment are 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 is a low-power radio transmitter and receiver, shown in figure 9-44. 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.

The AN/GRC-9 receives and transmits CW, MCW, and a-m radiotelephone signals in the 2- to 12-mc frequency range. There are provisions for six crystal-controlled channels, with master oscillator tuning also available for any frequency within the band.

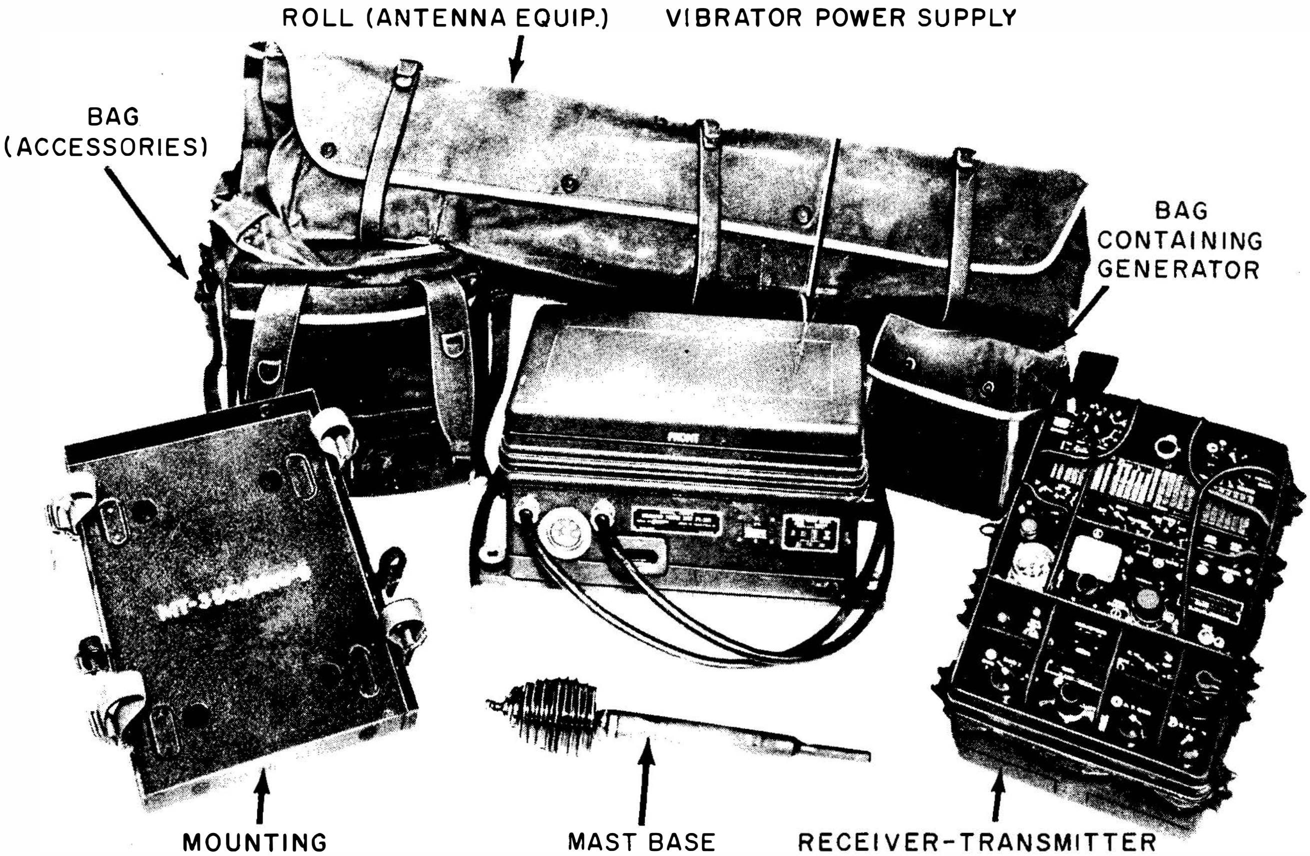


76.30

Figure 9-43. —Frequency meter AN/URM-82.

For different kinds of installations, the radio set can be operated with batteries, dynamotors, gasoline-driven generators, or hand-driven generators.

The output power of the transmitter varies somewhat depending upon the type of power supply used. When powered by the hand-driven generator, 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 will vary considerably according to terrain, atmospheric conditions, frequencies, and time of day, month, and year.




76.31
Figure 9-44. — Components of Radio Set AN/GRC-9.

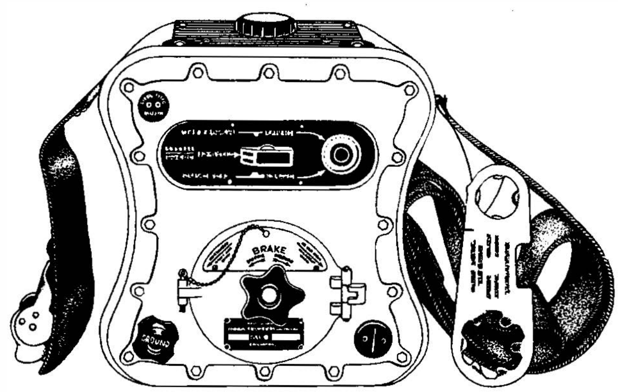
The receiver and transmitter are contained in a metal case that has a tight-fitting removable cover. These components are dirtproofed and waterproofed for complete protection while transporting the equipment and when operating under extremely adverse weather conditions.

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 rafts. It is shown in figure 9-45. No receiving equipment is included.

The transmitter operates on the international distress frequency, 500 kc, and the survival craft communication frequency, 8364 kc. (Uses of these and other distress frequencies are explained in chapter 6.)

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 9-45. — Emergency lifeboat 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. The frequency automatically changes every 50 seconds. These signals are intended for reception by two groups of stations, each having distinct rescue functions. Direction-finding stations cooperating in long-range rescue operations generally 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 teletypewriter, let us first consider one of the simpler devices for electrical communications: the manual telegraph circuit. In this circuit, shown in figure 10-1, we have 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. Remember: Marking occurs when the circuit is closed and a current flows; spacing occurs when it is open and no current flows.

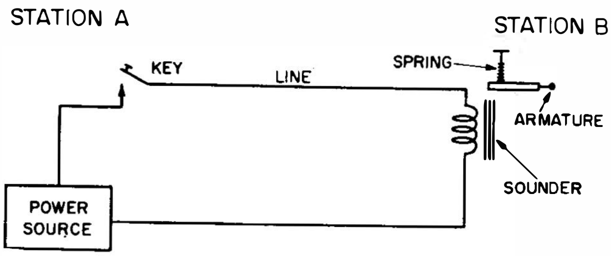
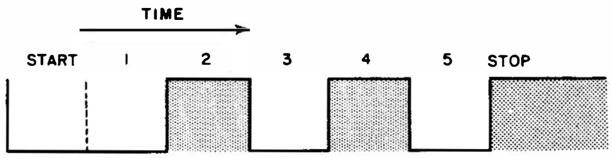



Figure 10-1. — Manual telegraph circuit.
1.196

When a circuit operates on current and no-current basis, as in figure 10-1, it is called a NEUTRAL circuit. This type is generally used to operate teletypewriters, although the Navy's machines sometimes operate on a line condition called POLAR OPERATION. This refers to the system whereby marking signals are formed by current impulses of one polarity, and spacing signals by current impulses of equal magnitude but opposite polarity. The following discussion is based on neutral circuit operation.

## TELETYPEWRITER SIGNAL CODE

If a teletypewriter signal could be drawn on paper, it would resemble figure 10-2. This is the code combination for the letter R. Shaded areas show intervals during which the circuit is closed (marking), and the blank areas show the intervals during which the circuit is open (spacing). There are a total of seven units in the signal. Five of these are numbered, and are called INTELLIGENCE units. The first and last units of the signal are labeled START and STOP. They are named after their functions: the first starts the signal and the last stops it. These are a part of every teletypewriter code character; the START unit is always spacing and the STOP unit is always marking. This method of teletypewriter communication—the so-called START-STOP method—gets its name from these units.




1.197
Figure 10.2.— Mark and space signals in the teletypewriter character R.

The start-stop method keeps teletypewriter 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.

Different characters are transmitted from the keyboard by an automatic process that selects various combinations of marking and spacing in the 5 intelligence units (fig. 10-3). When you come to tape reading, you will see that the mark and space units match the holes and blank spaces on the tape. This is because holes in the tape allow the transmitter distributor pins to rise, sending a marking pulse. No holes mean no pulses—that is, spacing intervals. The machine, without benefit of tape perforations, automatically takes care of start and stop elements.

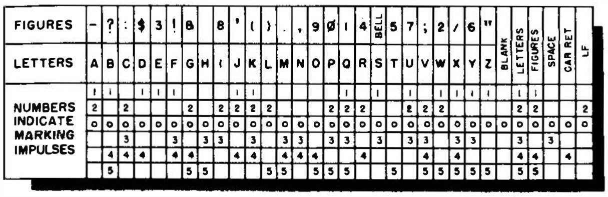
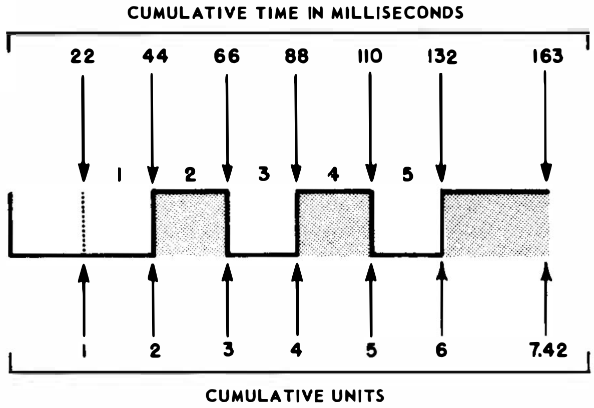



Figure 10-3.— Mark and space combinations for characters on the teletypewriter keyboard. 1.198

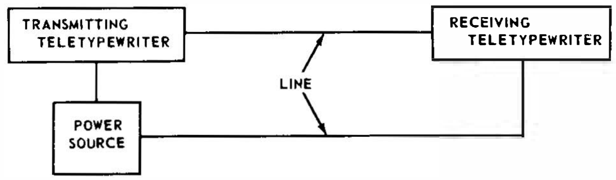
A total of 32 combinations can be obtained from the five intelligence units, but, by using uppercase and lowercase, the number of characters obtainable is nearly doubled. When a teletypewriter printing mechanism is shifted to uppercase as a result of receiving a FIGS shift character, all succeeding characters 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 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. This is theoretically 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 milliseconds of circuit time for transmission. This is based on a transmission speed of 60 words per minute. In teletypewriters operating at 75 or 100 wpm the times for all 7 units are reduced proportionally. The stop unit requires 31 milliseconds. If you assign a value of 1 to each of the first 6 units, then the stop unit has a value of 1.42. The total number of units in the letter R (or any other teletypewriter character) is 7.42, requiring a transmission time of 163 milliseconds. There is no allowance for transition time, for a transition has zero time duration. See figure 10-4.




1.1999
Figure 10-4.— The 7.42-unit teletypewriter signal.

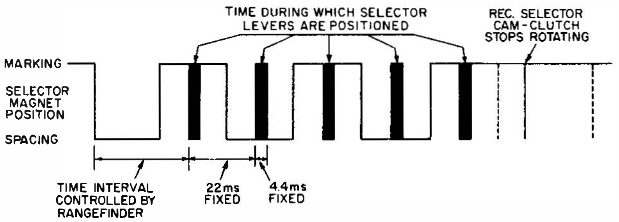
The telegraph circuit in figure 10-1 can be converted to a simple teletypewriter circuit by substituting a transmitting teletypewriter for the key at station A, and a receiving teletypewriter for the sounder at station B. This arrangement is shown in figure 10-5.




1.2000
Figure 10-5.— Simple teletypewriter 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-millisecond spacing unit functioning as a start pulse to release the receiving mechanism, plus five 22-millisecond intelligence pulses—either marking or spacing—and a 31-millisecond marking pulse used to stop the receiving mechanism.

The selector magnet of the receiving teletypewriter 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 milliseconds. This time, again, is based on a teletypewriter running at 60 wpm. Cams on the selector cam-clutch are so located at the time between each selector lever operation is fixed at 22 milliseconds. During 4.4 milliseconds of the first pulse the first selector lever is positioned; during 4.4 milliseconds 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 teletypewriter 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, the figure 1 is divided by the time duration of the shortest unit interval present in the signal. For example, 22 milliseconds (.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, we divide .022 into 1. Rounding off the results of our division, we arrive at the figure 45.5, which is the baud equivalent of 60 wpm.

At 100 wpm, the teletypewriter 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 teletypewriter operation.

Conversion formulas for baud operations are as follows:

$$\text{Baud} = \frac{1}{\text{Unit interval}}$$

$$\text{WPM} = \frac{\text{Baud}}{\text{Unit code x 0.1}}$$

## DISTORTION

An ideal teletypewriter circuit reproduces signals at the receiving and exactly as they are impressed at the sending end. Unfortunately, this seldom happens under actual operating conditions, for 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 teletypewriter signals.

1. Bias distortion is the uniform lengthening or shortening of the mark or space elements, one at the expense of the other. This 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 cross-talk interference between circuits, atmospheric noise, power line induction, poorly soldered connections, lightning storms, dirty keying contacts, and such similar disturbances.

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.

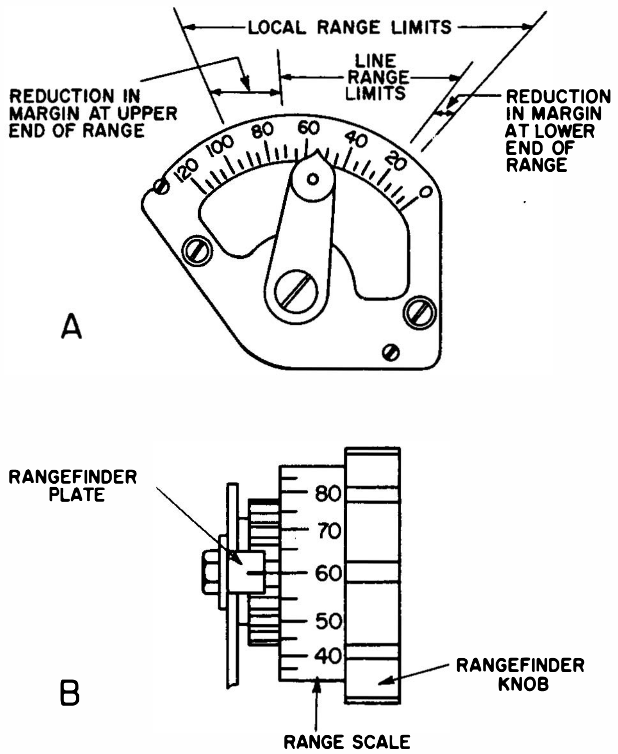
The components of distortion, with their causes and effects, have been only briefly defined here. The proper recognition, identification, and correction of signal distortion is a job for maintenance personnel, using special test equipment designed for the purpose.

ORIENTATION RANGEFINDER

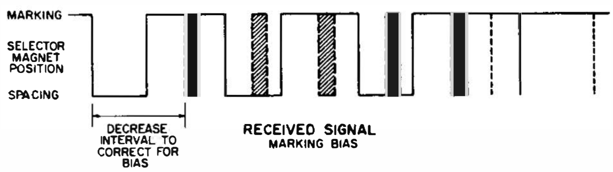
Every teletypewriter has an orientation rangefinder. By means of the rangefinder scale, the operator can set the machine at the range of best signal reception. Low equipment range indicates only a lowered operating margin. It does not clearly indicate whether the cause is distortion or a badly adjusted teletypewriter.

Refer again to figure 10-2, illustrating the signal for the letter R. Each unit or element is perfect in every respect. To print the 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 this 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. This means that the selection point of the rangefinder scale must be positioned so that the best portion of the element is used by selecting mechanism.

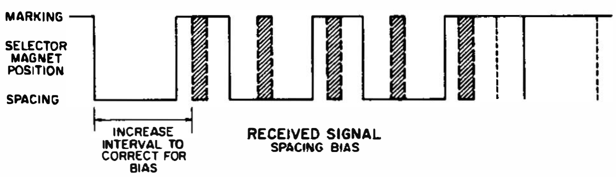
The rangefinder shown in part A of figure 10-7 is located at the left side of model 15 and 19 teletypewriters, and at the top of model 14 reperforators. It has a scale and a movable finder arm. The rangefinder in part B of figure 10-7 is located on the right side of model 28 page printers and at the right front of model 28 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 both types of rangefinders. Points on the scale--0 to 120 —divide the first unit of the signal only, not the entire signal. When you adjust the rangefinder, you shift the selection point of the first unit with respect to the starting unit. Figures 10-8 and 10-9 illustrate this. Because all other units of the signal follow at 22-millisecond intervals, this amounts to adjustment or orientation of the entire signal to the start pulse. Shifting the point of selection simply means you are moving the first black bar shown in figure 10-6 back and forth across the first signal unit, looking for the most suitable position. The scale goes up to 120, hence you can shift far enough so that the selection interval moves entirely off the unit. Even if the signal were perfect, you could still shift the finder far enough to produce errors.




1.202
Figure 10-7.— Two types of orientation rangefinders.




1.203
Figure 10-8.— Signal with marking bias.




1.204
Figure 10-9.— Signal with spacing bias.

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. With the selection point midway between the transitions, there is the least chance of error.

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, observations are made of the typed record and a reading is taken when about one error is typed per line of copy. This means about one error in 69 characters. Orientation ranges on properly adjusted teletypewriters for different degrees of signal distortion are as follows:

| | Points |
|---|---|
| Very little distortion... | 80 |
| Moderate distortion.... | 60-70 |
| Average distortion..... | 50 |
| Large distortion....... | Less than 40 |

As shown in figure 10-7(A), the 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 arm of the receiving teletypewriter is set at the midpoint (55) of this range.

Actually, the orientation range is determined twice: First, range of the machine (local range) is determined, then range of machine when connected to the line (line range) is determined. 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 running a test tape through the transmitter distributor. Normally, the letters R and Y are used because they give a complete reversal of impulses. Letter R is S-M-S-M-S and 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 the range determined by local test, and the corresponding range obtained when receiving signals over a line, represents the reduction in margin due to signal distortion. The reduction, as illustrated in figure 10-7(A), is a direct measure of total signal distortion. This illustration shows the line range limits to be 20 and 70 on the scale. The line range represents a reduction of local range limits by 5 points on the lower end and 25 on the upper.

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—the 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, this is due to 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 is an indication of 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, and spacing bias reduces the lower range limit.

Maintenance men sometimes test distortion tolerance of a teletypewriter by applying predistorted signals. This 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 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 teletypewriter operation we shall concentrate on the communication sense of the word.

A duplex circuit is a circuit between two stations that permits the 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. The fleet broadcast is an example of a half-duplex circuit.

A simplex circuit embraces features of both the duplex and half-duplex type 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.

You learned in your study of amplitude modulation in chapter 9 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, and a transmitter in which the carrier has been suppressed may be used to send a separate message on each of the sidebands. The 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 contain 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 on one sideband of each SSB circuit through a frequency multiplexing system. 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 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) or at an intermediate point along the line.

Repeaters cannot be used with RATT transmissions. Radioteletypewriter 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 teletypewriter operation. The difference is that RATT requires transmitters and receivers to send and pick up signals.

## THE TELETYPWRITER

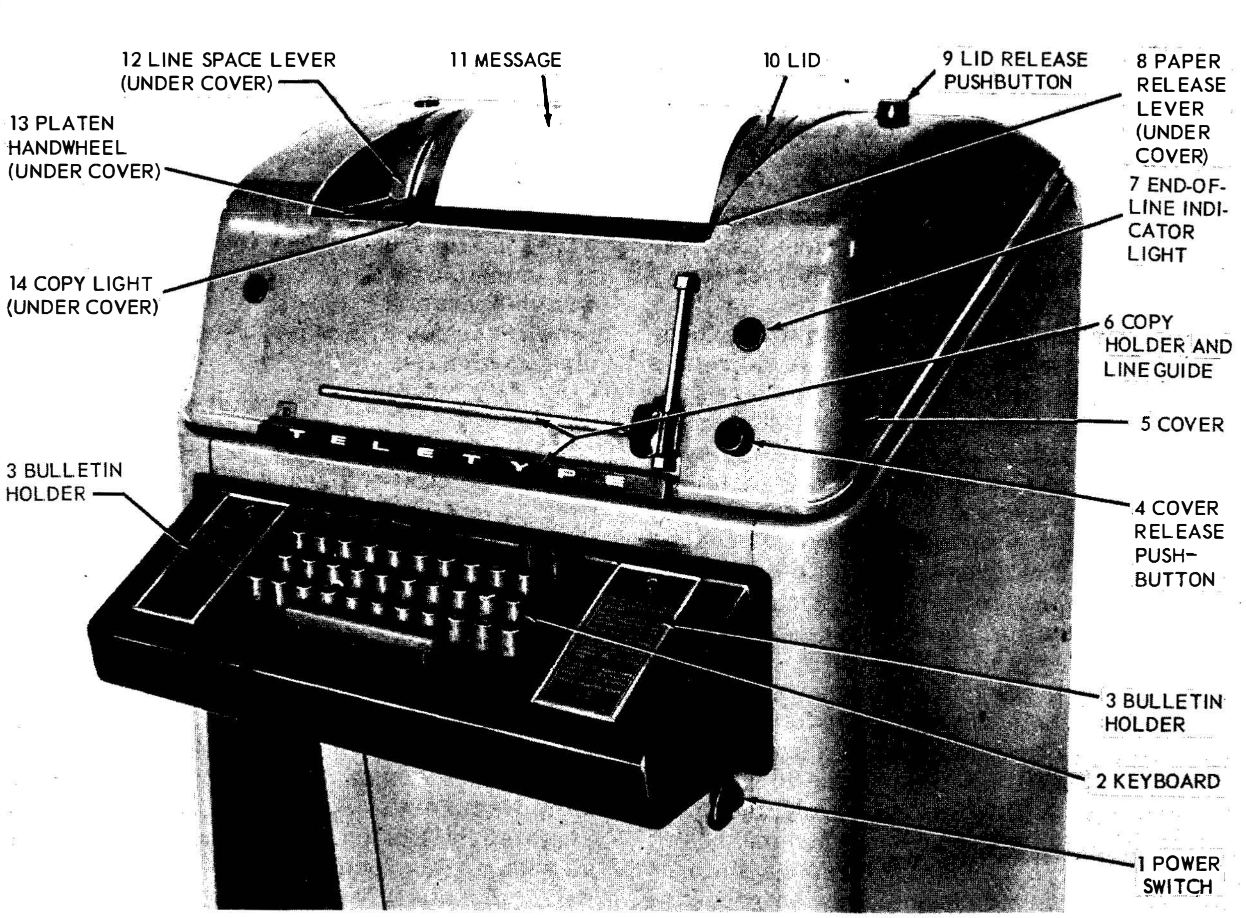
The teletypewriter, of course, is little more than an electrically operated typewriter. The prefix "tele" means "at a distance." Coupled with the word "typewriter" it forms a word meaning "typewriting at a distance." By operating a keyboard similar to that of a typewriter, signals are produced that print characters in page form, called hard copy.

The 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, virtually as soon as it is formed in New York. The same will apply at all receiving stations that tie into the network. One commonly used machine is the model 28 page teletypewriter, also called the model 28 printer, a machine widely used by both military and commercial communication systems.

## MODEL 28 TELETYPEWRITERS

Model 28 is a manufacturer's designation applied to a complete line of teletypewriter equipments. Compared with some of the older models that we will discuss, the components of the model 28 series feature smaller size, lighter weight, increased speeds, quieter operation, and less maintenance. They are also better suited for shipboard use under severe conditions of roll, vibration, and shock.

One component of the model 28 line (designated TT-48/UG) is the keyboard-sending and page-sending and page-receiving teletypewriter shown in figure 10-10. Let us look at some of the external features of this machine. The numbers following correspond to those shown in figure 10-10.




1.217
Figure 10-10.—Model 28 teletypewriter (TT-48/UG).

1. POWER SWITCH—When turned ON, this switch starts the motor in the teletypewriter, and makes the machine operative. To secure the machine, turn the power switch OFF.

2. KEYBOARD—Described in next section.

3. BULLETIN HOLDERS—There are two on the machine. Used as necessary for recording any information an operator needs to have at his fingertips.

4. COVER RELEASE PUSHBUTTON—Releases cover of machine for raising.

5. COVER—Raised for access to typing unit. It is hinged at the rear and is counterbalanced by a mechanism that aids in lifting and holding it open.

6. COPYHOLDER AND LINE GUIDE—The copyholder holds the message to be typed. The line guide helps the operator follow the lines as he types.

7. END-OF-LINE INDICATOR LIGHT--A red lamp that lights about six characters from the end of the line. The machine is adjusted to type 69 characters to the line, including spaces between words or groups.

8. PAPER RELEASE LEVER—Located under cover. When pushed back, this control frees the paper for adjustment. When pulled forward, it holds the paper tight.

9. LID RELEASE PUSHBUTTON—When pushed, releases lid of machine for raising.

10. LID—When raised, provides access to the paper, paper release lever, and line space lever.

11. MESSAGE—In the form of hard copy.

12. LINE SPACER LEVER—Located under cover. Pull forward to single space, push back to double space.

13. PLATEN HANDWHEEL—Located under cover. When depressed and turned, feeds paper in direction in which turned, up or down.

14. COPY LIGHT—A clear lamp that is lit while the teletypewriter is on, illuminating the copy.

## KEYBOARDS

The model 28 printer is equipped with either of two types of keyboards: communication or weather. The first contains letters and punctuation marks common to the standard typewriter, and the weather keyboard provides necessary symbols for transmission of weather data. Similarities and differences in the two keyboards are illustrated in figure 10-11. 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.

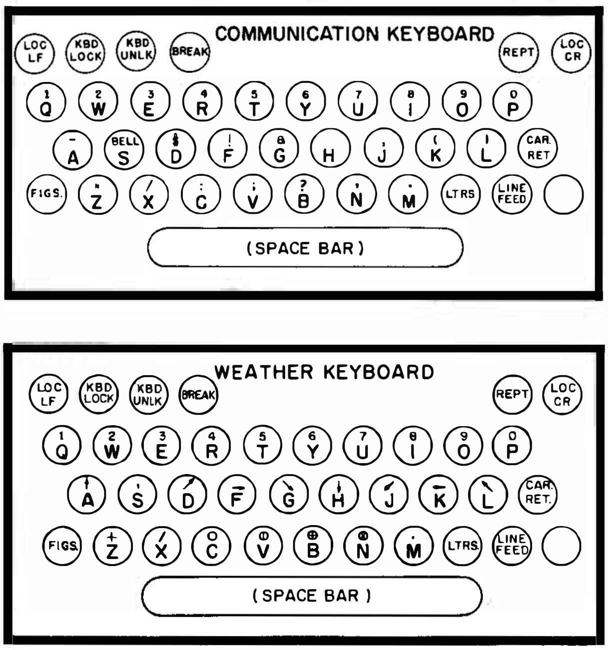



Figure 10-11.— Two types of teletypewriter keyboards.

Figure 10-12 is another illustration of the communication keyboard with emphasis placed on the function keys. The action performed by the function keys is described as follows:

1. SPACE BAR—The space bar, located at the front of the keyboard, is used to send spaces (as between words).

2. CAR RET (carriage return)—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. LINE FEED—When depressed, this 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. FIGS (figures)—The figures key is pressed to condition the machine for printing figures, punctuation marks, or other uppercase characters.

5. LTRS (letters)—The letters key is used to condition the machine for printing the letters (lowercase) characters.

6. BELL—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. BLANK (unlabeled key in bottom row)—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 circumstances, through operation of the KBD UNLK key by the operator desiring to send from his keyboard.

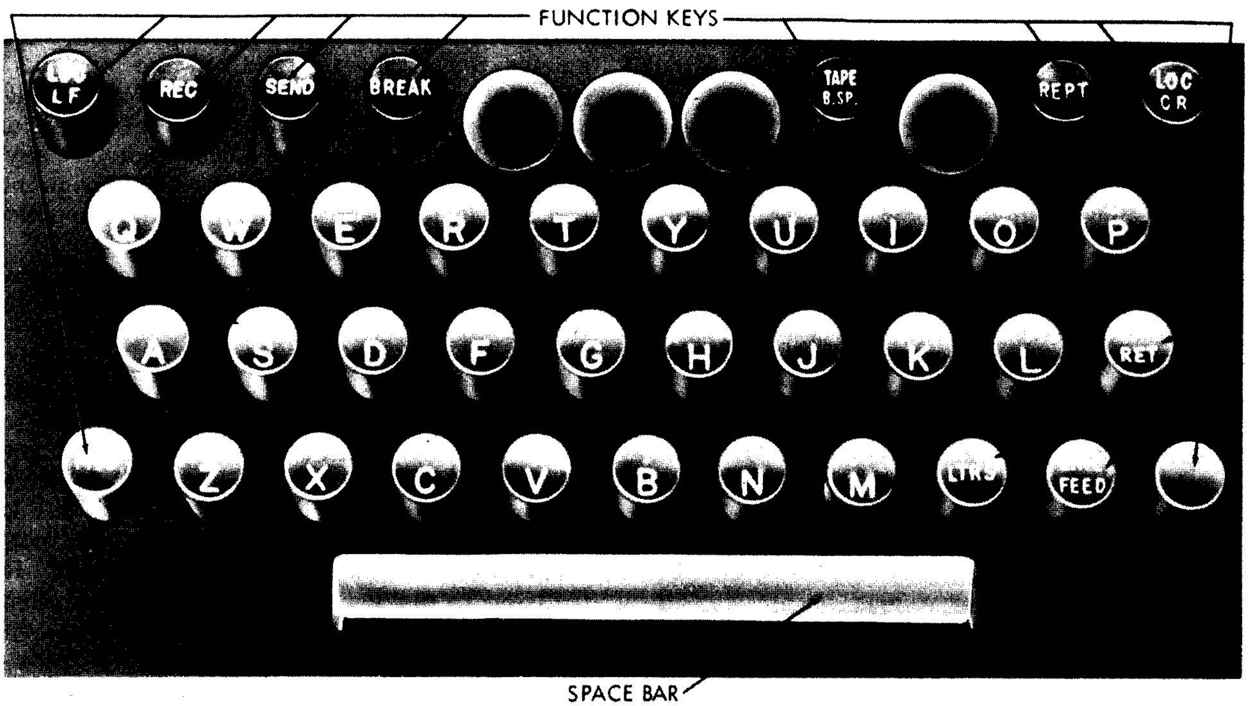
8. BREAK—To stop (break) another station's sending, depress the BREAK key for about 3 seconds. This causes the KBD LOCK key to drop and lock keyboards on both sending and receiving machines. After a break it is necessary to operate the KBD UNLK key to free the keyboard for sending.

9. REPT (repeat)—To repeat a character, depress the character key and the REPT key. The character will be repeated automatically at line speed as long as both keys are held down.

The four 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. LOC LF (local line feed)—To feed the paper up in the local machine, depress the LOC LF key, which 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. KBD LOCK (keyboard lock)—To lock the keyboard on the local machine, depress the KBD LOCK key. The keyboard is now inoperative until released by the KBD UNLK (keyboard unlock) key. The KBD LOCK key also drops automatically when the power switch is turned OFF, when the BREAK key is operated, or when a break is received.




50.93
Figure 10-12.— Model 28 keyboard with emphasis on function keys.

12. KBD UNLK (keyboard unlock)—To unlock the keyboard on the local machine, depress the KBD UNLK key. This action raises the KBD LOCK key, making the keyboard operative. Operate this key after turning on the power switch and after sending or receiving a BREAK.

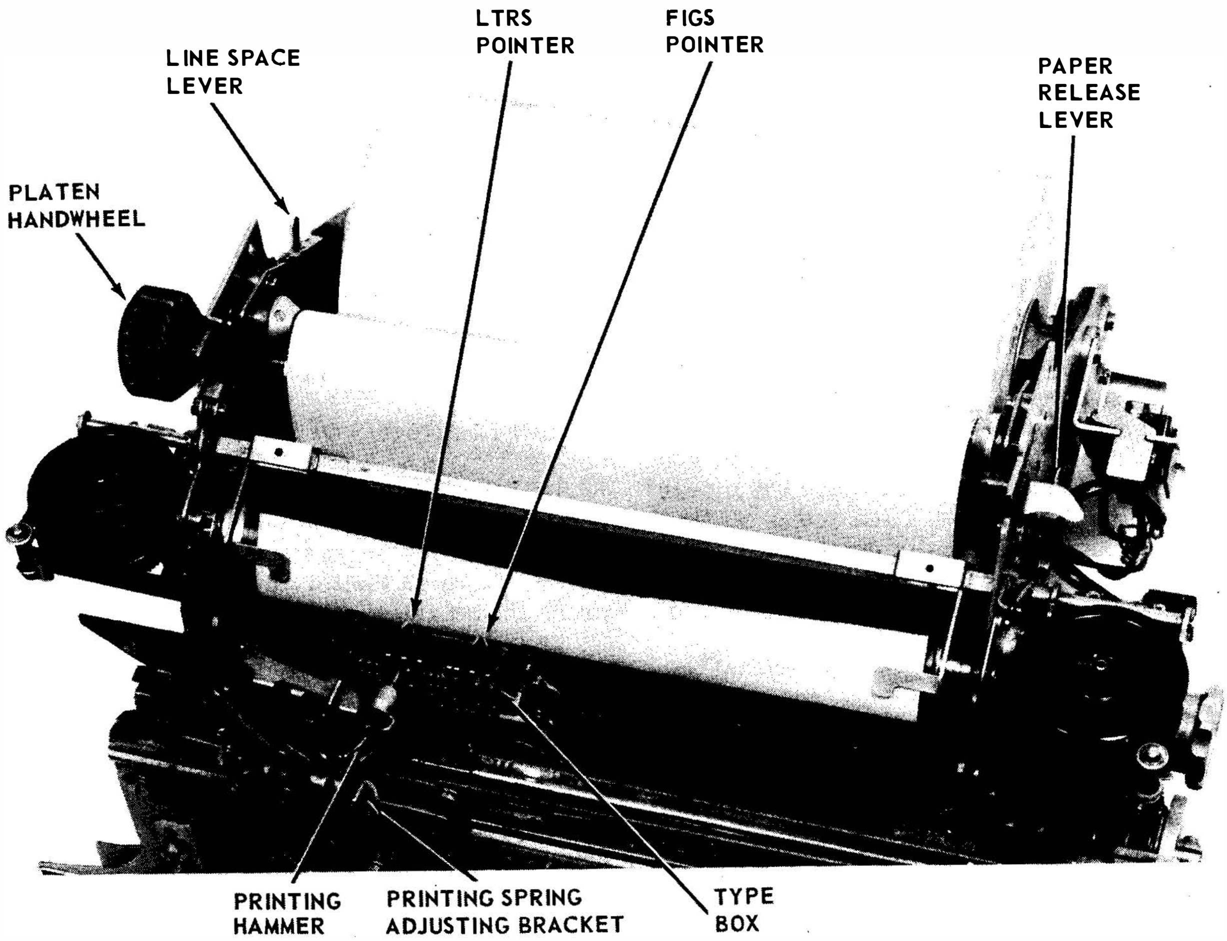
13. LOC CR (local carriage return)—To return the type box to the left margin on the local machine, depress the LOC CR key. This key is for use in omission of carriage return at the end of a transmission from another station.

## TYPING UNIT

The model 28 typing unit is shown in figure 10-13. 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 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 produce satisfactory copies.

Type pallets are arranged in four rows. The type box moves up and down in selecting the row in which each character to be printed is located. Lowercase characters are in the left half of the box and 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 teletypewriters. This combined vertical and horizontal motion brings the character to be printed into 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.




1.218
Figure 10-13.— Model 28 typing unit.

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.

## OPERATING THE MODEL 28 TTY

The controls and parts used to operate the model 28 printer are illustrated in figures 10-10 and 10-12. You will find frequent reference to these illustrations helpful in comprehending the instructions for operating this equipment.

Assuming that the printer is functioning properly and is connected to an incoming signal, the only action necessary to commence receiving traffic is to apply power to the equipment. This is accomplished by rotating the power switch (located slightly below and to the right of the right of the keyboard) upward to the ON position. Do not be alarmed if the first few characters are garbled, because the printer's driving motor requires several seconds to attain running speed.

Conditioning the machine for transmitting is a simple process. After applying power and allowing the motor to attain running speed, depress the BREAK key and hold it down for at least 2 seconds. This locks the keyboards of all stations on the circuit. Additionally, depressing the BREAK key starts the motors of those machines in which the motor shutoff mechanism is utilized. (Model 28 printers have a mechanism that shuts off the motor when no signal is received for approximately 2 minutes, but the mechanism often is disabled by stations not desiring this feature.) After releasing the BREAK key, press the KBD UNLK key to unlock your keyboard. The machine now is ready for transmitting to other stations.

Transmission begins at the keyboard. With the touch system, use the CAR RET key as a guide for the right hand and the A key for the left hand. The little finger of each hand is used on the guide key. It is important that you use a light, quick, even touch on the keys. Force is unnecessary because the machine is operated electrically. Teletypewriter manual operation requires accuracy, rhythm, confidence, and speed in their proper relation. Although a light touch is essential to speed, each key must be pressed in a positive manner. Otherwise you may be writing the word FOR and have FR appear on the page simply because the letter O was pressed without allowing sufficient time for printing the letter F. To become a skillful teletypist, proficiency in the touch system of typing is, of course, a "must."

The function keys represent "functional operations," or nontyping selections; that is, when pressed, they do not print anything on the page. Each function key was described in our discussion of the keyboard, but let us review the ones used most commonly in transmitting messages. These are the figures (FIGS) key, the letters (LTRS) key, space bar, carriage return (CAR RET) key, and LINE FEED key.

To shift the machine to the uppercase for typing numerals, punctuation marks, and special characters indicated on the upper part of the keys, press FIGS. To UNSHIFT the machine, press LTRS, and type the letters of the alphabet.

The space bar is used to space between either words or characters. On Navy printers the space bar functions the same whether uppercase or lowercase characters are transmitted. Some commercial machines, however, have a feature called "unshift on space," which means the printer returns to lowercase after each space. In fact, all printers have this feature, but on Navy machines it is purposely disabled. The operating procedure explained in the next chapter requires that you press the FIGS key before each group of uppercase characters so that the distant machine will print characters in the proper case whether it is adjusted to unshift on space.

The CAR RET key is used to return the carriage to the beginning of the line. Usually the machine is adjusted to print a line 69 characters in length. This includes the spaces between the typed words. The end-of-line indicator lamp lights about six characters before the end of the line.

The LINE FEED key feeds the paper up, one to two lines at a time, thus preventing overlining.

The latter two functions, carriage return and line feed, also are performed automatically by the printer upon printing the 69th character on each line. This prevents characters piling up at the end of a line when the normal carriage return and line feed functions are not received.

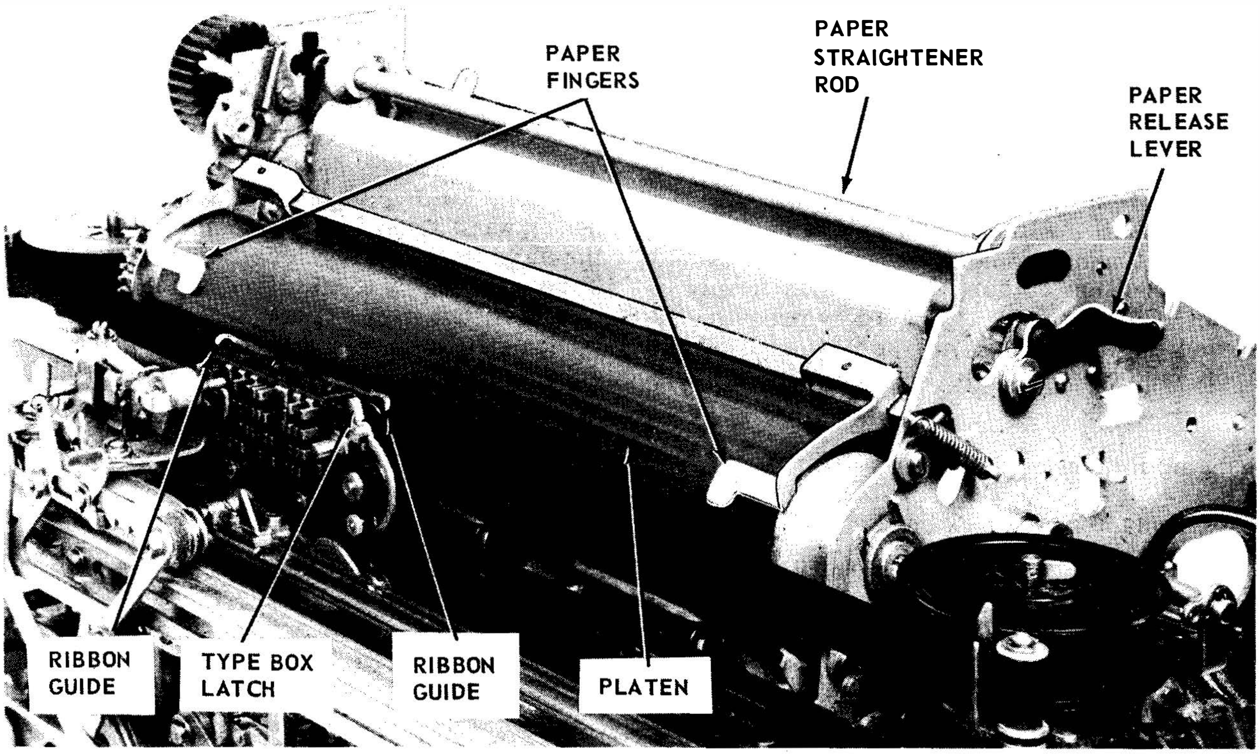
## MISCELLANEOUS OPERATING FEATURES

To raise the cover for access to the typing unit to change paper and ribbon or to clean type, press the cover release pushbutton and lift the cover. To raise the lid for access to the paper, press the lid release pushbutton and lift the lid. To turn the paper up or down, raise the cover, and press and hold down the platen handwheel (so that it engages the platen ratchet wheel) while turning it in the desired direction. Do not attempt to hold down or operate the platen handwheel while the teletypewriter is operating. To adjust the paper, raise the lid, push back the paper release lever to free the paper, straighten the paper, and pull the lever forward to its normal position. To set the line spacing for single or double space, raise the lid, press the line space lever to the left and pull it forward for single space or push it back for double space. To space to a desired location for typing, space the type box over until the LTRS pointer is at the desired typing location. Then, if uppercase is desired, operate the FIGS key.

### Changing Paper

To insert a new roll of paper in the model 28, first shut off the power. Press cover release pushbutton and lift cover. (Refer as necessary to figs. 10-14 and 10-15.) 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 you. 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 you would




1.219
Figure 10-14.— Paper roll removed.

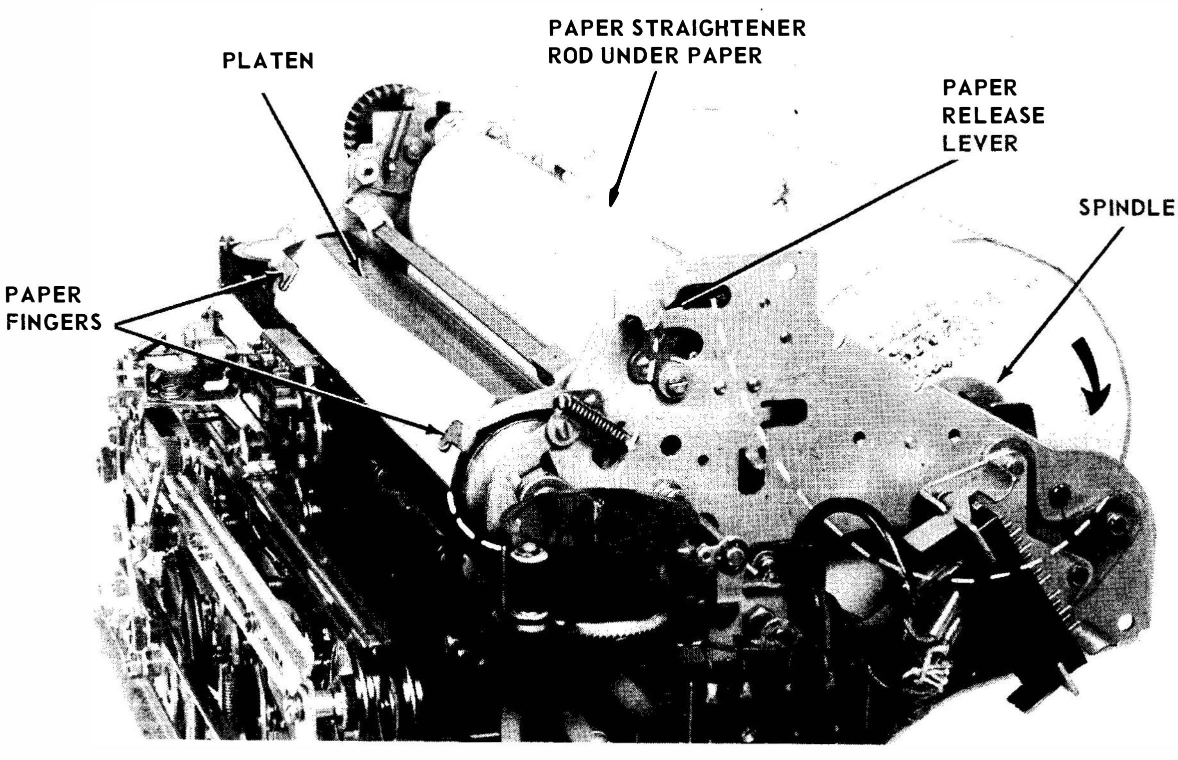



Figure 10-15.— Paper roll inserted. 1.220

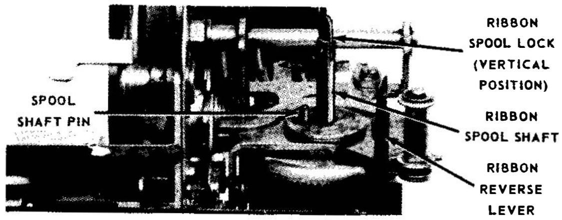
straighten paper in a typewriter. Then lower paper fingers onto paper and pull paper release lever forward.

While inserting paper, care should be taken not to disturb the ribbon or the type box latch. After paper is in place, check to see that the ribbon still is properly threaded through the ribbon guides. Also check to make certain the 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 pushbotton, bring up the end of the paper, and close lid with paper feeding out on top of it.

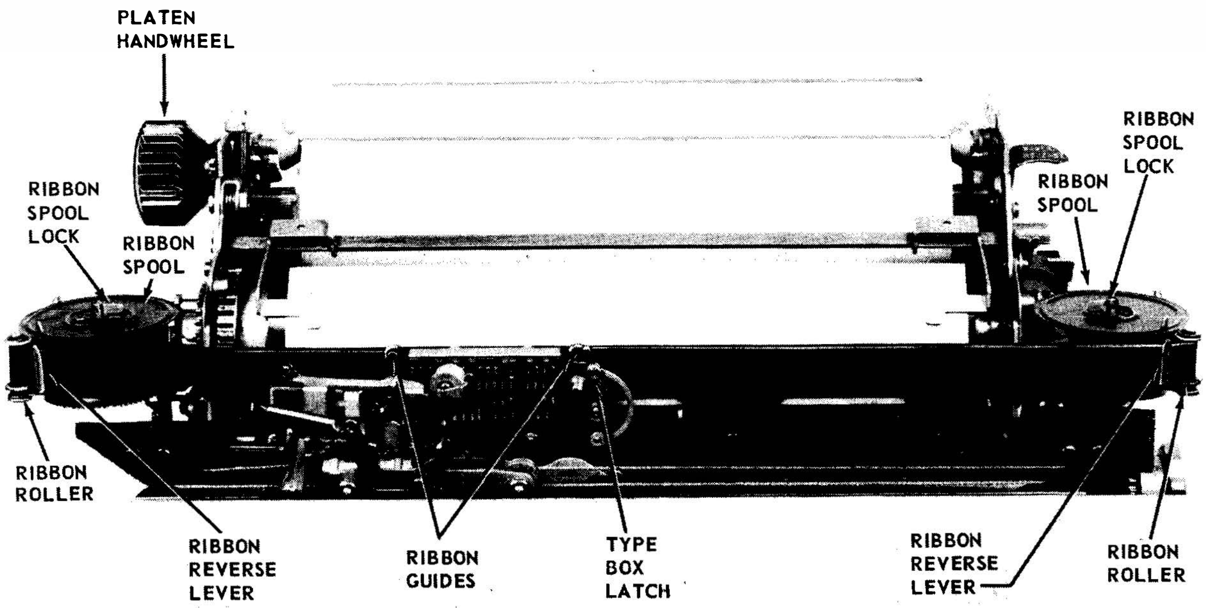
Changing Ribbon

To replace a worn ribbon, press cover release pushbutton and lift cover. (Refer as necessary to figs. 10-16 and 10-17.) 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.

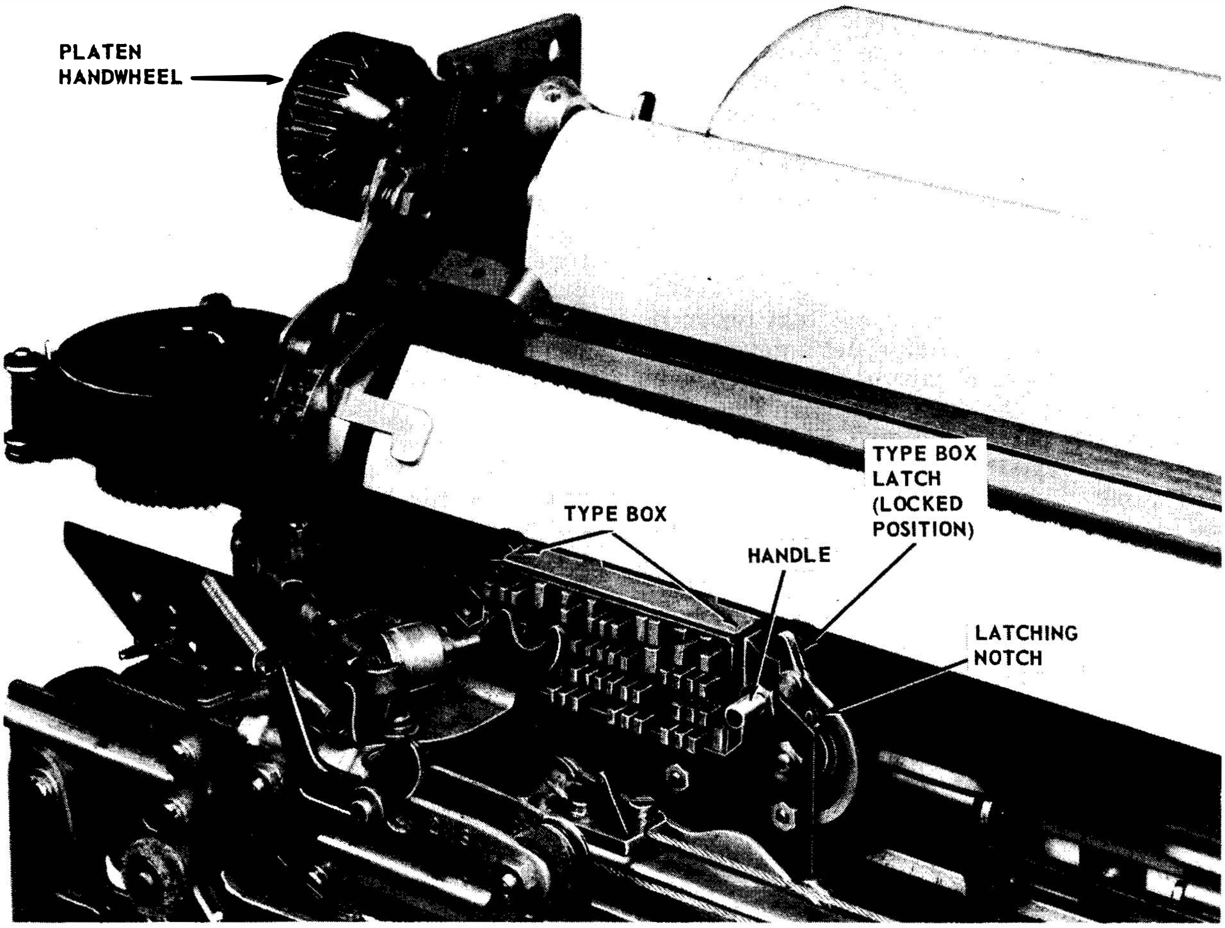
Replace spools on ribbon spool shafts, making sure they go down on spool shaft pins, and that the ribbon feeds from the outside of the spools. Turn down ribbon spool locks to a horizontal position, locking spools in place. Thread ribbon forward around both ribbon rollers, through the slots in the ribbon 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.




1.221
Figure 10-16.— Ribbon spool mechanism.




1.222
Figure 10-17.— Ribbon inserted.



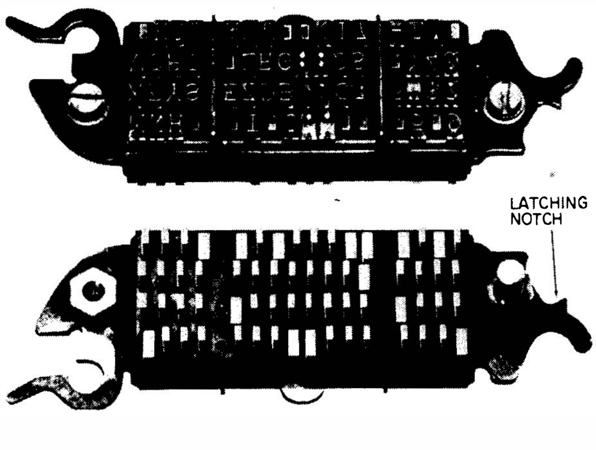

31.27
Figure 10-18.— Type box in place.

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, and close lid, with paper feeding out on top of it.

Cleaning Type

When printing is smudged, the type should be cleaned. You must remove the type box from the machine. Open cover and unlock type box latch by moving it to the right (see fig. 10-18). Grasp handle on right side of type box, and raise that side up and to the left until the type box unhooks on the left side and can be freed from type box carriage. Turn type box over to side with type (fig. 10-19) 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



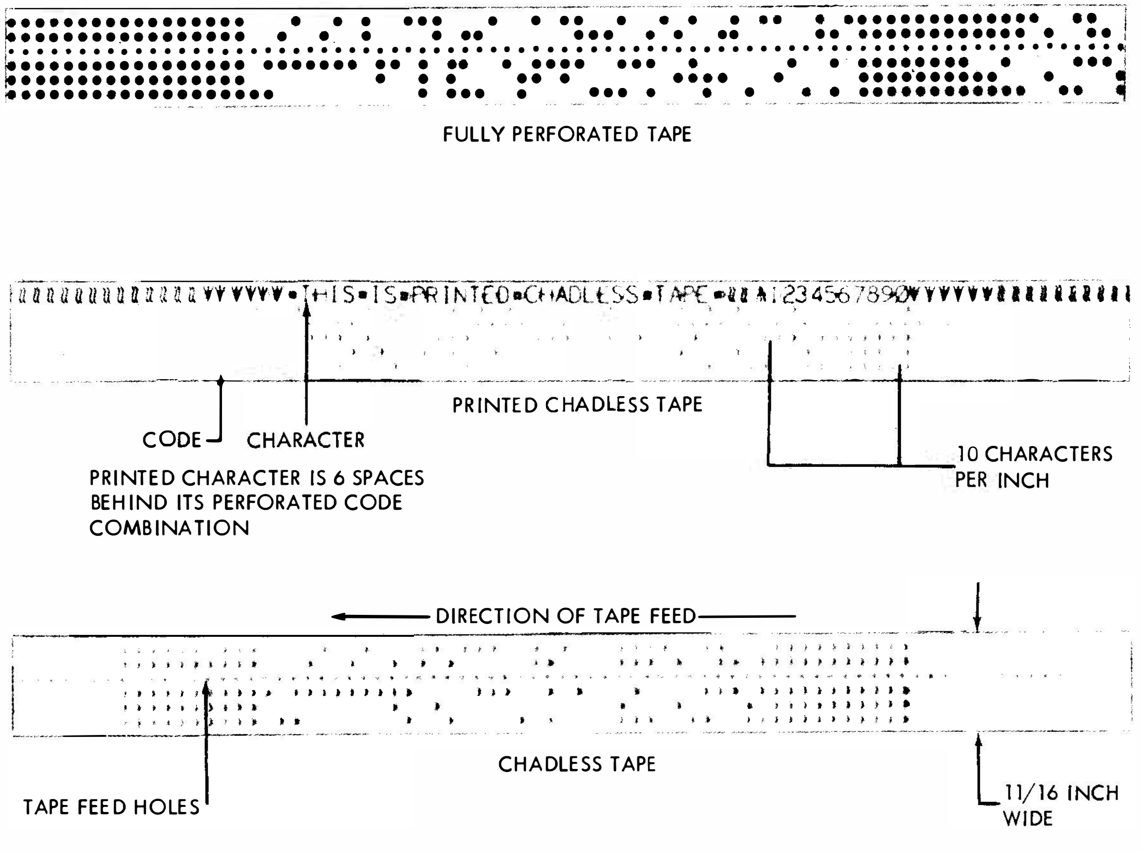

31.28
Figure 10-19.— Type box, front and back.

hook under stud in front of left type box roller, and push smaller hook on right side down into place on stud in front of right type box roller. Hold 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.

## TELETYPE TAPE

Before discussing equipment that produces and handles messages on tape, let's get squared away on the two types of tape used for messages transmitted over the NTX system. The first type is the fully perforated, or CHAD, tape (fig. 10-20). (Incidentally, "chad" is the confetti (small paper disks) punched from the tape to make the holes.) On chad tape the teletypewriter code is completely punched, and no printing appears. The other type, only partially perforated, is called CHADLESS. There is, however, more than one kind of chadless tape. The center tape in figure 10-20 is produced by newer models of perforators and reperforators and carries the printed message in addition to the perforations. The printing always lags the perforated code by six spaces. In other words, the pattern of holes representing letter A may be punched as the first letter of a message, and six spaces later (to the right) the letter A is printed on the tape. The reason for this is that both printing and perforating occur at the same time. Because of their simultaneous action, printing and perforating must necessarily occur at different locations on the tape. Accordingly, the machines are designed to print the character six spaced to the right of the corresponding perforation.

The partial perforations of chadless tape remain hinged to provide enough surface for the printed word, which eliminates need for reading the perforations, at the same time permitting the transmitter distributor sensing pins to penetrate the perforations and transmit the message. When a tape is completely perforated—as is chad tape—the remaining surface is not sufficient for printed characters.




1.206(76)
Figure 10-20.— Chad and chadless tape.

Older teletypewriter reperforators, such as the model 14, similarly produce a chadless tape different only in that the alphabet characters print along the upper edge of the tape, whereas the figures and other uppercase characters print along the lower edge.

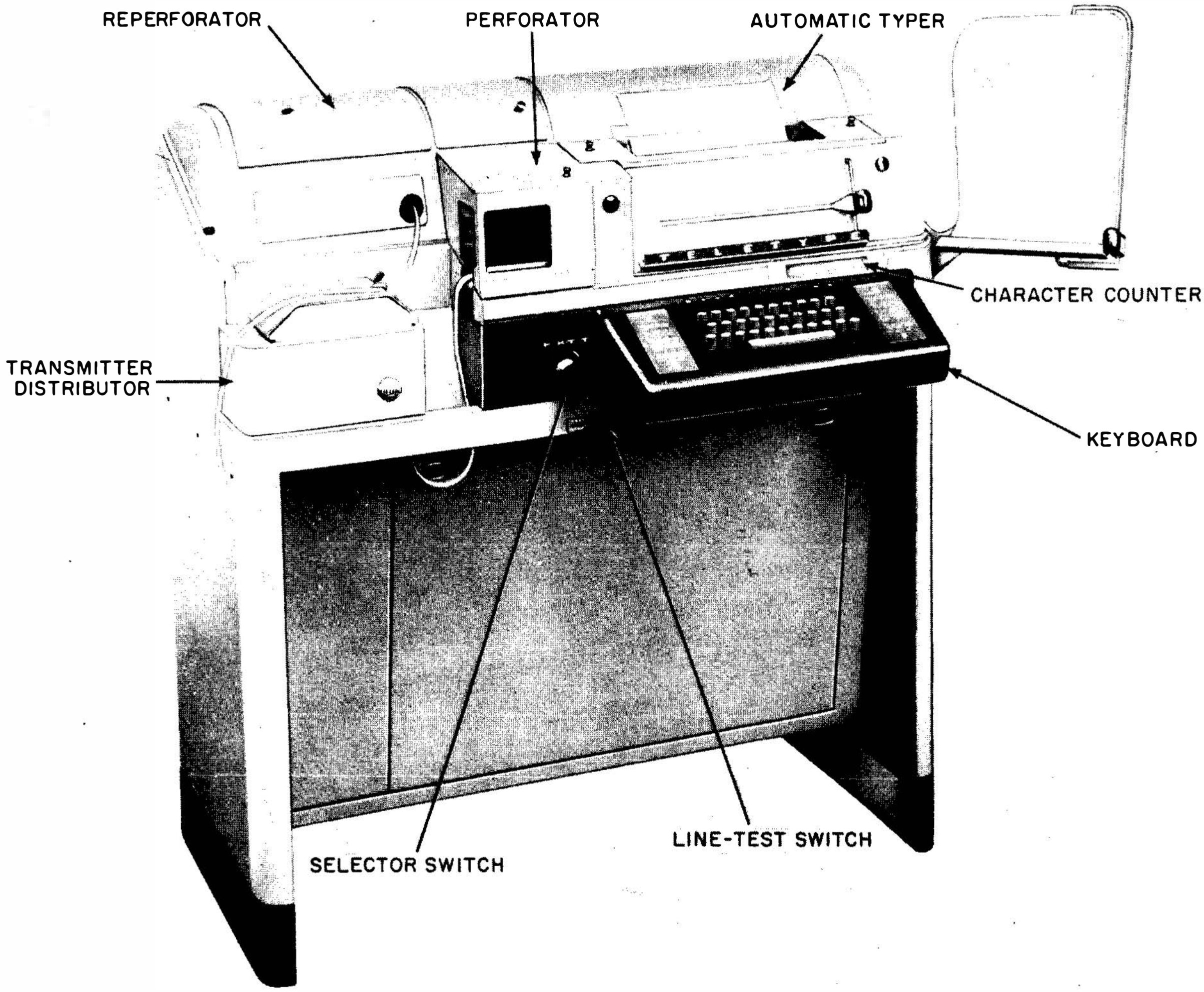
A third king of chadless tape has the same type of partial perforations but does not have any printing whatsoever (lower tape in figure 10-20). The teletypewriters and high-speed reperforators used on cross-office circuits at the automatic relay centers produce this kind of chadless tape.

The continued widespread use of chad tape, and chadless tape without printing, make it necessary for the operator to learn to read tape. We will have a lesson in tape reading at the end of the chapter.

## MODEL 28 SEND-RECEIVE CONSOLE (AN/UGC-6)

The AN/UGC-6 teletypewriter (fig. 10-21) is a versatile communication equipment. It receives messages from the signal line and prints them on page size copy paper. In addition, 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 teletypewriter set is composed of the following components: a cabinet, a keyboard, an




31.29A
Figure 10-21. — The AN/UGC-6 teletypewriter.

automatic typer, a typing perforator, a transmitter distributor (TD), a typing reperforator, and power distribution panels.

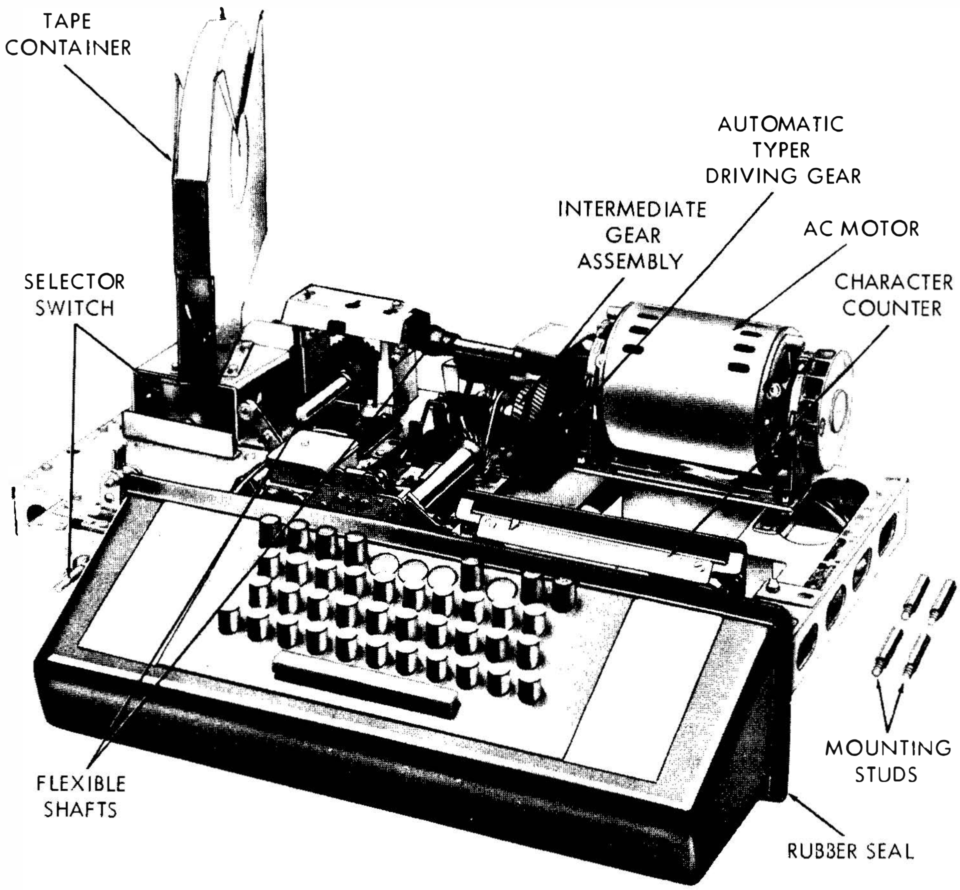
In operation, the components are linked together by electrical or mechanical connections to offer a wide range of possibilities for sending, receiving, or storing teletypewriter messages. All equipment components are housed in the cabinet. Transmission signals are initiated through the keyboard or the transmitter distributor. Signals are received, and local transmission can be monitored, on the automatic typer. 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 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.

The major components of the AN/UGC-6 send-receive console are described in greater detail in the following paragraphs and illustrations.

## KEYBOARD

The keyboard (fig. 10-22), similar to the keyboard of the TT-48/UG that we discussed earlier, actually is a keyboard and a base combined. It




50.92
Figure 10-22.— Keyboard unit.

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.

The keys on the AN/UGC-6 keyboard are identical to those on the TT-48/UG, except for the addition of a tape backspace (TAPE B. SP.) key in the top row. Depressing this key reverses the direction of tape feed in the perforator by one space. It is used when correcting errors in tape preparation.

## AUTOMATIC TYPER

Automatic typer is just another term for the typing unit described in our discussion of the TT-48/UG teletypewriter set. Except for minor changes in operating features, all model 28 typing units (or automatic typers) are identical in appearance and function. They convert electrical impulses into printed matter on page form.

## TYPING PERFORATOR

Tape perforation by operation of the keyboard is accomplished by the typing perforator (fig. 10-23). 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.

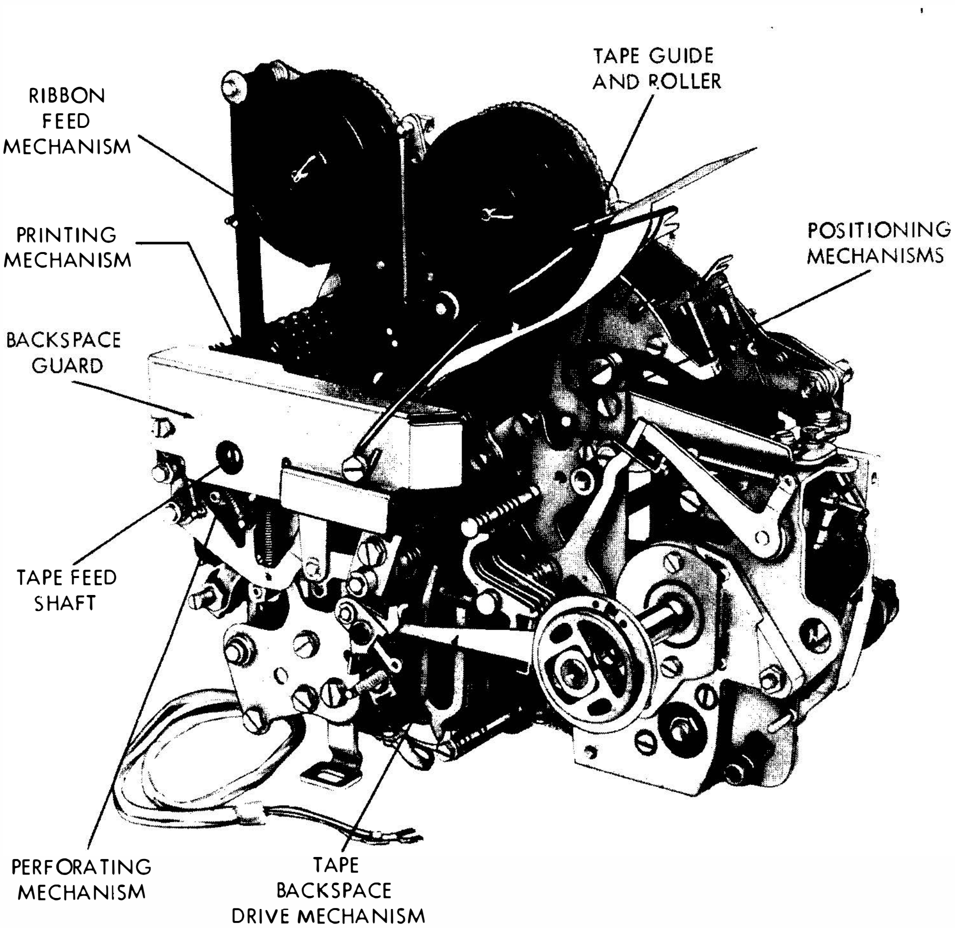



Figure 10-23. — Typing perforator (front view). 50. 98

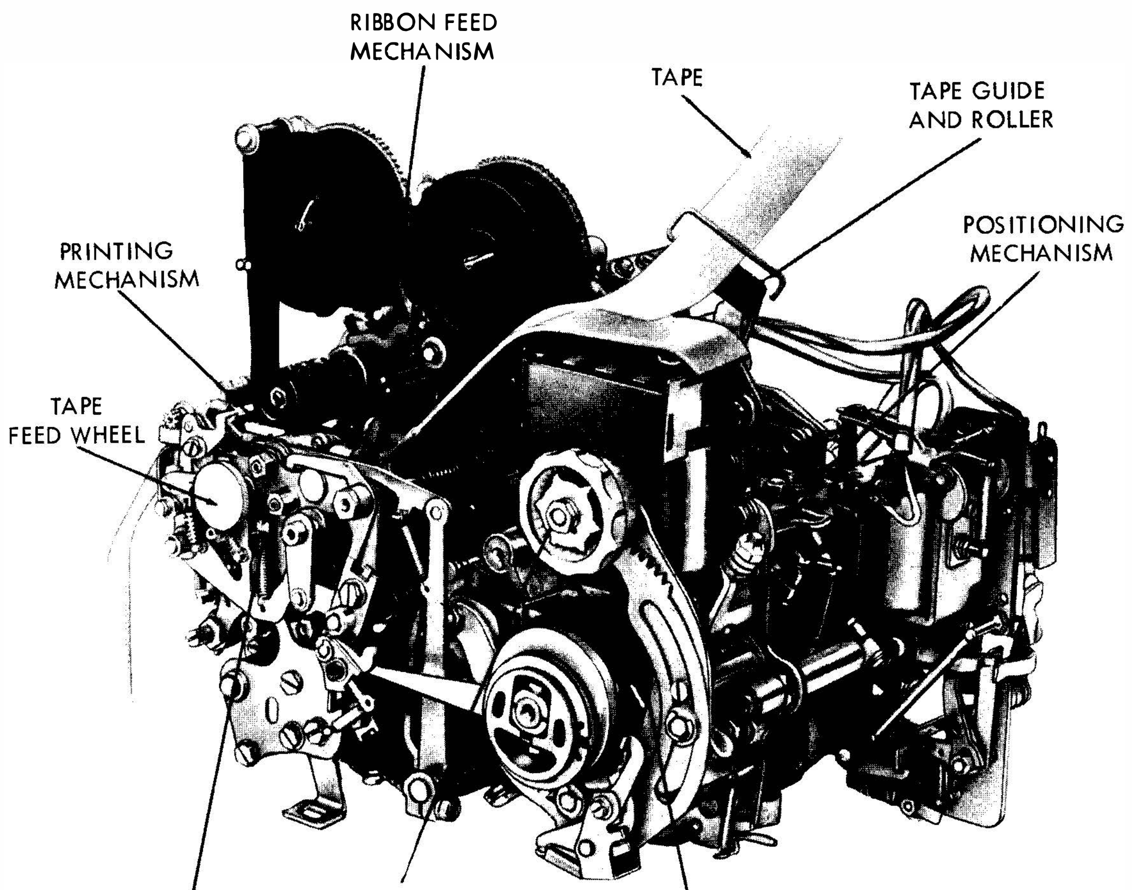
Printing is accomplished by a type wheel that is controlled by positioning mechanisms and a hammer for driving the tape and an inked ribbon against the type wheel to imprint the selected characters. The positioning mechanisms select the proper characters by moving the type wheel in accordance with mechanical 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.

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 B.SP. 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 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. 10-24.) 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 received 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




50.102
Figure 10-24.— Typing reperforator (front view).

a station on one circuit, while the other components in the console are transmitting traffic to the same station on another circuit.

Additional features of the reperforator that are uncommon to the perforator are the signal bell, low tape alarm, a mechanical variable speed drive mechanism, a blank tape feed-out mechanism, and a tape threading feed wheel.

TRANSMITTER DISTRIBUTOR (TD)

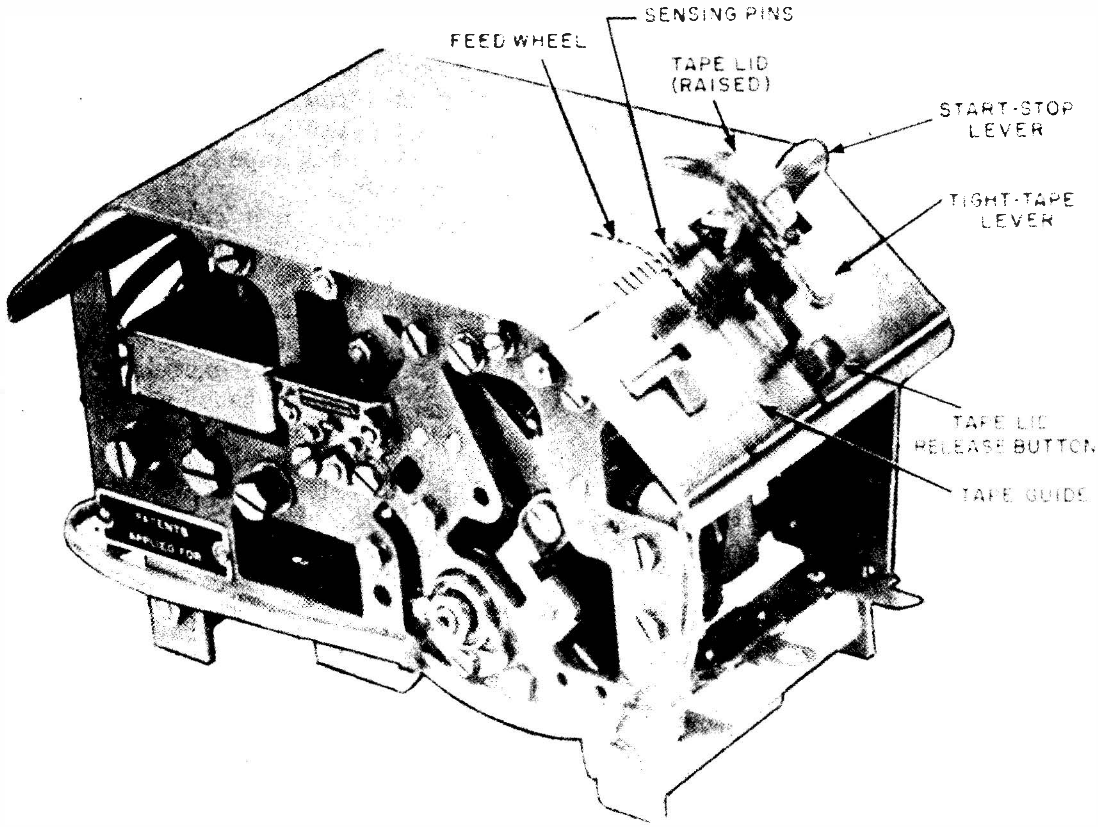
The transmitter distributor (fig. 10-25) is mounted on its own base in the front of the cabinet on the left side. It is a mechanical tape reader used to convert messages on standard chadless or fully perforated tapes to the electrical impulses of the teletypewriter code. The impulses are transmitted 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, depending upon whether the sensing pins rise into a perforation or are held stationary by the tape.

The unit includes a start-stop switch in which 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 in the 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




76.33
Figure 10-25.— Transmitter distributor (TD).

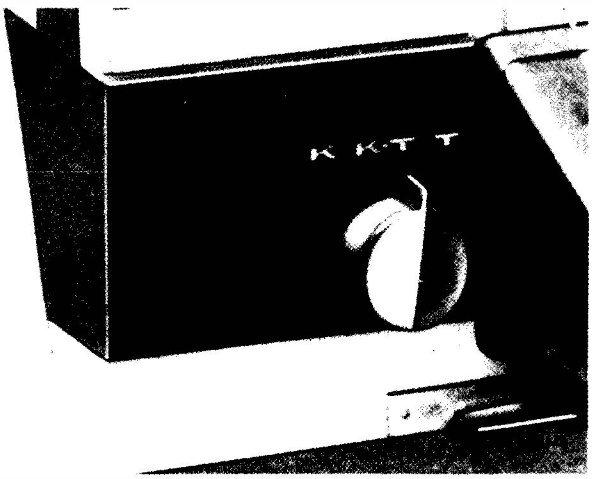
protruding through the tape guide plate. As long as this pin is depressed by tape feeding through the guide, the TD is operable. When the end of the tape passes over the pin, the pin rises and the TD stops transmission automatically.

## OPERATING THE AN/UGC-6

Power is applied to the AN/UGC-6 in the same manner as to the TT-48/UG. The switch is 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 for 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 the 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), and no intelligence is sent to the signal line. This, 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. 10-26). From left to right, the three positions of the switch are keyboard (K), keyboard and tape (K-T), and tape (T).




76.34
Figure 10-26. — Selector switch.

## KEYBOARD MODE OF OPERATION

To transmit a message directly to the line as you are typing it, 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, and then depress the SEND (KBD UNLK) key to unlock your keyboard. Transmit five spaces, two carriage returns, and a line feed, in that order, to align the distant machines to the same position as yours, and then type your message. The automatic typer monitors your transmission, providing you with a printed copy of the message.

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 when 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. You can transmit the message on one circuit while preparing a tape for transmission on the other circuits.

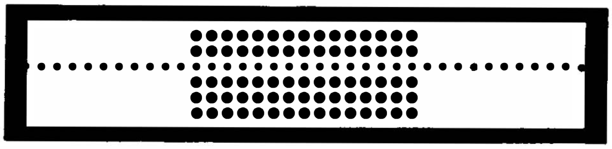
With the line-test switch in the TEST position, you can utilize this mode of operation to prepare tape for later transmission and, at the same time, to obtain a page copy of the transmission as it will appear when sent on the circuit. Care must be exercised in using this method, however, because you 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 permits you to prepare tape for transmission while transmitting messages via the transmitter distributor, or receiving messages on the printer. You type no page copy in this position, so watch the character counter to make certain that you do not type 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 you have 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 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 that you have reached the end of the line, you still may type as many characters as you lettered out. Figure 10-27 shows a lettered-out tape.

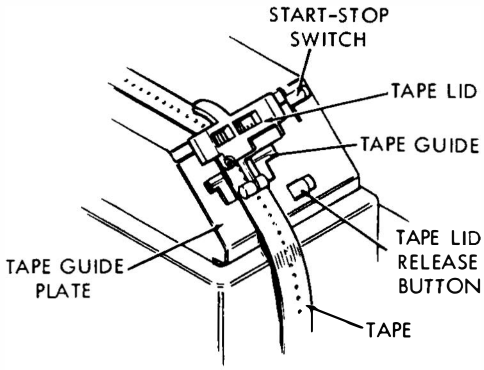


31.24
Figure 10-27.— A lettered-out tape.

USING THE 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 the following 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 10-28 shows the path of the tape through the TD.



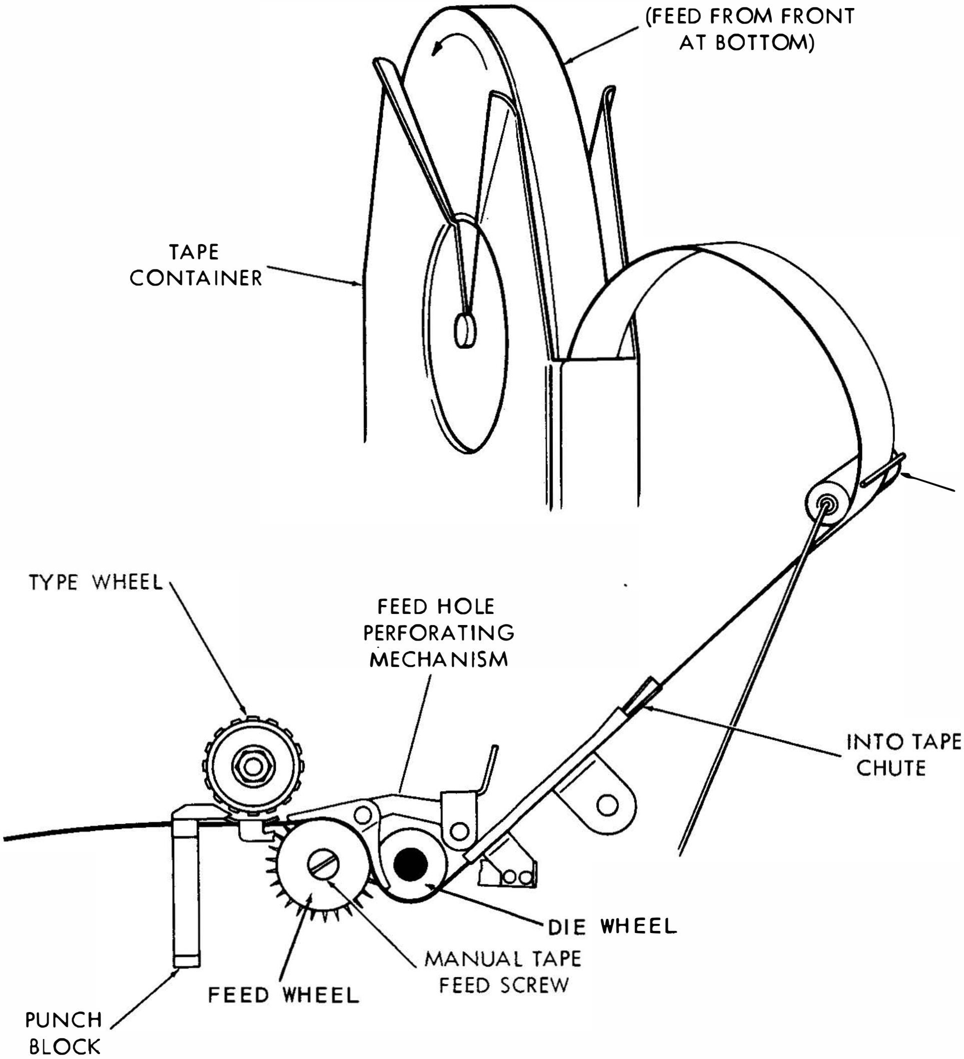

1.210(76)A
Figure 10-28. — Path of tape in transmitter distributor.

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 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, the roll is nearly exhausted and requires 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 tape chute (fig. 10-29). 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



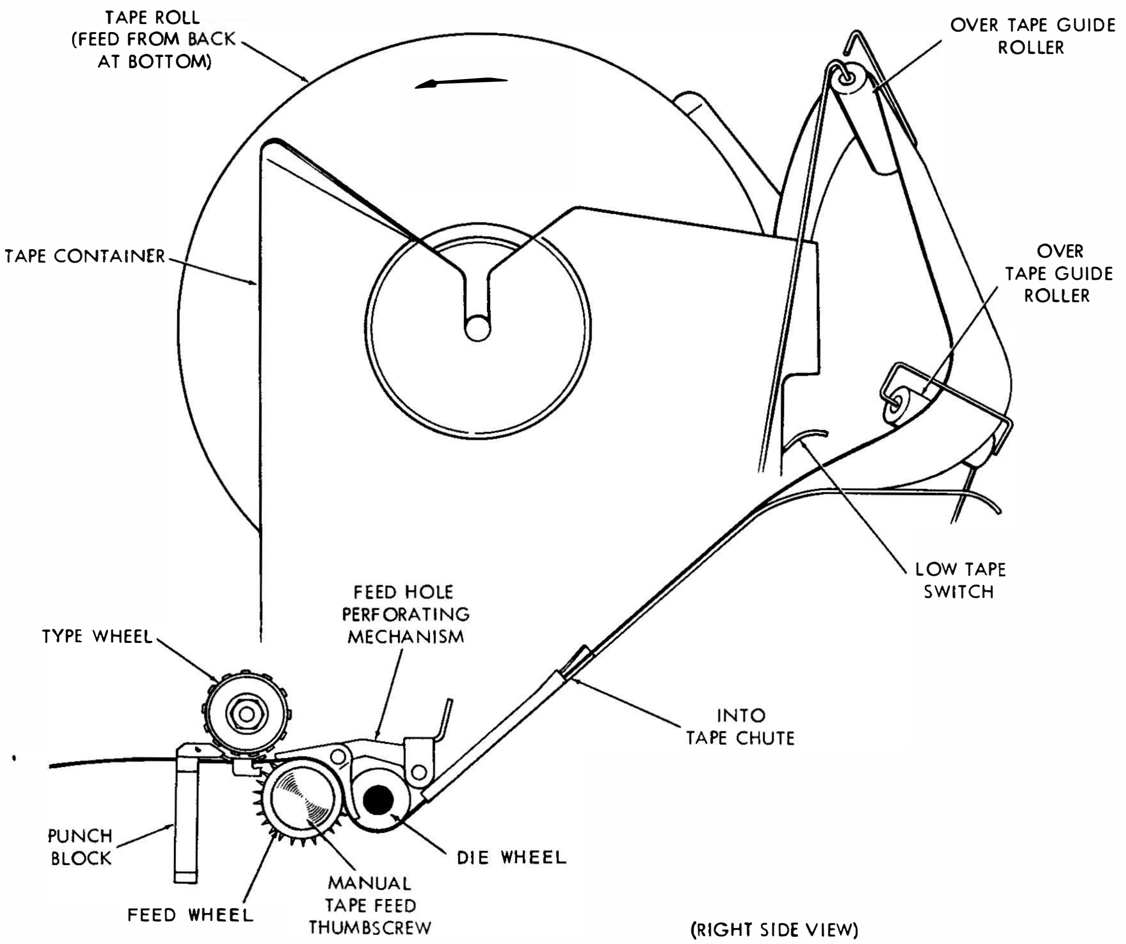

1.215(76) A

Figure 10-29. — Path of tape in typing perforator.

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, and, at the same time, 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. 10-30 as necessary.)

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




1.215(76)B
Figure 10-30.— Path of tape in typing reperforator.

certain that the lever on the tape out switch 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 and 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.

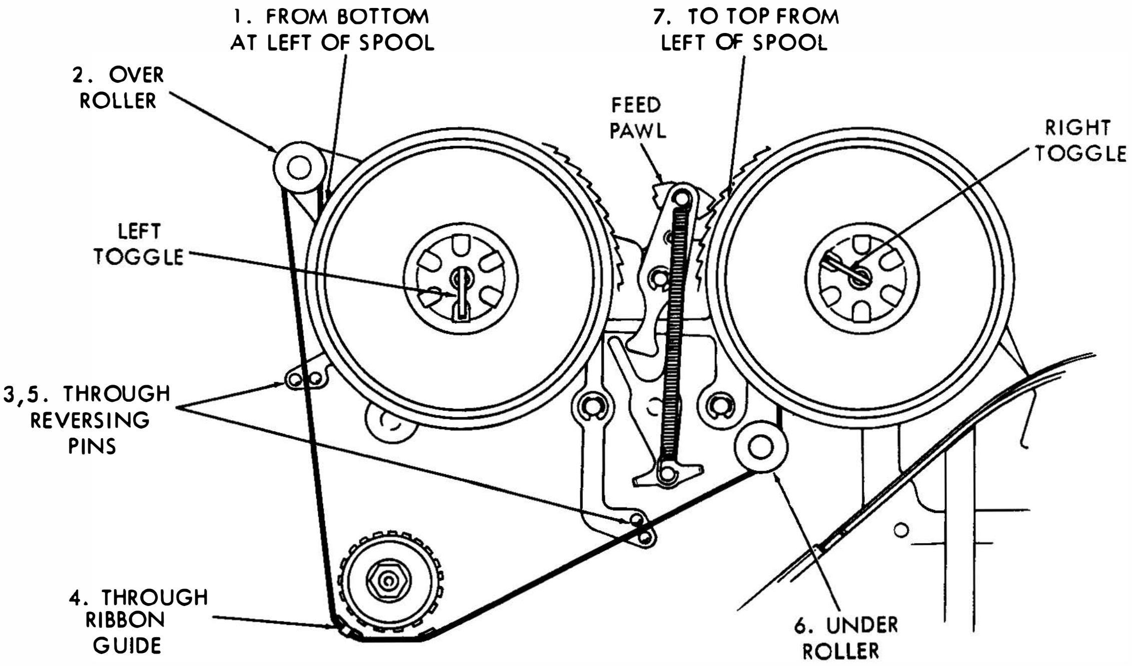
## CHANGING RIBBONS

You already know how to change the ribbon in the automatic typer. Now you will learn how this is done in the perforator and reperforator. The procedure for replacing the ribbon in either the typing perforator or the typing reperforator is the same.

Open the cabinet dome lid required 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. 10-31) 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

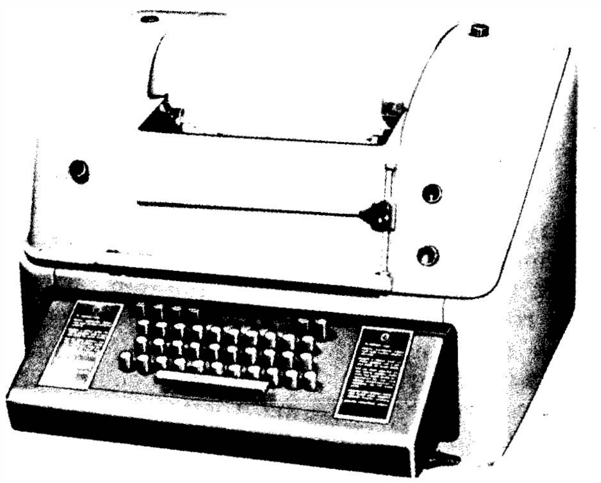



1.215(76)C
Figure 10-31.— Path of ribbon in typing perforators.

levers. Roll up any slack in the ribbon on the spool on which the ribbon is being wound.

## ADDITIONAL MODEL 28 UNITS

The design and function of the individual units in the model 28 line of teletypewriters remain basically the same, but the AN nomenclature assigned the units when they are employed separately (or in combinations such as found in the AN/UGC-6) usually is changed. Often, simply changing the style or type of cabinet in which a unit is enclosed causes a change in nomenclature. For example, when the keyboard and automatic typer comprising the TT-48/UG teletypewriter (fig. 10-10) are placed in the cabinet shown in figure 10-32, they become the TT-69/UG teletypewriter set. The latter set is designed for installation aboard ship.

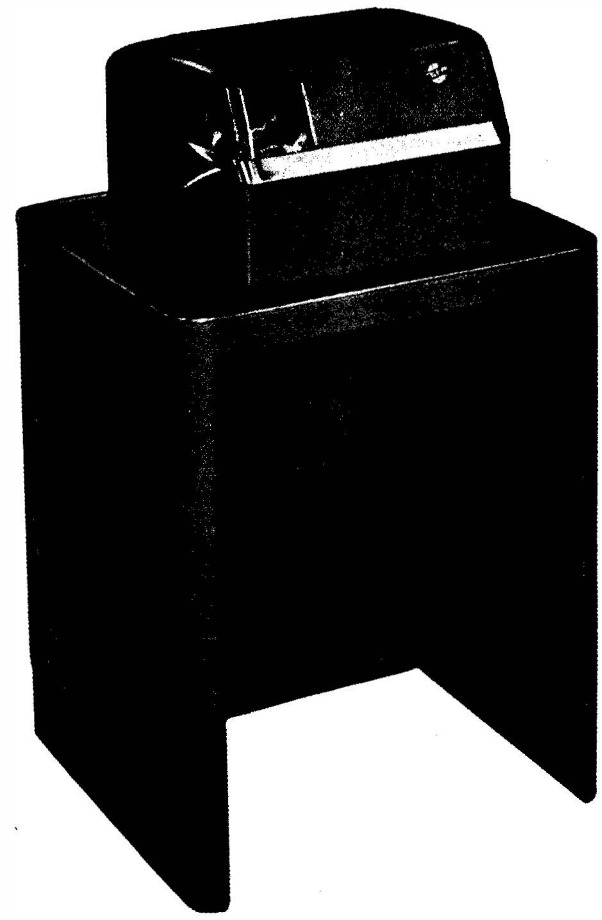


76.35
Figure 10-32.— Teletypewriter TT-69/UG.

## TYPING REPERFORATOR TT-192/UG

The typing reperforator shown in figure 10-33 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 shown in the illustration.

Normally, the reperforator's wiring is terminated in a patch panel (described later in this chapter) so that it can be patched or connected into any teletype circuit wired through the panel. By patching the reperforator into a circuit, a tape copy of each message is obtained, and messages



50.114(76)
Figure 10-33. — Model 28 typing reperforator set TT-192/UG.

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. 10-34) is installed aboard ship 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 a page copy is not required.

TRANSMITTER DISTRIBUTOR TT-187/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 10-35. The unit is self-contained, and can be mounted in any convenient space that is large enough to accommodate its base.

OLDER TELETYPEWRITERS

The forerunners of the model 28 line of teletypewriter equipment are the model 14 typing reperforator (fig. 10-36), the model 15 page printer (fig. 10-37), and the model 19 teletypewriter set (fig. 10-38). A number of these equipments still are found at shore stations (and possibly aboard a few ships), but their use is limited because of their operating speed. The maximum operating speed of the older equipment is 60 wpm, which is incompatible with the higher speeds now employed on most Navy circuits. Consequently, as these older models age beyond economical repair, they are being replaced by components from the model 28 line.

Operating the older machines is similar to operating their model 28 counterparts. By comparing figures 10-36, 10-37, and 10-38 with the previous illustrations of model 28 equipment, it readily is seen that the location and appearance of some of the functional controls are somewhat different. But an operator familiar with the purpose of these controls can adapt easily to operating either the older models or their counterparts in the model 28 line.

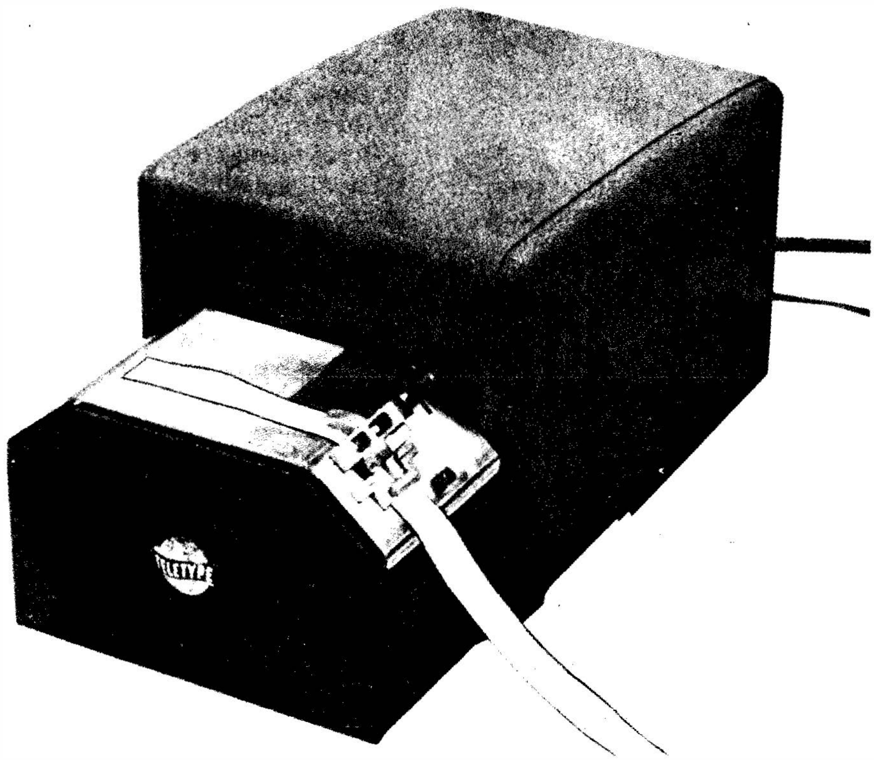
TELETYPEWRITER SERVICE TROUBLES

Here are some of the more common service troubles you may encounter, with a brief description of how they may be recognized, their causes, and what action the operator may take to correct them.

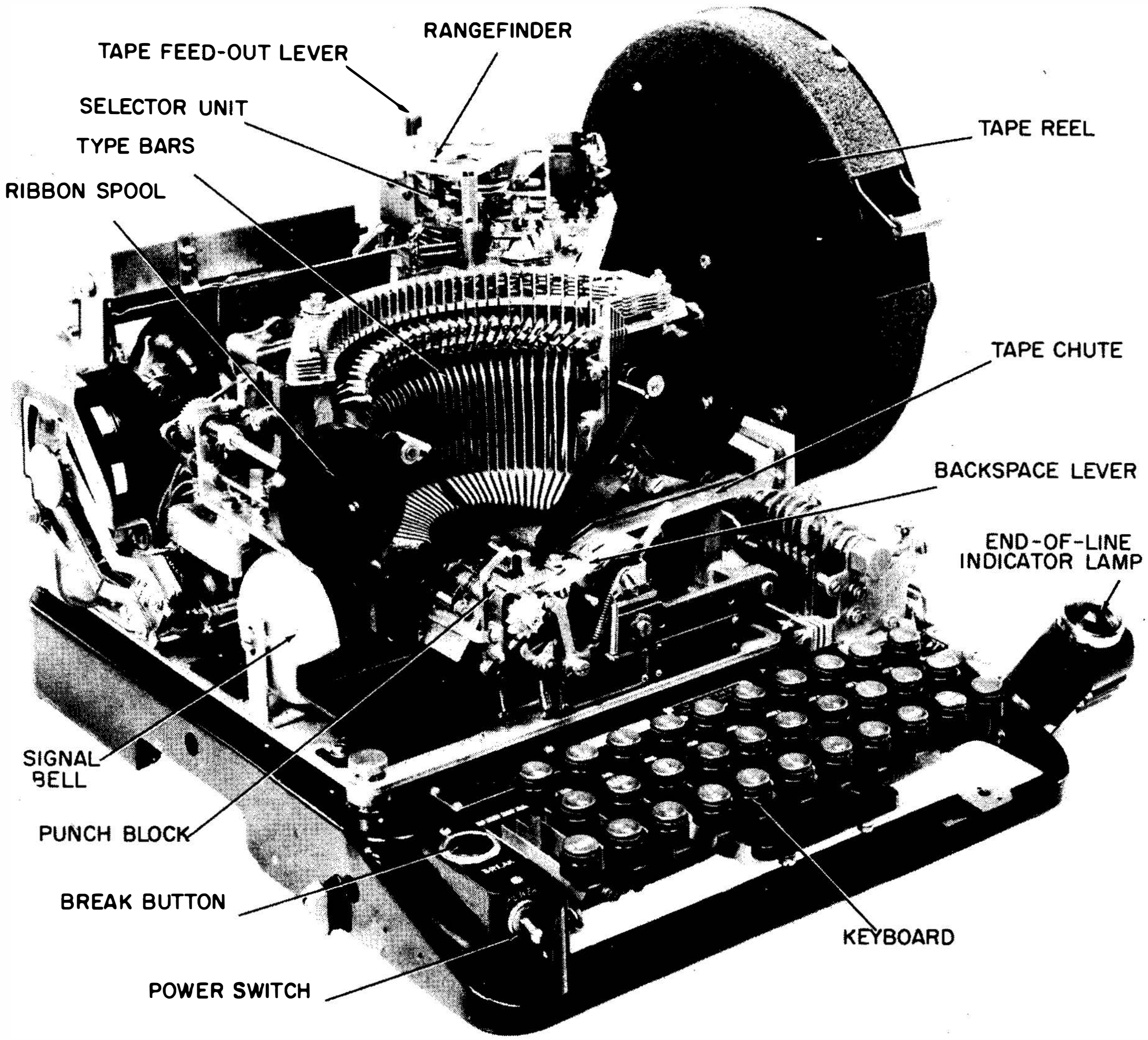
The troubles presented here are only a representative sample of those that may be encountered. The equipment technical manuals give a thorough coverage and include helpful charts to aid in tracking down the trouble.

MACHINE WILL NOT START: See that the plug on the power cord from the teletypewriter is pushed all the way into the outlet. Check for a power or fuse failure. If a fuse is open, rotate the motor by hand and check for excessive bind. If the fuse is not blown, check the motor

50.116
Figure 10-34.— Send/receive typing reperforator TT-253/UG.



1.210(76)B
Figure 10-35.— Transmitter distributor TT-187/UG.



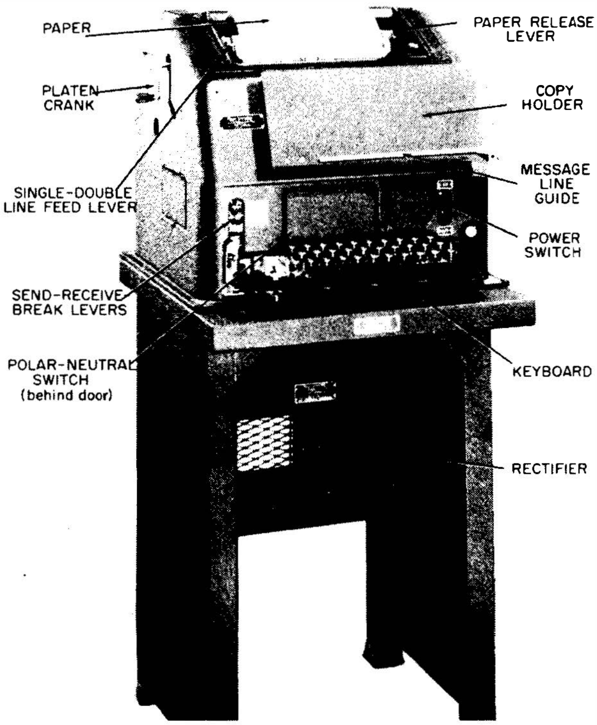

31.25
Figure 10-36. —Model 14 typing reperforator.

for excessive temperature. The synchronous motor in the Model 28 is equipped with a thermal circuit breaker that protects it against excessively high temperatures caused by a prolonged overload. If the breaker is tripped, reset it by pressing the red button on the motor plate at the rear of the motor.

UNABLE TO COMMUNICATE WITH OTHER OFFICES: Make sure the SEND key is depressed. Be sure the line switching lever is positioned correctly.

PRINTER RUNS "OPEN": This trouble may be recognized by the machine operating continuously without either printing or spacing. The machine also appears to run faster than during normal operation. Shift the line switching lever to the TEST position or patch the equipment into a test circuit as applicable. If this causes the machine to become idle, it is an indication that the trouble probably is in the incoming signal circuit.

PRINTING ERRORS: When printing errors occur that obviously are not typographical, some




1.205
Figure 10-37.— Model 15 page printer.

comparisons may be made to determine whether the trouble is in the machine or the circuit. If the errors occur when you are sending, operate the line switching lever to the TEST position (or plug in the test loop) and try the machine. If the same errors occur, the trouble probably is in the machine.

If you have a spare machine, connect it to the circuit. If errors occur on both machines, the trouble is in the circuit. If the errors happen on only one of the machines, the trouble is probably in that machine.

For errors when receiving, connect a spare machine to the circuit. As pointed out already, errors on the spare machine indicate circuit trouble, and correct copy from the spare machine indicates that the first teletypewriter is causing the trouble.

RIBBON TROUBLES: If the ribbon is feeding and the printing is faint, a new ribbon is needed. If the ribbon is not feeding, make sure it was placed in the machine correctly.

PAPER FEED TROUBLES: This is indicated by the paper either feeding to one side, not feeding, tearing, or jamming. Make sure that the paper was placed in the machine as previously outlined. See that too much paper has not accumulated behind the unit. The paper may not have been torn correctly.

UNABLE TO SEND WITH TD: Make sure the tape was properly placed in the transmitter distributor. Check to see that the end-of-tape pin is depressed, and that the tight-tape stop lever is down. See that feed holes in the tape are not mutilated.

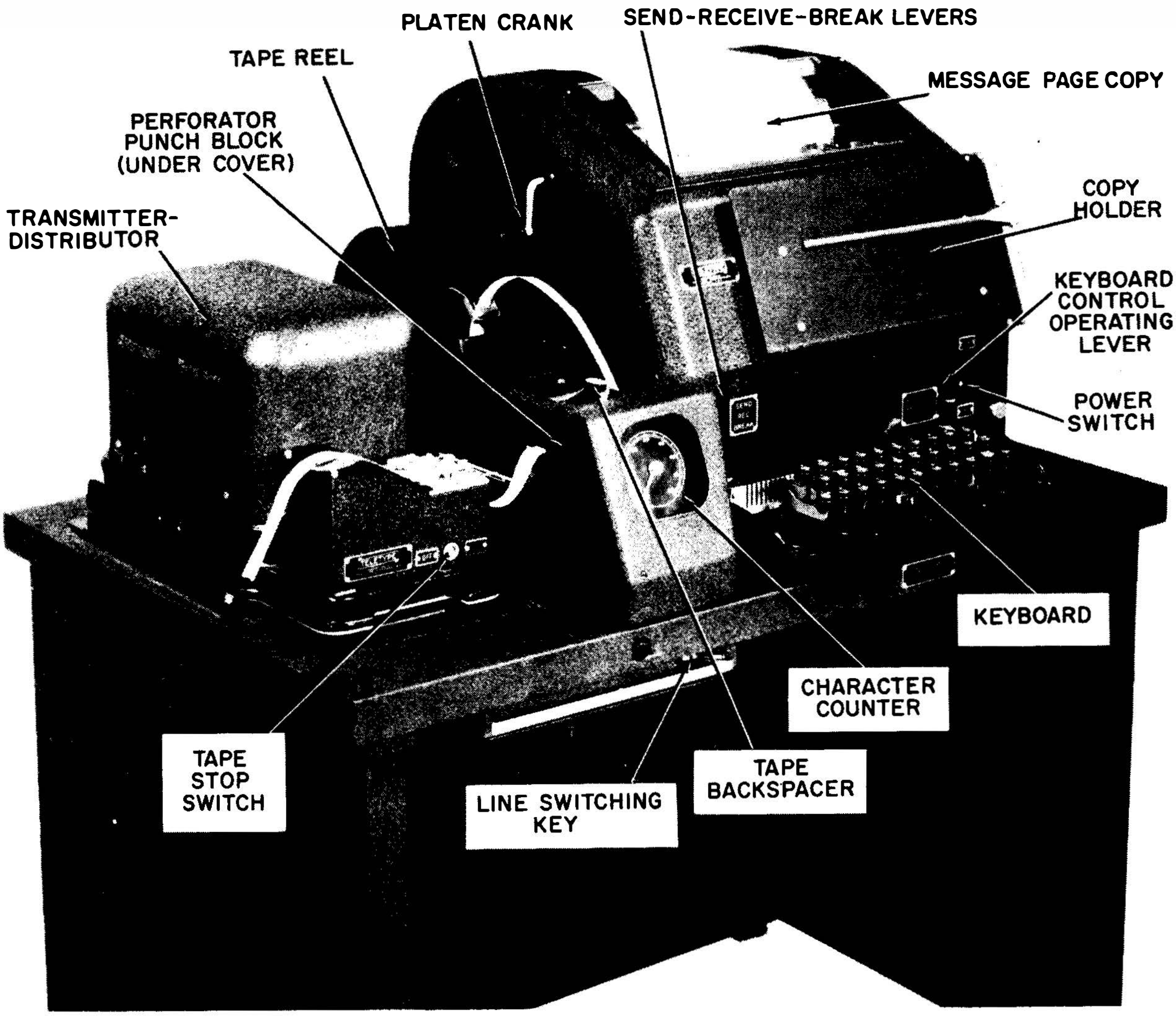
TAPE FEED TROUBLES WHILE PERFORATING: Make sure tape is feeding freely off the roll, and that it was placed in the machine correctly.

FAILURE ON LINE FEED: There may be binds in the moving parts of linkage for line feed function. Check these parts for freeness.

FAILURE TO PRINT: This may be due to binds in the printing carriage assembly. Check for freeness in moving parts, and for missing springs. Another source of this trouble may be the improper installation of the ribbon.

NO SIGNALS FROM KEYBOARD: This trouble may stem from either an open or a closed signal line. The contacts should be checked to determine if they are dirty or shorted.

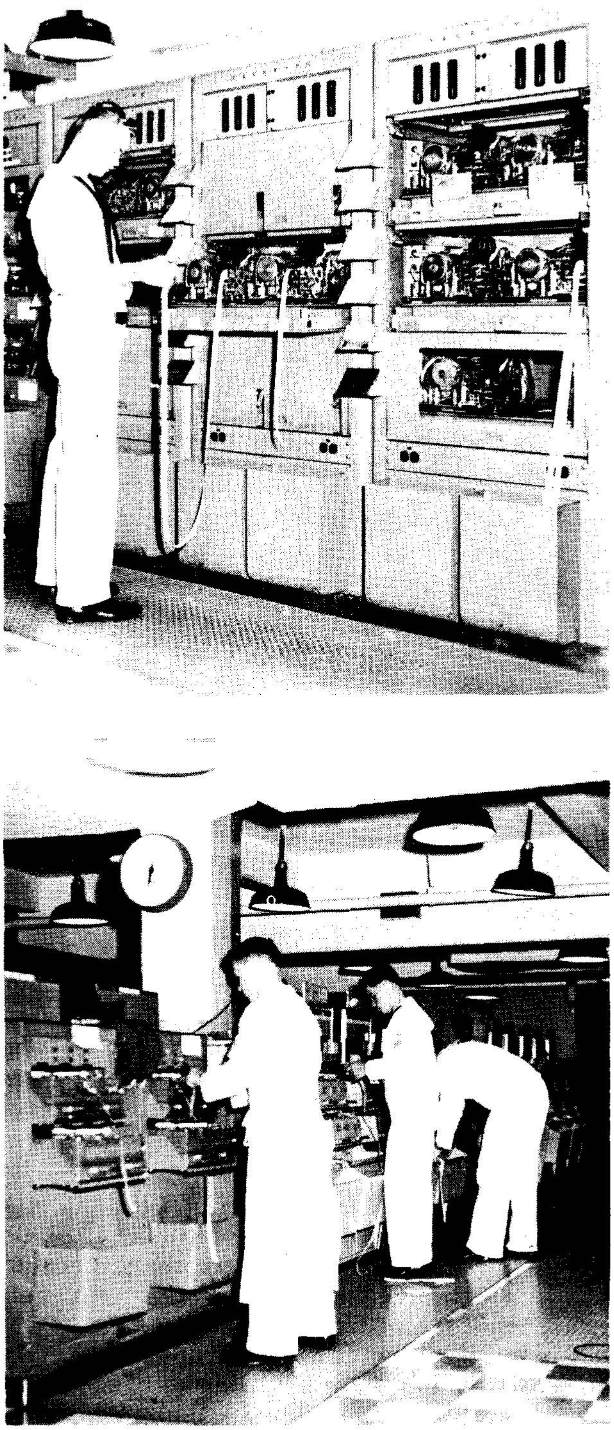
INTERMITTENT ERRORS: This trouble may have a variety of sources. Among them are inadequate or excessive line current, range finder set beyond range limits, or incorrect adjustments.




1.208
Figure 10-38.— Model 19 teletypewriter set.

PACKAGE EQUIPMENTS

The volume of teletypewriter traffic relayed by NAVCOMMSTAS and many of the smaller shore stations has led to the development of tape relay equipment that requires a minimum of operator attention. At the top in figure 10-39 are receiving banks or console packages, which house several typing reperforators for use on incoming lines in torn-tape relay centers. The operator logs each incoming message, tears it off at the end of the message, and determines the proper outgoing circuit from the routing indicators on the tape. He then hand-carries each tape to the appropriate sending bank of automatic transmitter distributors (bottom, fig. 10-39), and inserts it in the appropriate circuit tape grid (visible at tops of sending banks). The tape grid—sometimes called a washboard because of a certain similarity of appearance—is simply a place where tapes can remain during the period they are awaiting retransmission. They are stowed from top down in order of precedence. Other operators in attendance at the sending bank remove waiting tapes from the grid in order of precedence, and insert them in the TDs. A numbering TD applies a sequential channel number to each message, thus keeping a record of traffic relayed over each channel.

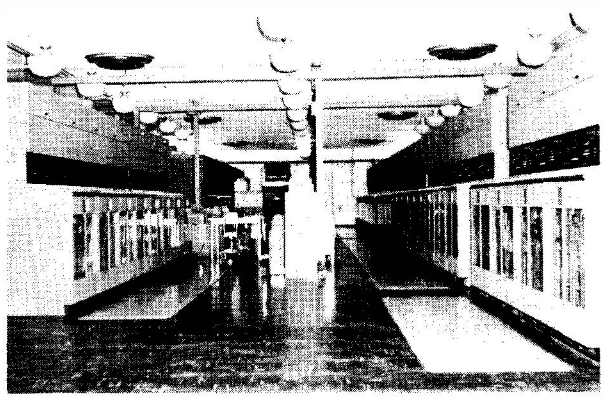


31.30
Figure 10-39.—Receiving and transmitting consoles at a torn-tape relay center.

If duplicate copies of relayed traffic are required for the files, monitoring equipment (not shown in fig. 10-39) is used. This is a group of typing reperforators that produces duplicates of tapes undergoing transmission on the sending bank, and winds the monitor tapes on reels suitable for stowage. The monitoring equipment also duplicates the channel number for each message, providing a means of reference if the message should be needed in the future.

## FULLY AUTOMATIC RELAY EQUIPMENT

High-speed automatic relay centers are equipped with the very latest model 28 teletypewriter components. The transmitter distributors and reperforators are enclosed in cabinets that also contain the operating controls. Figure 10-40 shows the equipment layout at an automatic relay center. At left are the incoming line cabinets; outgoing line cabinets are at right. At center are the supervisor's control position and the miscellaneous intercept section. There are two reperforator-transmitters in each incoming cabinet. They slide out of the cabinet for easy replacement in event of failure. The reperforator-transmitters operate at a cross-office speed of 200 wpm. Therefore, messages are relayed from the incoming line cabinets to the outgoing line cabinets in a matter of seconds. When necessary, a third machine can be assigned to an outgoing circuit, to which high-precedence messages can be switched. The equipment is designed to "recognize" high-precedence tapes; a message in this "priority" machine causes its transmitter to take control of the line as soon



31.31
Figure 10-40.— Automatic relay center.

as any message in progress is transmitted. The transmitter retains control until it has processed all urgent messages awaiting transmission. Only then does control revert to the two regular machines.

Traffic volumes to be delivered to a given destination may often exceed the capacity of one outgoing-line channel. In such an event as many as 10 machines and 10 line channels may be shifted to serve a single destination.

All lines are duplex circuits; that is, any station can transmit a message to the relay center at the same time it is receiving a message. Each tributary station normally has two teletypewriters; one is a sending machine and the other a receiving-only teletypewriter.

Automatic relay centers are manned by very few operators, compared with semiautomatic torn-tape relay stations. Improperly prepared or garbled message tapes are routed automatically to the intercept position (fig. 10-41) for operator action. Correctly prepared messages enter and leave the relay center untouched by human operators.

31.32
Figure 10-41. —Intercept section of automatic relay center.

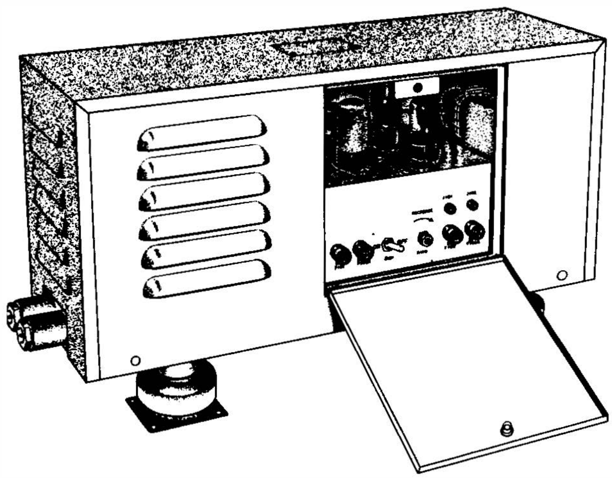
To reduce the frequency of supplying the reperforators with fresh tape, the machines use a 3000-foot tape supply roll, instead of the usual 1000-foot roll.

## ASSOCIATED EQUIPMENT

Teletypewriter 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 radioteletypewriter transmission and reception. Let us now get acquainted with the patch panels, keyers, converters, and other equipment necessary for RATT operation.

## RECTIFIER POWER SUPPLY

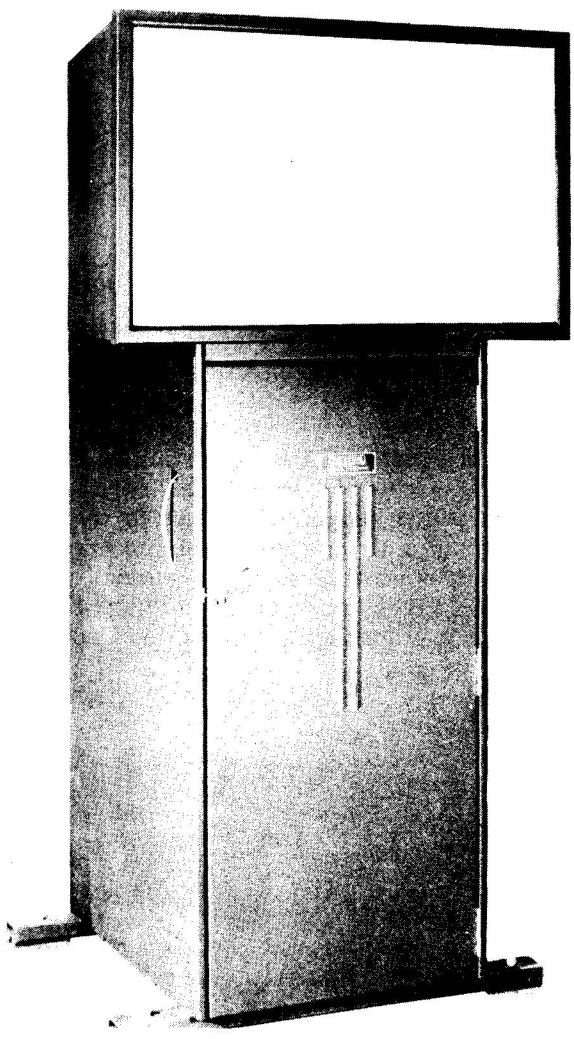
Although teletypewriter motors operate on alternating current, a source of direct current is always required for the signal circuit carrying the start-stop code intelligence. Figure 10-42 shows one model rectifier power supply installed aboard ship to rectify alternating current, changing it to d-c for the operation of teletypewriters and converters. This rectifier furnishes a power output of 120 volts d-c at 1.0 ampere, which 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.



31.33
Figure 10-42.—Rectifier power supply for teletypewriter operation.

## TELETYPEWRITER PROJECTOR UNIT

Teletypewriter projector unit model TT-71 shown in figure 10-43, enables a teletypewriter message to be read simultaneously by groups of persons. It is installed in the pilot ready rooms in aircraft carriers and in teletypewriter conference rooms ashore.



31.34
Figure 10-43.— Teletypewriter projector unit model TT-71.

The bottom of the cabinet houses a page printer. The message is printed on a roll of transparent cellophane. An optical lens system 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 you would install a roll of paper in an ordinary printer, except that the loose end must be started on an automatic takeup spool. The optical unit is focused easily and does not often need refocusing.

The screen size limits the length of the typing line to approximately half the normal line length. You must remember this whenever you are 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 you of this shortened line length.

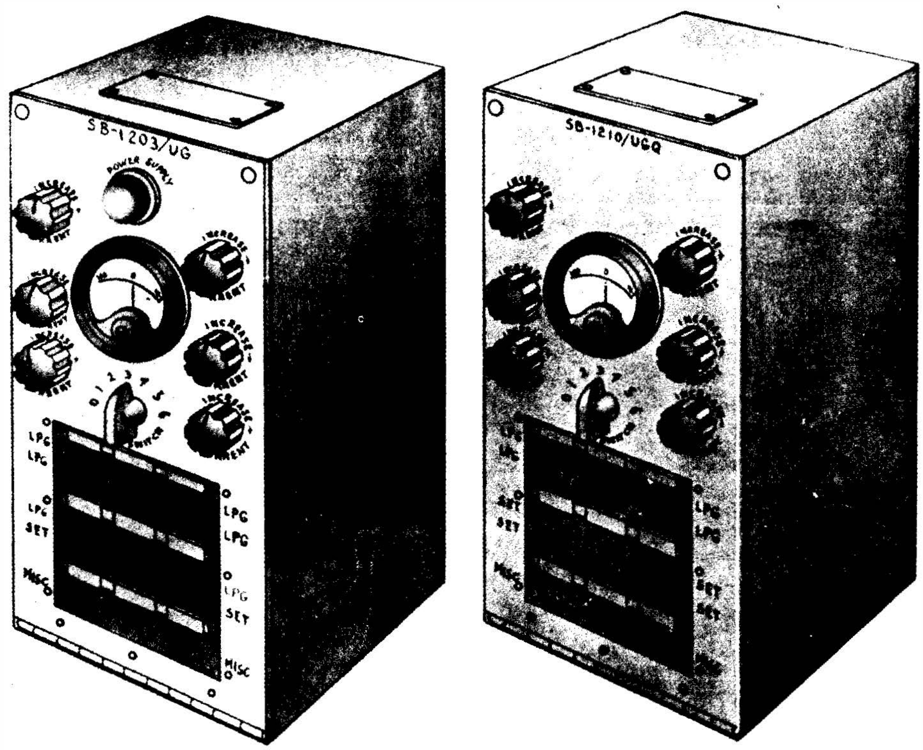
## TELETYPE PANELS

Teletype panels SB-1203/UG and SB-1210/UGQ, shown in figure 10-44, are used for interconnection and transfer of teletypewriter equipment aboard ship 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/UG is a general-purpose panel.

Each of the panels contains six channels, with each channel comprising a looping series circuit of looping jacks, set jacks, and a rheostat for adjusting line current. The number of looping and set jacks in each channel varies with the panel model. Each panel includes a meter and rotary selector switch for measuring the line current in any channel. There are six miscellaneous jacks to which may be connected any teletypewriter equipment not regularly assigned to a channel.

To operate 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.



70. 79(76)
Figure 10-44.— Teletype patch panels SB-1203/UG and SB-1210/UGQ.

4. Turn the meter selector switch to the desired channel and adjust the corresponding rheostat to give a line current indication of 60 milliamperes.

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.

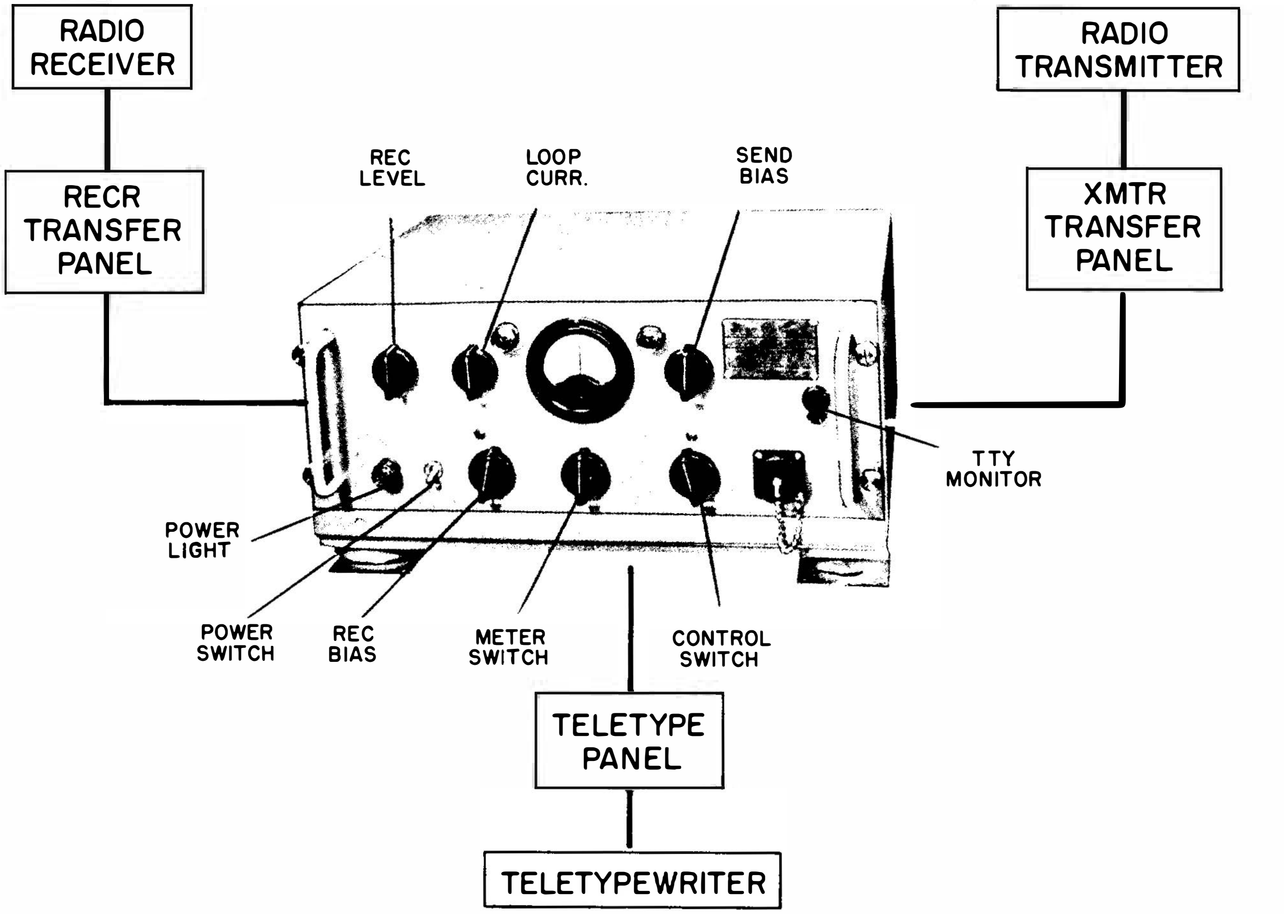
In any switching operation between the various plugs and jacks of a teletype panel, remember to never pull the patch plug from the machine (set) jack before first removing the other end of the cord plug from the loop jack. Pulling the plug from the set jack first will open-circuit the channel and cause 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.

## 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 10-45, with blocks to indicate other equipment necessary for a complete tone-shift system.

In 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




1.240
Figure 10-45.— Tone-shift keyer/converter AN/SGC-1A.

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 teletypewriter.

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 milliamperes 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 and the other (red) indicates the transmit condition. Both lights are off when the keyer/converter is in the standby condition.

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 teletypewriter loop when sending a message.

At the far right is a jack marked TTY MONITOR. A monitoring teletypewriter 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. When in the standby condition, the reception of an incoming mark tone causes the control circuit to change to receiving. Following the end of the incoming message, the circuits shift back to standby. When in the standby condition, the operation of the local teletypewriter causes the circuits to change to transmit. After the last letter is keyed, there is a time delay of about 3 seconds 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 AUTO position. After a station has completed 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 because it locks the equipment in the transmit condition and makes it impossible to receive any message.

The REC/STDBY position of the control switch prevents the equipment from changing to the transmit condition even though the teletypewriter is operated, but it can receive messages or remain in the standby condition.

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 the operation of the control circuits of the 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.

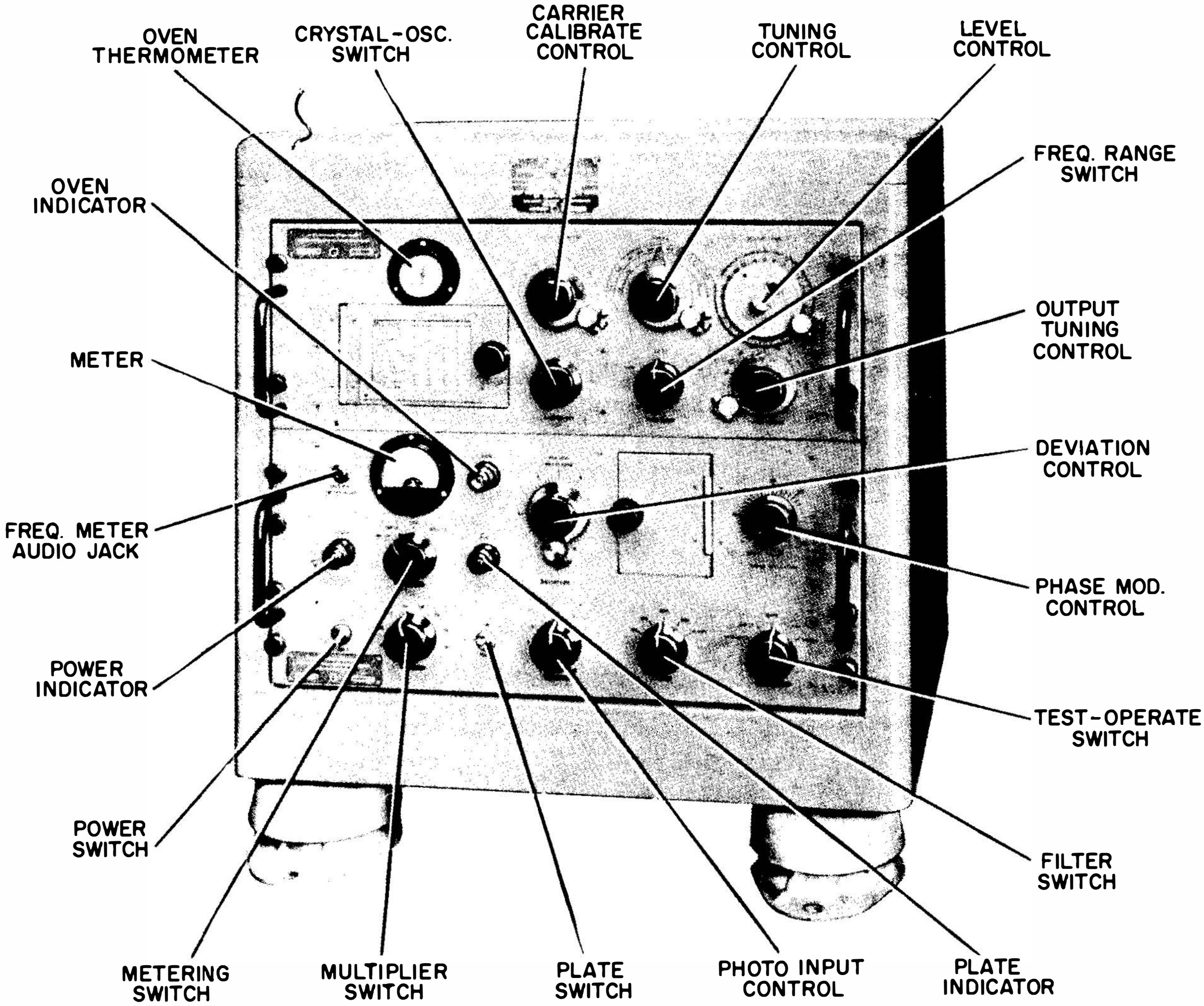
FREQUENCY-SHIFT KEYER

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 teletypewriter code. Such a frequency-shift keyer is model KY-75/SRT shown in figure 10-46.

During frequency-shift keying operation, the frequency of the transmitter's carrier appears at a certain frequency during s SPACE signal and shifts a few hendred 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 cycles per second. Usually, the keyer is adjusted for an 850-cycle shift, which 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 is that of adjusting the crystal oscillator and tuned circuits of the keyer to the desired crystal frequency. A signal from the teletypewriter is then applied to the keyer where it is frequency modulated and then 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 transmitters, such as the AN/SRT-15 described in chapter 9, have built-in keying circuits for frequency-shift mode of operation and do not require an external keyer for either RATT or facsimile transmission.




31.35

Figure 10-46. — Frequency-shift keyer KY-75/SRT.

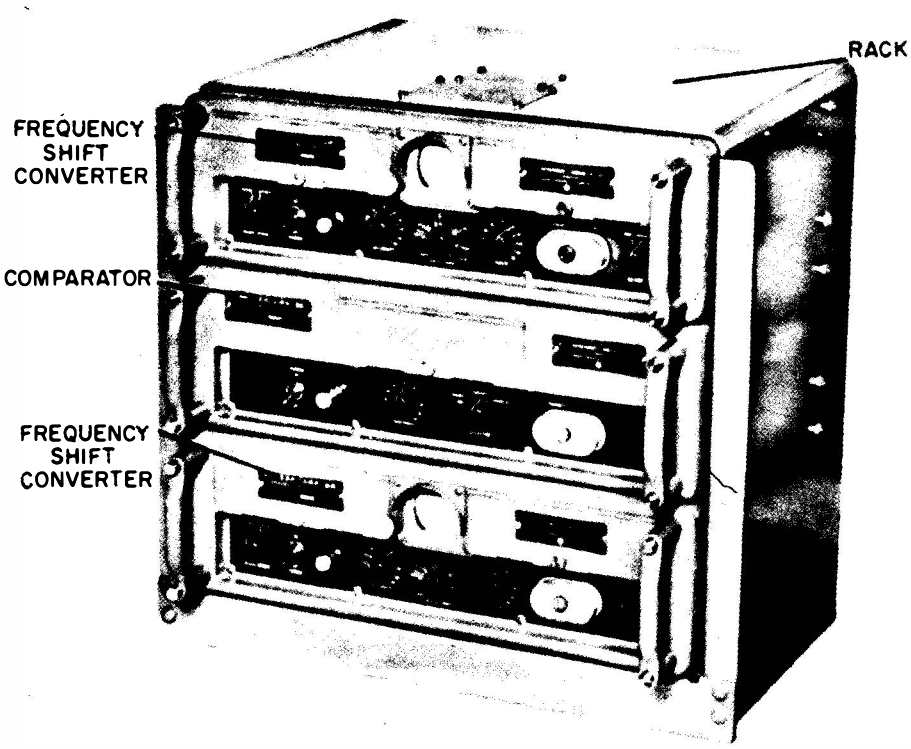
CONVERTER-COMPARATOR GROUPS

The AN/URA-8B frequency-shift converter-comparator group, shown in figure 10-47, 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).

For either space diversity or frequency diversity reception, two standard Navy receivers are employed in conjunction with the converter-comparator group. 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 comparator, an automatic circuit compares the pulses and selects the better mark and the better space pulse for each character. The output of the comparator is patched to the teletypewriter. The converter



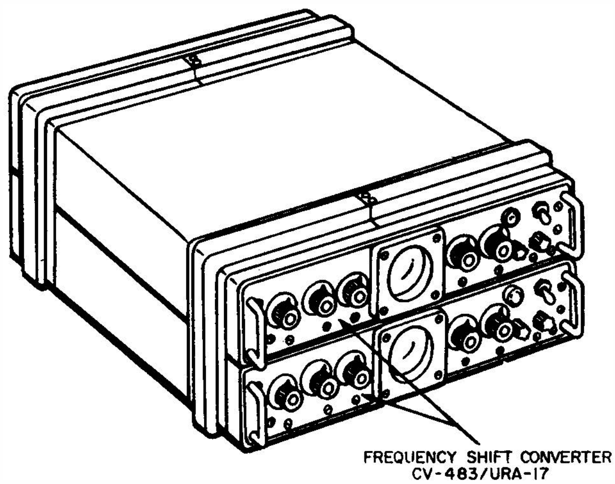

1.235
Figure 10-47.— Frequency-shift converter-comparator group AN/URA-8B.

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 10-48. This is a completely transistorized equipment 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, there are relatively few installations compared with the larger number of AN/URA-8B converters.

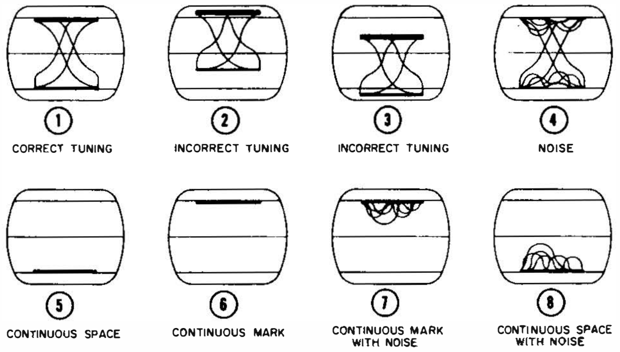
The AN/URA-17 consists of two identical converter units. Each converter has its own comparator circuitry. Hence, a separate comparator unit is not required. The physical size of the AN/URA-17 is further reduced by using transistors and printed circuit boards. The complete equipment is less than half 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




50.766
Figure 10-48. — Converter-comparator group AN/URA-17.

indication of the receiver tuning. The scope patterns for correct and incorrect tuning are shown in figure 10-49.



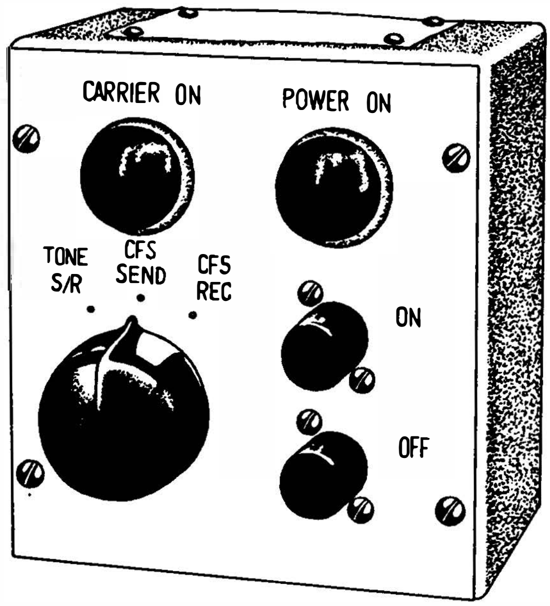

1.239.3
Figure 10-49.—Monitor oscilloscope patterns for frequency-shift converters.

Detailed instruction for operating the AN/URA-8B and the AN/URA-17 are contained in their respective technical manuals.

## TRANSMITTER TELETYPEWRITER CONTROL UNIT

Another piece of equipment used with teletypewriter installations aboard ship is the control unit shown in figure 10-50. This unit is mounted close to the teletypewriter 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.




1.244.1
Figure 10-50.— Transmitter teletypewriter control unit.

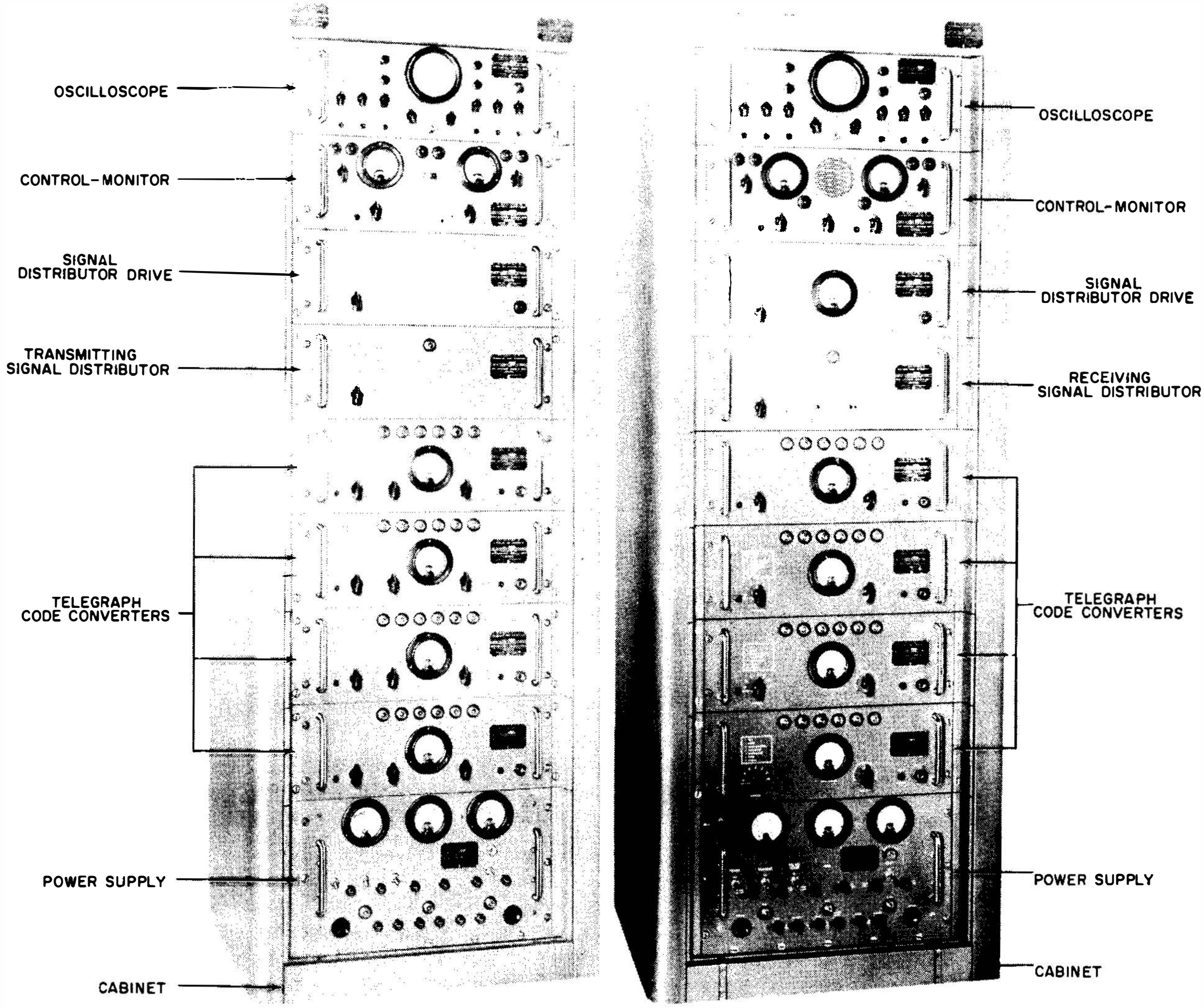
## ELECTRONIC MULTIPLEX TERMINAL SET

Model AN/FGC-5 (fig. 10-51) is a send-receive electronic time-division multiplex terminal set used chiefly for teletypewriter 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. Teletypewriter 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 10-51, AN/FGC-5 consists of two equipments, the telegraph transmitting group and the telegraph receiving group. These terminal equipments do 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 reception. You may think of the AN/FGC-5 transmitting group as the keyer, and the receiving group as the converter in the simpler RATT systems described previously.

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, 60-wpm channel speed is used, although the units and the teletypewriters can be changed to operate at 75 wpm.



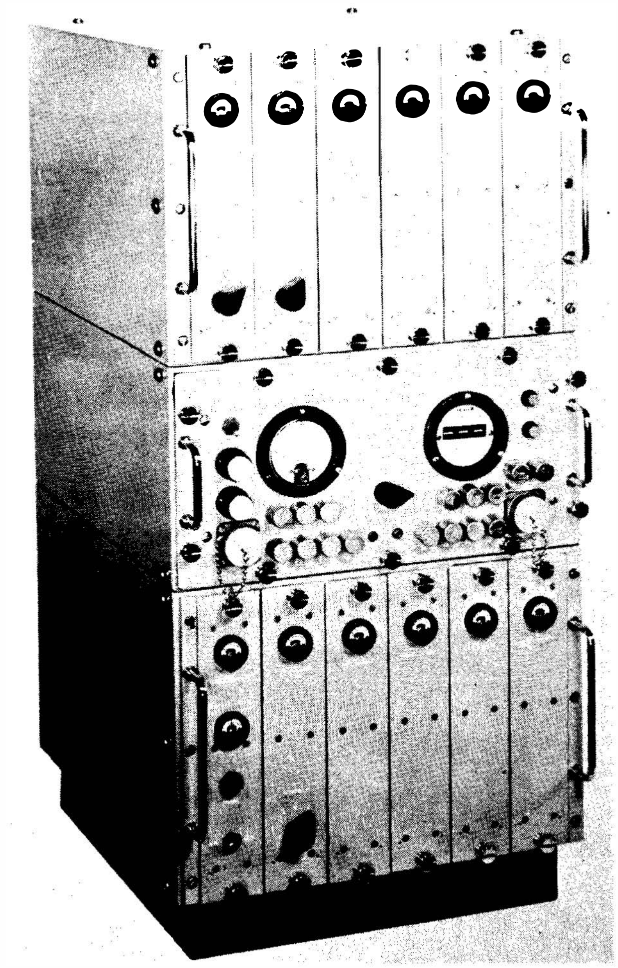

31.36
Figure 10-51.— Electronic multiplex telegraph terminal set AN/FGC-5.

A newer telegraph terminal set is model AN/UGC-1 (fig. 10-52). It is a completely transistorized version of the AN/FGC-5. The receiver group, transmitter group, and a common power supply are all housed in a single cabinet only 36 inches high. It is only one-fourth the size of the complete AN/FGC-5 equipment, with which it is operationally compatible. The AN/UGC-1 offers a choice of 3 system channel speeds: 60, 75, or 100 wpm per channel, and either 2, 3, or 4 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 (not illustrated). Multiplexing is accomplished by frequency division. The equipment has the capability of 16 narrow-band channels or 8 narrow-band channels and 4 narrow-to-wide-band channels, in the frequency range of 300 to 3300 cps. Spacing between channels is 170 cps.

## RATT SYSTEMS AFLOAT

Let us now see how the various pieces of equipment—teletypewriters, keyers, converters, receivers, and transmitters—are combined into complete RATT systems. The Navy uses two

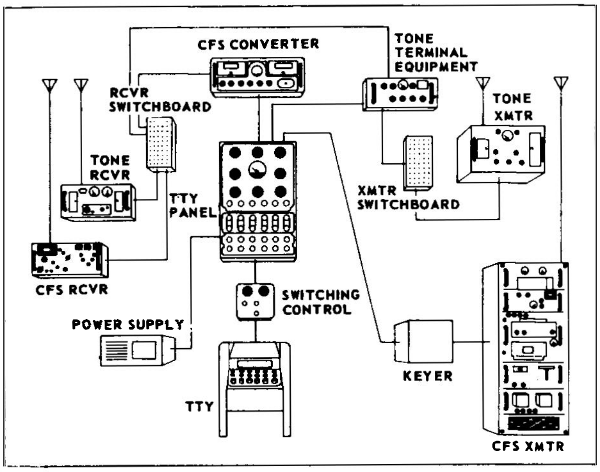


31.37
Figure 10-52.— Transistorized electronic multiplex telegraph terminal set AN/UGC-1.

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 integrated in figure 10-53.

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, as you know, 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

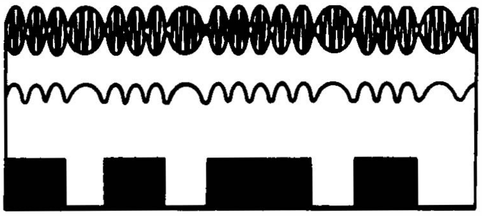



1.225
Figure 10-53.— Basic RATT transmit-receive systems.

joined by wire, operation is more complex. Direct-current mark and space intervals cannot be sent through the air.

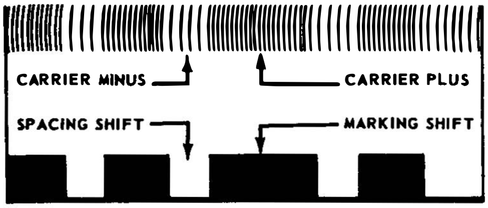
The gap between the machines must be bridged by radio. To bridge the gap, a radio transmitter and receiver are needed. The transmitter produces a radiofrequency carrier wave to carry the mark and space intelligence. Also, a device such as a KEYER is needed to change the d-c pulses from the teletypewriter 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 10-54 shows a modulated carrier wave with audio tone impulses impressed on the radiofrequency carrier wave, with corresponding d-c mark and space signals.



1.227
Figure 10-54.— Modulated carrier wave with corresponding audio tone for mark and space electrical impulses.

Figure 10-55 shows a carrier-frequency-shift wave that increases and decreases to denote mark and space d-c impulses.

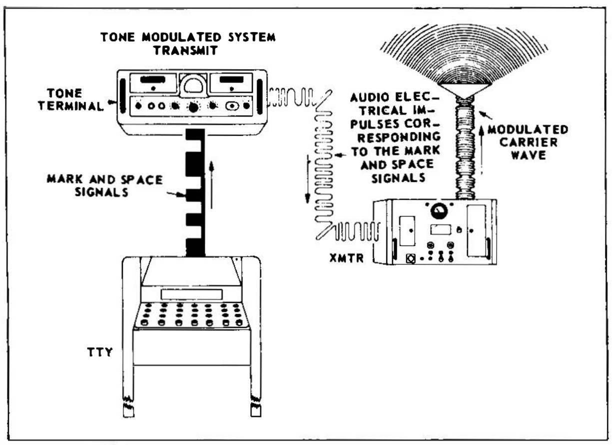



1.227
Figure 10-55.— Frequency of the carrier wave increases and decreases corresponding to mark and space impulses.

In the operations shown in figures 10-54 and 10-55, the 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.

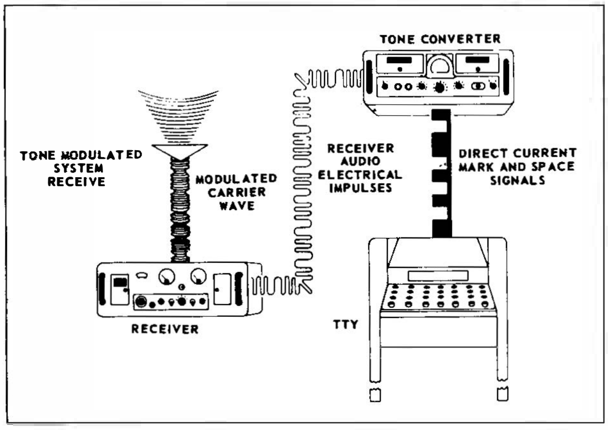
SHORT-RANGE SYSTEM

To transmit messages by the short-range system, a page printer, a tone terminal, and a transmitter are used. The 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. 10-56).




1.228
Figure 10-56.— 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. 10-57).



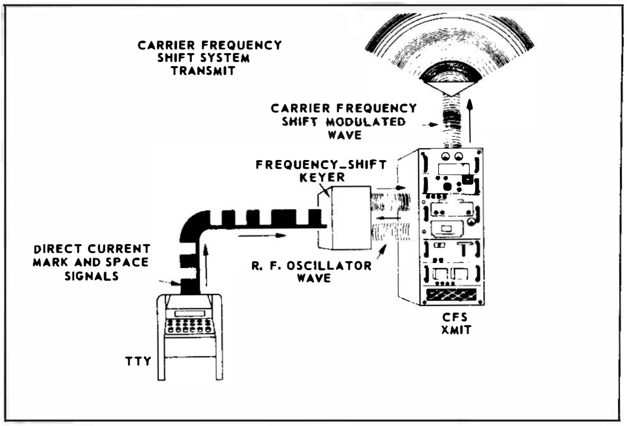

1.229
Figure 10-57.— Receiving operation of the tone converter.

In practice, the same tone terminal is used for the receiving and the sending circuits inasmuch as it contains both a transmit "keyer" unit and a receive "converter" unit.

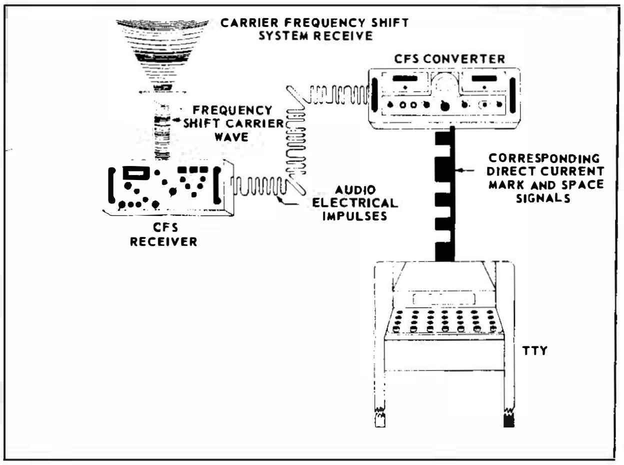
LONG-RANGE SYSTEM

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 the newer transmitters, but in some older systems it is a separate piece of equipment. When the page printer is operated, the d-c mark and space signals are changed by the keyer unit into frequency-shift intervals. The frequency-shift intervals are transmitted as carrier-frequency-shift signals (fig. 10-58).

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. 10-59).




1.230
Figure 10-58.— D-C mark and space impulses are changed by the keyer unit into frequency-shift intervals.




1.231
Figure 10-59.— Conversion of frequency-shifted carrier wave into mark and space impulses.

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.

## TAPE READING

In order to read perforated tape, you must understand arrangement of code positions. The code is a five-unit mark-space signaling code arranged vertacally 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. 10-60). This smaller perforation fits over the tape feed wheel that moves the tape through the transmitter-distributor, and is NOT a part of the code. 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 than two perforations will appear above the track, nor more than three below. In figure 10-60 the positions are numbered from 1 to 5. This is for study purposes: don't expect these numbers to 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.

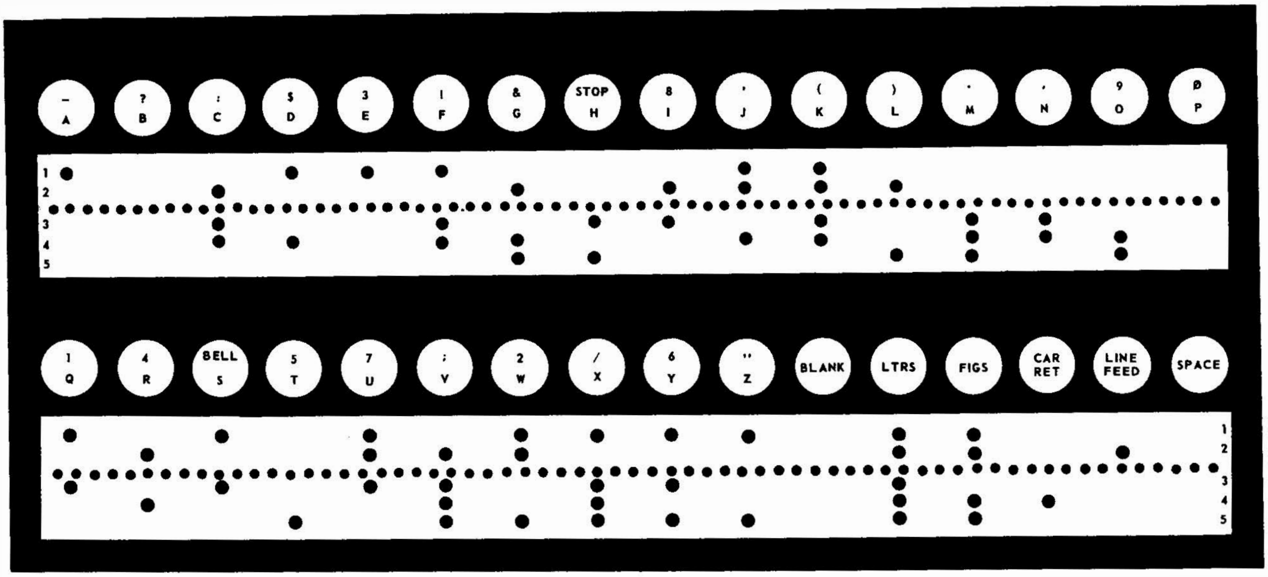
Read the perforations in lowercase until a FIGS code appears. Following a FIGS code read the tape as uppercase until a LTRS code appears, after which read as lowercase again. On circuits on which machines unshift on spacing, read codes in lowercase following the space code.

Memorize several codes at a time, learning the uppercase characters for each. Perforate strips of tape and read the codes you have memorized. Association of memory and eye will help you recognize codes quickly and will build reading speed.

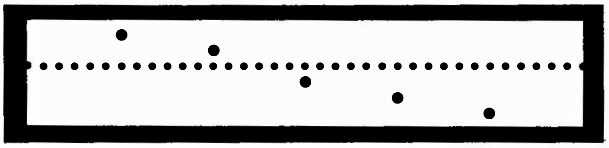
The discussion and illustrations following provide a study plan for learning the code. Begin by learning the 1-HOLE codes: E, LF, SPACE, CAR RET, and T (fig. 10-61). Letter E is perforated in the No. 1 position, and the remainder of the positions are blank. LINE FEED is one perforation in the No. 2 position—and 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.

Your next group is of three key letters: A, O, and N.

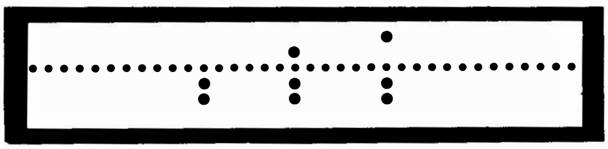
Check figure 10-62. The letter A is represented by two holes above the track. This pattern—two holes above the track—is




31.38
Figure 10-60.— The 5-unit teletypewriter code.

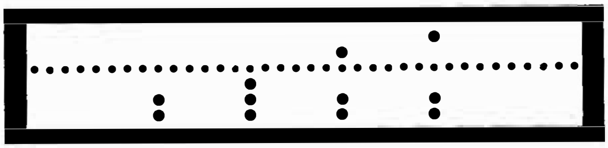


31.39
Figure 10-61. —The 1-hole codes: E, LF, SPACE, CAR RET, and T.



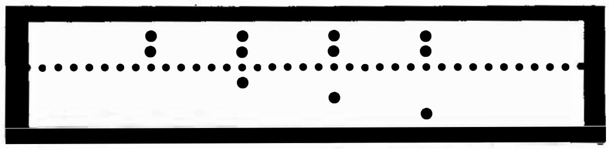
31.40
Figure 10-62.— Letters A, U, J, and W.

also characteristic of U, J, and W; read DOWN to find which. In the same way (fig. 10-63) O is



31.41
Figure 10-63.— Letters O, M, G, and B.

common to M, G, and B, but this time read UP to get the associated codes. The final letter of this series is N (fig. 10-64), which you read up for C and F.

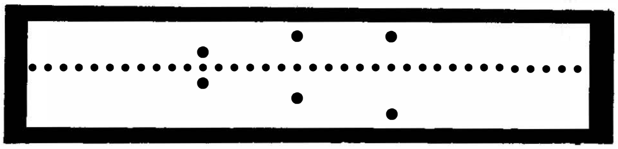


31.42
Figure 10-64. — Letters N, C, and F.

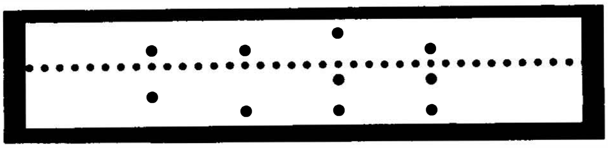
With this much information mastered, get plenty of practice before learning more letters. Perforate the codes and, as your reading improves, mix them to make the reading more difficult. Emphasize ACCURACY, not speed. If you haven't the opportunity to work with a perforator, draw the codes on 3x5 cards (with answers on back) and scramble them.

You can learn three more sets of letters 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. 10-65). Learn R and use it to read L; learn Y and read P (fig. 10-66).

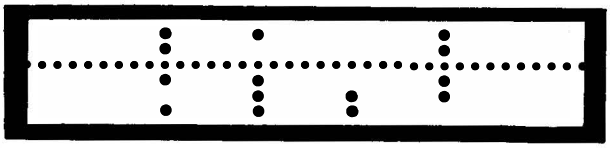
Eight letters that you can master by remembering them as opposites are Q and X, V and K, H and S, E and T (figs. 10-67 and 10-68). Letters E and T, remember, are also among the one-hole codes.



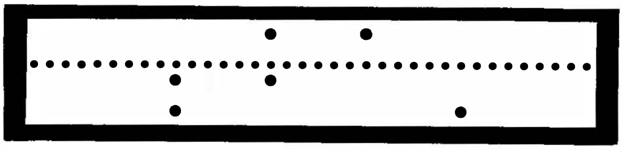
31.43
Figure 10-65.— Letters I, D, and Z.



31.44
Figure 10-66.— Letters R and L; Y and P.



31.45
Figure 10-67.— Letters Q and X; V and K.



31.46
Figure 10-68.— Letters H and S; E and T.

Two keys you will use a great deal are LTRS and FIGS, which shift your machine 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 there are two perforations above the track, and two below, with only the No. 3 position blank.

# CHAPTER 11

# TELETYPEWRITER PROCEDURE

Before discussing teletypewriter and tape relay procedures, a brief description of the network in which these procedures are employed is necessary.

As you learned in chapter 2, the Naval Communication System is the Navy operated portion of the DCS, and includes all shore-based communication activities and the fixed circuits (landline and radio) that bind them into a worldwide network. The majority of these fixed circuits are teletypewriter circuits. Collectively they are called the Naval Teletypewriter Tape Relay Network (NTX). Figure 11-1 is a schematic drawing of the NTX portion of the Defense Communication System Teletypewriter Network. Normally, ship-to-ship and ship-to-shore teletypewriter circuits are not a part of the NTX.

The communication activities of the NTX are primary, major, and minor communication centers, and tributary stations (independent message centers). These activities and their functions are described in chapter 2.

Each communication center maintains a tape relay station that receives and forwards messages in tape form by means of semiautomatic and automatic relay equipment. The relay station does not originate messages, except those relating to traffic handling (such as service messages and supervisor wirenotes), nor receive them as addressees. The message center belonging to the same communication center as the relay station originates and receives all messages for the communication center.

Tributary stations are activities connected electrically to the tape relay network through some relay station. Tributaries have no relay responsibilities. They are the points from which a large part of the NTX traffic originates, and to which it eventually goes for final delivery to addressees. Tributaries are located where there are Navy activities that need the services of the NTX. Typical places are depots, receiving stations, training centers, and so on. Even a flagship may temporarily become a tributary.

The network presently has both classified (on-line) and unclassified (off-line) relay stations. As cryptographic equipment becomes available, though, the entire network is being converted to on-line operation.

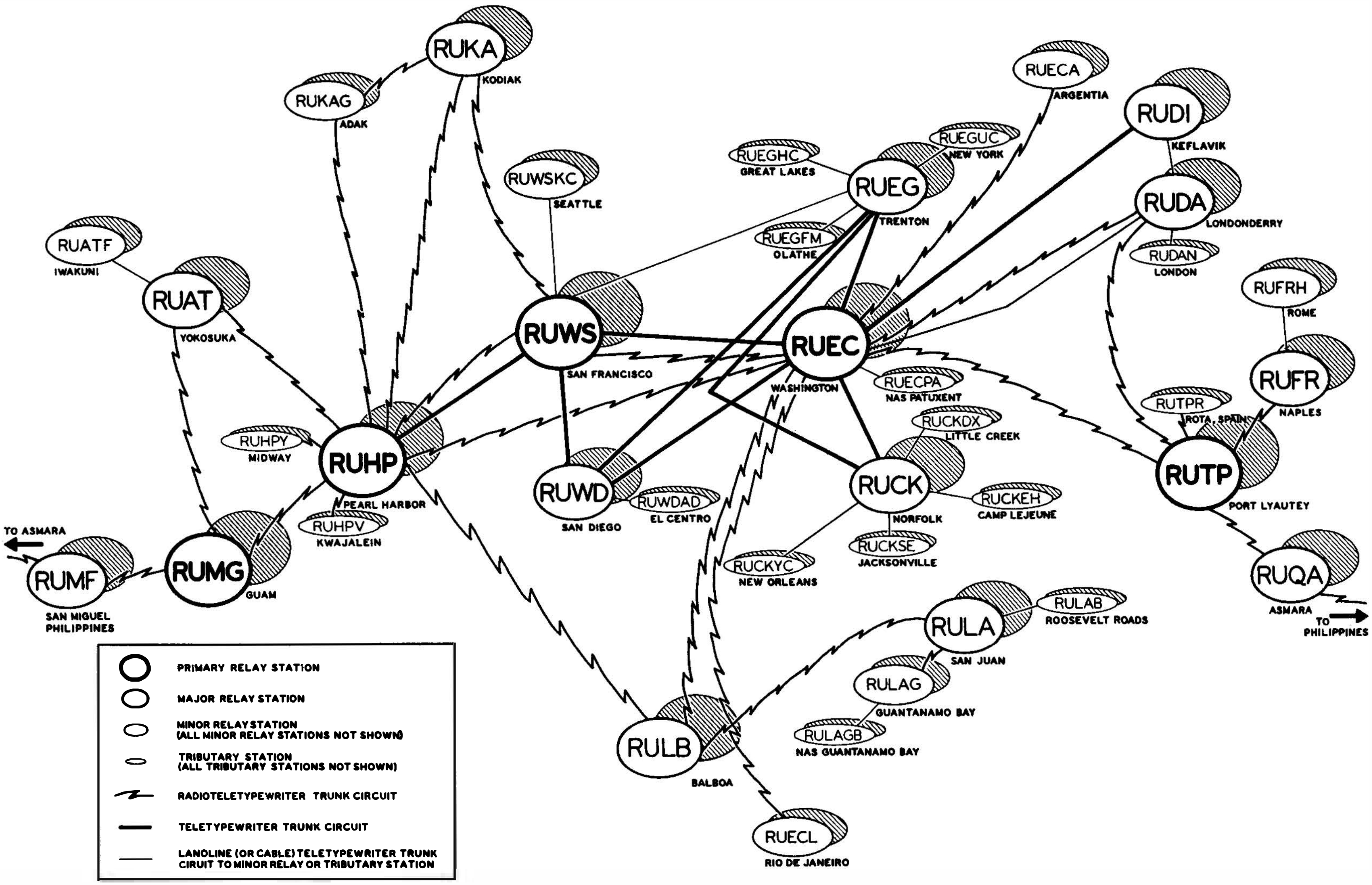
## AUTOMATIC RELAY

In chapter 2 you learned that there are five automatic relay stations in the Navy's tape relay network. They are located at Trenton, N. J., Cheltenham, Md., Norfolk, Va., San Diego, Calif., and Stockton, Calif.

The automatic switching equipment installed in these relay stations is designed to relay only those message tapes that meet certain requirements. In certain critical portions of an incoming tape, the equipment senses each character (letter and function) to determine the message routes and to guard against nondelivery resulting from garbles or improper character sequence. Any deviation from prescribed procedure, including omission or insertion of machine functions, results in a rejected message.

Messages rejected by the equipment are shunted to a miscellaneous intercept position for service action. When rejections occur, delay is inevitable and, depending upon the traffic load and number of rejects, the delay may amount to hours.

You must bear in mind that automatic relay stations are manned by very few operators. If your message is not punched correctly and the precedence is lower than IMMEDIATE, the relay station does not reprocess and correct it for you. Your station is notified by service message to transmit a correctly prepared tape, and you will have to repunch the message. It is most important, therefore, that you learn and always use the correct teletypewriter procedure.




31.52

Figure 11-1. —U.S. naval teletypewriter tape relay system.

Even if your tributary station does not work directly into an automatic relay station, your messages enter the automatic system if there are addressees in the continental United States.

The sequences of letter, numeral, and machine function characters required for automatic system operation are shown in message examples later in this chapter.

## TORN TAPE RELAY

Torn tape relay is a term derived from the manner in which message tapes are processed at a semiautomatic relay station. At such stations, incoming message tapes are received on a reperforator, torn from the reperforator by the operator, and hand-carried to the outgoing circuit. Hence, torn tape relay means that the tape actually is torn at the receiving machine, and is transferred to the outgoing machine by hand.

An operator at a torn tape relay station usually is assigned to operate several circuits in the immediate vicinity of one another. He is responsible for all traffic passed over these circuits; maintains a separate message log for each circuit; screens all messages for obvious errors or garbles; makes certain that messages given him for transmission are transmitted on the circuit indicated; and disposes of incoming messages in accordance with the practices of his particular station.

Except for a slight difference in format line 1, the message format for torn tape relay is identical to the format for automatic relay. We will discuss this difference when we take up the message format.

## ROUTING INDICATORS

In order to move tape relay 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 from four to seven letters, following 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 either the letter R or U. These letters, in that order, show whether the message will be handled by the worldwide communication network or will travel over a net serving some local area. Messages with routing indicators beginning with the letter U do not enter the worldwide system. 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 its 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. There are 15 such areas. Following is a list of the letters used to designate each.

A--Eastern Asiatic area, including Japan and Korea;
C--Central United States;
M--Southwest Pacific area, including the Philippines and Marianas;
Y--Australian-New Zealand area;
K--Alaskan-Aleutian area;
H--Central Pacific area, centered on the Hawaiian Islands;
W--Western United States and Canada; Mexico;
E--Eastern United States and Canada; Greenland;
L--South American and Caribbean areas;
D--British Isles and Iceland;
F--European area;
T--Northwest African area;
Q--East African, Arabian, Turkish, and Iranian areas;
V--South African area below equator;
S--Western Asian area, including India.

Zone boundaries are laid out according to latitude and longitude; but, despite area boundaries, a tributary must carry the same area designator as the parent relay station, regardless of location. For example, although in a different zone area, the Naval Air Station in Olathe, Kansas (C zone) is assigned a routing indicator from major relay Trenton, N. J. (E zone).

Fourth and subsequent letters (except for and special suffixes) designate relay and tributary stations. Four-letter indicators designate either primary or major relay stations. The fourth letter does not distinguish between the two, however. (Although A is assigned as the fourth letter to the major relay station at Asmara, and some alphabetical connection can be seen in some of the other assignments, they are not assigned alphabetically.)

Following are breakdowns of the routing indicators for (1) a primary station, RUMG, and (2) a major station, RUAT.

R--Worldwide network;
U--U. S. facility;
M--Southwest Pacific;
G--Primary relay station (Guam, Mariana Islands).
R--Worldwide network;
U--U. S. facility;
A--Eastern Asia;
T--Major relay station (Yokosuka, Japan).

Routing indicators containing four letters always mean a primary or major relay station. These four-letter indicators form the basis for every routing indicator in the tape relay network. If you learn the geographical location of the relay stations and their routing indicators, you will have no trouble routing or relaying NTX messages.

Fifth and subsequent letters of a routing indicator designate a minor relay station or a tributary of some primary or major relay station. You will have to look it up to know which one it is. A minor relay station always has a five- or six-letter routing indicator, the first four letters of which are identical to the indicator of the primary or major station into which it feeds. The minor relay station RUKAG at Adak, Alaska, for example, feeds into the major relay station RUKA, Kodiak.

Routing indicators simplify message handling in semiautomatic relay systems because operating personnel do not need to look up locations of distant addressees to relay the message properly. Assume that NAS Patuxent River originates a message addressed to NAS Guantanamo Bay--served by the tributary station RULAGB. (Refer to fig. 11-1 to follow this example.)

The first relay point is Washington (relay station is located at Cheltenham, Md.), where the message is received in the automatic relay center but must be transferred to the semiautomatic relay section that handles overseas traffic. An operator in the semiautomatic relay station, seeing that the routing indicator begins with the letters RULA, knows that the message goes to the major relay station at San Juan, P.R., and forwards it to RULA through the facilities of RULB. At San Juan, RULA, the operator knows that the next letter, G, designates the minor relay center at Guantanamo Bay. At Guantanamo, RULAG, the operator knows that the last letter, B, designates the Naval Air Station, and forwards the message to that tributary.

SPECIAL SUFFIXES

The letter C, and all two-letter combinations CA through CZ, are reserved for suffixes to routing indicators. Additionally, the two-letter combinations SO, SU, and SX are used as routing indicator suffixes by the U. S. Air Force only. There is a prescribed meaning for each suffix. Suffixes aid routing of tapes for processing purposes or localized action by the relay station or any of its supplementary sections or facilities. A list of suffixes and their meanings follows. Those authorized for Navy use are so indicated in ACP 117 CAN-U. S. SUPP-1.

C--Local delivery or refile in page form is required.
CF--Section accomplishing delivery by broadcast methods.
CI--Section coordinating routing information.
CM--Section preparing tape copies for retransmission.
CN--Electrical conference facility or section.
CR--Cryptocenter.
CS--Section dealing with service messages.
CT--Section effecting delivery by telephone.
CU--Section using tape relay for delivery to commercial carriers.
CW--Section relaying by radiotelegraph.
CX--Section using tape relay for refile to activities served by teletypewriter exchange systems.

Following are two examples of suffixes as used with the routing indicator of the primary COMMCEN Washington, D. C. (RUEC).

RUECC--Primary message center, COMMCEN Washington,
RUECCR--Cryptocenter, COMMCEN Washington.

## PUBLICATIONS

Publications of principal importance to NTX operators are the effective editions of ACP 127 (with United States supplement), ACP 117 (with Canadian and United States supplements), and DNC 5. Tape relay procedure is dealt with in ACP 127 and DNC 5. Routing indicators are listed in ACP 117.

Supplements actually are separate publications, issued by the 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 the United States tape relay networks. In ACP 117 CAN-U. S. SUPP-1 (a Joint supplement) are listed the routing indicators of the teletypewriter stations belonging to the United States and to Canada. The ACP 117 U. S. SUPP-1 contains instructions for routing U. S.-originated messages to military and nonmilitary activities that are not assigned a routing indicator in the CAN-U. S. SUPP-1.

At the 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 the 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 the current routing information. They also provide more space for entering the frequent routing indicator changes than is available on a fixed, printed page.

## MACHINE FUNCTIONS

Machine functions are of the utmost importance in teletypewriter operation. Because some functions do not show up on the printed page copy of the message, you may wonder why it is necessary to use them at all. Remember that NTX messages are relayed in tape form; machine functions play an important part in efficient operation of the tape relay system.

An explanation of the machine functions and the rules for their use are given in the ensuing six topics.

### SHIFT (FIGS) AND UNSHIFT (LTRS)

Teletypewriter 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 the 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 teletypewriter.

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 (SPACE) 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 your own 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 examples in this chapter.

LINE FEED (LF)

The line feed function advances the paper on the page. You will 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. Consequently, correct procedure 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 teletypewriter perforator. The blank function is required in the operation of certain cryptosystems, but has no application in NTX 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 your guidance when preparing message tapes for transmission. Functions that usually are inserted by the automatic channel numbering unit are not included here, but are discussed in the next topic.

Machine functions that are a part of the 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, two carriage returns, and one line feed. The transmission must begin with the five spaces. Any tape feedout functions preceding the five spaces are not transmitted.

The 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 the line is also the end of a page of a long message. Then, the end-of-line functions are two carriage returns and four line feeds.

End-of-message functions are two carriage returns, eight line feeds, the letter N repeated four times, and 12 letters (functions). (The BL key is not used in lieu of LTRS, and any tape feedout in excess of 12 LTRS is removed before the 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 the message examples). Spacing between routing indicators in the routing line is particularly important because the routing indicators are sensed by the automatic switching equipment when it is determining message routes.

The lines of a teletypewriter message are limited to 69 characters, including spaces.

## MESSAGE NUMBERING

Aside from the DTG and any message identifying numbers (called cite numbers) in the text, the numbers assigned a message for identification purposes are of two types. They are station serial numbers and channel numbers.

STATION SERIAL NUMBERS

Teletypewriter 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.

The station serial number is a permanent means of message identification, and it remains the same regardless of whether the message is destined for one or many addressees. Communication activities that have occasion to refer to the message (to obtain repetitions, for example) cite the station serial number of the message as part of their identifying data. The station serial number is also 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 letter appears following the station serial number. Letter A usually is assigned the first channel. The next channel is designated B, the next C, and so on. For example, the station serial number 1Ø7B indicates a message transmitted over channel B of a teletypewriter station.

## CHANNEL NUMBERS

Another name for channel numbers is transmission identification (TI). You will see and hear both terms 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 the following: (1) the letter V; (2) the start of message indicator ZCZC; (3) the 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 once (and only once) in each transmission introduced directly into an automatic relay station.) Letters ABC are the station (AB) 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 that for the automatic system, except that the characters VV(3 SPACES) replace the start of message indicator. This substitution is made because the ZCZC serves no purpose unless automatic switching equipment is used.

## NTX MESSAGE FORMAT

Messages transmitted over tape relay circuits must be prepared in the NTX message format shown in table 11-1. The 15 format lines are explained briefly in the table, and are amplified in the following paragraphs.

Table 11-1. —NTX Message Format

| Parts | Components | Format line | Elements | Contents | Explanation */ |
|---|---|---|---|---|---|
| HEADING | PROCEDURE | 1 | Handling instructions. | Transmission identification.<br>Security warning prosign (when used).<br>Pilot - Pilots contain: Repeated precedence prosign**/. Routing indicator(s). Prosigns, operating signals and address designations***/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. |
| | | 2 | Called station(s). | Repeated precedence prosign**/.<br>Routing indicator(s) of station(s) responsible for delivery or refile. | Basic routing line. If message is dual-precedence, only the higher precedence is shown in this line. |
| | | 3 | Calling station and filing time. | Prosign DE.<br>Routing indicator of station preparing message for transmission.<br>Station serial number.<br>Filing time: Date separated by slant from hour and minutes expressed in digits followed by zone suffix. | Filing time is the date and time the message was filed with the communication center. |
| | | 4 | Transmission instructions. | Security warning operating signal (when used).<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. |

Table 11-1. — NTX Message Format—Continued

| Parts | Components | Format line | Elements | Contents | Explanation */ |
|---|---|---|---|---|---|
| | PREAMBLE | 5 | Precedence; date-time group; message instructions. | Precedence prosign(s). Date-time group and zone suffix (Z indicating Greenwich mean time). 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 | 6 | Originator. | Prosign FM. Originator's designation. | Message originator is indicated by plain language, routing indicator, address group, or call sign. |
| | | 7 | Action addressee(s). | Prosign TO. Routing indicator(s). Operating signal. 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. |
| | | 8 | Information addressee(s). | Prosign INFO. Routing indicator(s). Operating signal(s). Address designator(s). | Same as for line 7, except that line 8 pertains to information addressee(s). |

Table 11-1. — NTX Message Format—Continued

| Parts | Components | Format line | Elements | Contents | Explanation */ |
|---|---|---|---|---|---|
| | | 9 | Exempted addressee(s). | Prosign XMT, 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 | 10 | Accounting information: group count. | Accounting symbol (when required). Group count prosign GR. 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 | . . . . . . . . . | 12 | Classification; internal instructions; thought or idea expressed by originator (in that order). | . . . . . . . . . . . . . . . . | See ACP 121 series. |
| SEPARATION | | 13 | . . . . . . . . . . . | Prosign BT. | |
| ENDING | PROCEDURE | 14 | Confirmation. | . . . . . . . . . . . . . . . . | Not used in tape relay operation. |
| | . . . . . . . . . | 15 | Correction. | Prosign C. 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. |

*/ Included only when required for clarity.

**/ If message is dual-precedence, only the higher precedence is shown in this line.

***/ Plain language designators are not permitted in codress messages.

LINE 1: Because format line 1 contains the message transmission identification, its construction varies with the type of relay station into which you are transmitting. If you are transmitting into an automatic station, this line must include the start of message indicator (ZCZC).

The 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 text. (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 the 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 to multiple-address message, and the message requires 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. You must remember: When the FLASH precedence prosign is transmitted in the routing line, it is preceded by the bell signal.

LINE 3: Line 3 consists of the prosign DE, the routing indicator of the station preparing the message for transmission, the station serial number, and the date and time the message was filed with the communication center for transmission.

It is essential that the prosign DE follow immediately the two CRs and one LF at the end of the routing line (line 2). The automatic relay equipment is designed to stop seeking outgoing channels upon receipt of the letter D at the beginning of line 3.

LINE 4: The operating signal ZNR is transmitted as the first component in format line 4 of all unclassified messages (including off-line encrypted messages and service messages), except unclassified EFTO messages. When used in this manner, ZNR means "This message may be forwarded without change by radio or nonapproved circuit." The absence of ZNR indicates that the message is classified and must be transmitted over secure circuits.

When necessary, transmission instructions denoting transmission 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 the addressees, nor when delivery responsibility is indicated in the address portion of the message.

LINES 5 AND 6: See table 11-1 for explanation of format lines 5 and 6.

LINE 7: Line 7 is the action addressee line. It commences with the prosign TO and contains the address designations of commands or activities that are to take action on the message. Addressees normally are designated by plain language. But, as you will see in the message examples that follow this section, there are certain instances when the addressees are designated by both plain language and call signs or address groups.

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 is when the addressees are designated by a collective address designator or an address indicating group. Then, it is not necessary 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 designation.

LINE 8: The explanation of line 8 is the same as line 7, except that line 8 pertains to information addressees.

LINE 9: When necessary to exempt one or more addressees from a collective address designation appearing in lines 7 or 8, line 9 is utilized. Line 9 consists of the prosign XMT and the designator(s) of commands or activities exempted from the collective address designation.

LINE 10: In tape relay procedure, line 10 (group count) is included only when the text of the 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: The prosign $\overline{\text{BT}}$ appears in line 11. It separates the text from the message heading.

LINE 12: Line 12 is the text of the message. The first word of all plain language text 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. CLEAR indicates that the message is classified, but 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: The prosign BT appears in line 13. It separates the text from the 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 canceling the transmission (or destroying the tape) and starting the message again, the error is corrected in line 15. The correction consists of the prosign C, followed by the correct version of the error.

The end-of-message functions are a part of line 15. They follow any necessary corrections, and consist of two carriage returns, eight line feeds, the letter N repeated four times, and 12 letters functions. The end-of-message functions must be in the exact order indicated.

## NTX MESSAGE EXAMPLES

The 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. The format of the examples, however, gives the proper sequence of the message elements and of line functions used. End-of-line and end-of-message functions are in parentheses. The messages are prepared as they would appear when reproduced on a page printer set for single line feed.

## PLAINDRESS MESSAGE

A plaindress message carries the originator and addressee designations in the message heading. The message text may be plain language or encrypted. A group count is not required for plain language, but an encrypted message always carries a numerical group count.

As explained earlier, in line 7 the addressees of NTX messages normally are designated in plain language. Intra-Navy messages, however—those originated by and addressed to commands and activities served entirely by Navy-operated stations—destined for mobile units, such as ships and commands afloat, must indicate the mobile units by their call signs or address groups and by their plain language designations. You must remember that the foregoing method of addressing messages applies only to messages handled within the tape relay system. It does not affect the addressing of messages sent via CW (which are addressed by call signs/address groups), nor those sent via manual RATT (discussed later in this chapter). In addition, the only call signs/address groups authorized for use with their plain language equivalents are those assigned to U. S. Navy, Marine Corps, and Coast Guard units.

### Single-Address

Following is a plaindress version of a single-address message destined for a mobile unit (ship).

| Format line | | |
|---|---|---|
| | (5 SPACES 2CR LF) | |
| 2 | PP RUHPC | (2CR LF) |
| 3 | DE RUHPB 85 Ø1/Ø841Z | (2CR LF) |
| 4 | ZNR | (2CR LF) |
| 5 | P Ø1Ø837Z | (2CR LF) |
| 6 | FM CINCPACFLT | (2CR LF) |
| 7 | TO RUHPC/NWBJ/USS | (2CR LF) |
| | 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) |

| Format line | | |
|---|---|---|
| 12 | UNCLAS (continued) | (2CR LF) |
| | PRESCRIBED FOR INTRA- | (2CR LF) |
| | NAVY MSGS ADDRESSED | (2CR LF) |
| | TO MOBILE UNITS. | (2CR LF) |
| | 2. TRANSMISSION IN- | (2CR LF) |
| | STRUCTIONS ARE UN- | (2CR LF) |
| | NECESSARY BECAUSE | (2CR LF) |
| | DELIVERY RESPONSIBLE | (2CR LF) |
| | IS INDICATED IN ADDRESS | (2CR LF) |
| | OF MSG. | (2CR LF) |
| | 3. NOTE UTILIZATION OF | (2CR LF) |
| | LINE 15 TO CORRECT AN | (2CR LF) |
| | ASSUMED ERROR | (2CR LF) |
| 13 | BT | (2CR LF) |
| 15 | C WA PLAINDRESS | (2CR 8LF) |
| | SINGLE-ADDRESS | (2CR 8LF) |
| | NNNN | (12LTRS) |

Multiple-Address

A multiple-address message intra-Navy form appears in the next example. Plain language address designators are employed because all the addressees are stationary commands, and 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 3Ø15Ø5Z | (2CR LF) |
| 4 | ZNR | (2CR LF) |
| 5 | R 3Ø1455Z | (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. ADDEES NOT | (2CR LF) |
| | MOBILE UNITS | (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 introducing the message into the network. (It is called the refile station.)

Assume that a refile station receives an unclassified message via radiotelegraph. Prior to tape preparation, the station must (1) insert routing indicators in format lines 7 and 8, (2) convert the heading to authorized plain language address designators, and (3) retain the call signs/address groups for mobile addressees. These follow the routing indicators and precede the plain language designators.

The following exemplifies 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 Ø9/1542Z | (2CR LF) |
| 4 | ZNR | (2CR LF) |
| 5 | P R Ø91428Z | (2CR LF) |
| 6 | FM USS TUCKER | (2CR LF) |
| 7 | TO RUCKCF/SQBC/ | (2CR LF) |
| | COMDESRON 12 | (2CR LF) |
| 8 | INFO ZEN/COMDESDIV 121 | (2CR LF) |
| | RUCKHC/CINCLANTFLT | (2CR LF) |
| | RUEGNE/COMCRUDESLANT | (2CR LF) |
| | RUCKCF/E5TT/CTF 14Ø | (2CR LF) |
| 11 | BT | (2CR LF) |
| 12 | UNCLAS | (2CR LF) |
| | 1. PLAIN LANGUAGE TEXT. | (2CR LF) |
| | 2. NOTE USE OF ZEN TO | (2CR LF) |
| | INDICATE MSG DLVD BY | (2CR LF) |
| | OTHER MEANS TO COM- | (2CR LF) |
| | DESDIV 121. | (2CR LF) |
| | 3. NOTE USE OF DUAL | (2CR LF) |
| | PRECEDENCE. | (2CR LF) |
| | A. ONLY HIGHER PRE- | (2CR LF) |
| | CEDENCE APPEARS IN | (2CR LF) |
| | ROUTING LINE. BOTH AP- | (2CR LF) |
| | PEAR 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 the RATT broadcast, routing indicators and call signs normally are not removed. But if the message is sent on the CW broadcast, routing indicators and call signs must be removed by RUCKCF. In other words, only the plain language address designators appear in the heading, and these 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. The formats of joint and combined forms are exactly alike. 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. Similarly, call signs and address groups are mixed with plain language to designate addressees of joint and intra-Navy messages. but such mixtures are never permissible in combined form messages. The address must consist of either all plain language designators or all call signs and address groups.

## ABBREVIATED PLAINDRESS

Operational requirements for speed of message handling may sometimes require abbreviations of plaindress message headings. In such instances, 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 NTX 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 is an exception to the definition of the abbreviated plaindress form.) Only in encrypted messages are numerical group counts required for messages originated within the NTX 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 the designations of the originator and addressees (and any internal passing instructions) in the encrypted text. Accordingly, the address components (format lines 6, 7, 8, and 9) are omitted. Codress is a valuable security 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 following the prosign T in line 4. An example of a codress message follows.

| Format line | | |
|---|---|---|
| | (5 SPACES 2CR LF) | |
| 2 | OO RUCKHCR RUECK | (2CR LF) |
| 3 | DE RUTPC 42C 12/1Ø4ØZ | (2CR LF) |
| 4 | ZNR | (2CR LF) |
| | RUECK T RUECK XYPT | (2CR LF) |
| 5 | O 121Ø37Z | (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) |
| | a line.) | (2CR LF) |
| 13 | BT | (2CR 8LF) |
| 15 | NNNN | (12LTRS) |

## ROUTING LINE SEGREGATION

The automatic relay system uses a method of routing multiple-call tapes (messages having two or more routing indicators in the routing line) known as routing line segregation. This 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 the tape preparation at the originating station; it is accomplished at the relay stations. At the automatic relay stations, the relay equipment segregates the 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. Semiautomatic relay stations require an operator using special routing segregation equipment to perform the routing line segregation.

Refer again to figure 11-1 to follow the 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 27 21/1234Z
(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 27 21/1234Z
(Etc.)

As relayed to RUMF:

VZCZCQAA1Ø3
PP RUMFC
DE RUQAC 27 21/1234Z
(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:

VZCZTPA296QAB137
PP RUFRC
DE RUQAC 27 21/1234Z
(Etc.)

Transmission to RUEC:

VZCZCTPC678QAB137
PP RUCKC RUWSC
DE RUQAC 27 21/1234Z
(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 27 21/1234Z
(Etc.)

As relayed to RUWS:

VZCZCECD935TPC678
PP RUWSC
DE RUQAC 27 21/1234Z
(Etc.)

As can be seen from the preceding examples, 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, and 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 of the 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 | ? |
| Quotation marks | QUOTE UNQUOTE | " " |
| Apostrophe | --- | ' |

## TABULATED MESSAGES

The 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 the headings of the columns require more space than the data in the column. When this happens, use more than one line for the headings. (Compare the form of the headings in the examples of incorrect and correct methods.) Another point: Keep your columns as close as possible to the left margin, to reduce the 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          REQUIRED
   CAT NO         ARTICLE
 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

Most message centers ashore serve several addressees. To provide the addressees with sufficient copies of each message, the messages are run off on a duplicating machine. Usually, the paper used in duplicating the messages is standard letter-size paper on which approximately 20 lines can be typewritten. To facilitate the duplication process, messages containing more than 12 lines of text are divided into pages by the operator preparing them for transmission.

The first page of a multiple-page message contains the heading and the first 10 lines of text. Each succeeding page contains 20 lines of text, with the exception of the last page, which may have fewer. No more than five pages may be sent in any one transmission.

The second and succeeding pages carry a page identification line above the first line of text. This page identification line gives the page number, the originating station's routing indicator, the station serial number of the message, and, if the text is plain language, the security classification or the abbreviation UNCLAS. Page identification is not included in the group count of those messages for which a group count is required.

In the following example of the proper way to page a message, note that necessary corrections are made at the end of each page, and that the pages are separated from each other by 4LF functions.

```
(5 SPACES 2CR LF)
RR RUWSPG RUHPB              (2CR LF)
DE RUECW 43B Ø81123Z         (2CR LF)
ZNR                          (2CR LF)
R Ø8Ø951Z                    (2CR LF)
```

| | |
|---|---|
| FM CNO | (2CR LF) |
| TO RUWSPG/COMWESTSEAFRON | (2CR LF) |
| RUHPB/CINCPACFLT | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| (Ten lines of plain language text | (2CR LF) |
| on page.) | (2CR LF) |
| C LINE 6 WA LANDING POINT | (2CR 4LF) |

| | |
|---|---|
| PAGE 2 RUECW 43B UNCLAS | (2CR LF) |
| (Twenty lines of plain language text.) | (2CR 4LF) |

(Note: Pages 3 and 4 appear as shown for page 2.)

| | |
|---|---|
| PAGE 5 RUECW 43B UNCLAS | (2CR LF) |
| (Remaining lines of text.) | (2CR LF) |
| BT | (2CR LF) |
| C PAGE 3 LINE 2 WA BEACH ALL | (2CR 8LF) |
| NNNN | (12LTRS) |

Paging rules do not apply to statistical and meteorological (weather) messages that are intended for processing by computers. Messages of this type that exceed 100 lines, however, are divided into transmission sections, which are discussed in the next topic.

## LONG MESSAGES

Messages that exceed five teletypewriter pages are transmitted in sections. This procedure prevents prolonged circuit tieups that could result in delaying more important traffic. By breaking the longer messages into sections, higher precedence messages can be sent between sections without appreciable delay.

At a convenient point within the limits of five pages, the text of a long message is separated into sections. Normally, the separation is at the end of a sentence or a cryptopart. (Long encrypted messages have cryptoparts.) Each section then is numbered, and the section number is inserted on a separate line at the beginning of the text. If the text is plain language, the section number follows the security classification or the abbreviation UNCLAS. For example, 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, the designation of the cryptopart follows the designation of the transmission section.

Transmission sections of a long message have exactly the same heading, except that station serial numbers change with section. 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 identifications are not included in the group count. The cryptopart identification is included.

Here is a message handled in two transmission sections:

(5 SPACES 2CR LF)

| | |
|---|---|
| RR RUHPB RUWSPG RUMGB | (2CR LF) |
| DE RUECW 1Ø5A 18/2Ø15Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 181912Z | (2CR LF) |
| FM CNO | (2CR LF) |
| TO RUHPB/CINCPACFLT | (2CR LF) |
| INFO RUWSPG/COMWESTSEAFRON | (2CR LF) |
| RUMGB/COMARIANAS | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| SECTION 1 OF 2 | (2CR LF) |
| (Plain language text in- | (2CR LF) |
| cludes 90 teletypewriter lines | (2CR LF) |
| in this section, paged as | (2CR LF) |
| required.) | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12LTRS) |

(5 SPACES 2CR LF)

| | |
|---|---|
| RR RUHPB RUWSPG RUMGB | (2CR LF) |
| DE RUECH 1Ø6A 18/2Ø15Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 181912Z | (2CR LF) |
| FM CNO | (2CR LF) |
| TO RUHPB/CINCPAFLT | (2CR LF) |
| INFO RUWSPG/ | (2CR LF) |
| COMWESTSEAFRON | (2CR LF) |
| RUMGB/COMARIANAS | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| FINAL SECTION OF 2 | (2CR LF) |
| (This transmission section con- | (2CR LF) |
| tains the remainder of the text, | (2CR LF) |
| paged as required.) | (2CR LF) |
| 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 you are sending 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 is the method 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; you 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, you must backspace and obliterate the entire classification. Then, start anew with the first letter of the classification.

When transmitting from the keyboard, you cannot correct mistakes that occur in the message heading, nor in the security classification when it is the first word of the text. You must cancel the transmission and again send the message from its beginning. To cancel the transmission, send 2CR, 1LF, 1LTRS, and prosigns E E E E E E E E AR, followed by your station's routing indicator and the usual end-of-message functions. In NTX 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 the 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 you are transmitting the words IN ACCORDANCE WITH PREVIOUS INSTRUCTIONS and make a mistake 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 you discover an error in it, make the correction on the line following the prosign BT. Use of the 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 the prosign C. If the 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 over NTX circuits. When the 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 58A Ø1/231ØZ
Z Ø12312Z
(Etc.)

Notice that the precedence prosign appears in lines 2 and 4, 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, and a receipt obtained from every station to which the message is relayed.

The equipment in automatic relay stations is designed to "recognize" IMMEDIATE as well as FLASH messages. Upon receipt of the repeated prosigns ZZ or OO at the beginning of the routing 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 as follows:

1. Messages originated and addressed entirely within the automatic relay network require a receipt from the addressee to the 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 addresses 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

Occasionally you will receive a message that was delivered to your office through error. Whenever this happens, remember that every NTX office 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.

If you should receive two copies of a multiple-address message, and the second is not marked SUSPECTED DUPLICATE, you must assume that one of the other addresses did not receive his copy. You must notify the relay station from which you received the duplicate message, 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. Here are four important types of NTX pilots.

| 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 soon as possible as a corrected copy.

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 ZDG RUHP | (2CR LF) |
| VV (3 SPACES)MGA19ØVV | (2CR LF) |
| (3 SPACES)ATA1Ø5 | (2CR LF) |
| OO RUECN | (2CR LF) |
| DE RUATH 93 18/19Ø1Z | (2CR LF) |
| ZNR | (2CR LF) |
| O 18191ØZ | (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 ZEL RUHP | (2CR LF) |
| VV (3 SPACES)MGA19ØVV | (2CR LF) |
| (3 SPACES)ATA1Ø5 | (2CR LF) |
| OO RUECN | (2CR LF) |
| DE RUATH 93 18/19Ø1Z | (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) (5 SPACES 2CR LF) | |
| PP RULAGB | (2CR LF) |
| ZFD RULA | (2CR LF) |
| PP RULAT RULAC RULAGB | (2CR LF) |
| DE RUECH 48A 11/1158Z | (2CR LF) |
| P 111213Z | (2CR LF) |
| (Etc.) | (Etc.) |

REROUTE PILOT

As you 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 the 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 signals ZNR (when appearing in the original heading) and 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 ZOV RUHP | (2CR LF) |
| VV (3 SPACES)UATØ98 | (2CR LF) |
| RR RUHPB RUHPE | (2CR LF) |
| DE RUATA 43 Ø8/Ø759Z | (2CR LF) |
| ZNR | (2CR LF) |
| R Ø8Ø923Z | (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 the 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 future misroutes.

## TWX SYSTEM

The TWX is a commercial teletypewriter system owned and operated by the various telephone companies. Its services are available to anyone on much the same basis as 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 Navy uses TWX as an extension of the NTX system. 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 NTX.

A message to an activity served by TWX is forwarded over NTX to the station nearest its destination and there is refiled into the TWX network This method results in considerable savings because the long-haul portion of such traffic is then handled over Navy-leased lines and the only extra cost is for the short-distance transmission from the NTX station. The routing indicator given in ACP 117 for an activity served by TWX is the basic indicator of the relay station or tributary station that will effect transfer of traffic, with the suffix CX added. For instance, the routing indicator for the Naval Propellant Plant at Indian Head, Md. is listed as RUECCX, which indicates that the message would be sent to the TWX section of RUECC COMMCEN in Washington, and there refiled by TWX for delivery to Indian Head. Keep in mind that any time you have a message to an activity whose routing indicator ends in CX, there are commercial charges for final delivery.

When a message is received for TWX refile, the operator finds the TWX number in the directory. When he has the number, he calls the local TWX operator, states the number he wants, and then stands by until he receives a GA (go ahead) from the distant station.

Assume that RUECCX receives a message for refile to the Naval Propellant Plant at Indian Head. This is the way it came in:

| | |
|---|---|
| VZCZCCCB395CDAØ78 | (5 SPACES 2CR LF) |
| RR RUECCX | (2CR LF) |
| DE RUECD 21B 11/1412Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 111533Z | (2CR LF) |
| FM BUWEPS | (2CR LF) |
| TO RUECCX/NPP INDIAN HEAD | (2CR LF) |
| NAVY | (2CR LF) |
| BT | (2CR LF) |
| (Etc.) | (Etc.) |

In the following procedure for delivery by TWX, the TWX operator answers as soon as the RUECC operator turns on his machine. Example:

| Transmission | Explanation |
|---|---|
| GA PLS | TWX operator answers "Go ahead, please." |
| INDIAN HEAD MD 241 | RUECC operator gives number he wants. |
| MIN PLS | TWX operator says "Stand by a minute please," then makes the circuit connection. |
| INDIAN HEAD | TWX operator calls Naval Propellant Plant, Indian Head, Md. |
| GA PLS | Naval Propellant Plant, Indian Head, answers. (At this point, the TWX switchboard operator drops off line.) |
| RUECC 3, etc. | RUECC transmits message. |
| END (bell signal) | Sent by RUECC operator at end of message or end of last message, if more than one is transmitted. |
| R NR3 | Operator at Indian Head receipts for message. Both the RUECC and Indian Head operators turn off machines, and the TWX operator disconnects circuit. |

## COMMERCIAL MESSAGES VIA NTX

Official messages to commercial activities are sent over NTX circuits to the message center 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. An accounting symbol is always required in format line 10. Example 1:

| | |
|---|---|
| VZCACCDA198 | (5 SPACES 2CR LF) |
| RR RUEGCU | (2CR LF) |
| DE RUECD 43A 26/1Ø15Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 261235Z | (2CR LF) |
| FM BUSHIPS | (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) |
| NAVY | (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 CMM ROUTED TO | (2CR LF) |
| AUTHORIZED REFILE POINT | (2CR LF) |
| NEAREST ADDEES | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12 LTRS) |

Example 2:

| | |
|---|---|
| VZCZCCDB312 (5 SPACES 2CR LF) | |
| RR RUCKDY RUWPLC | (2CR LF) |
| DE RUECD 296B 27/1759Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 272331Z | (2CR LF) |
| FM BUWEPS | (2CR LF) |
| TO RUCKDY/NAVSHIPYD NORVA | (2CR LF) |
| RUWPLC/CONSOLIDATED | (2CR LF) |
| VULTEE ACFT | (2CR LF) |
| CORP POMONA | (2CR LF) |
| NAVY | (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 NTX FOR 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 | (12 LTRS) |

## 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 NTX form.

| | |
|---|---|
| (TI) (5 SPACES 2CR LF) | |
| RR RUECC | (2CR LF) |
| DE RULAC 125A 14/Ø913Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 141227Z | (2CR LF) |
| FM NAVCOMMSTA SAN JUAN | (2CR LF) |
| TO RUECC/NAVCOMMSTA WASHDC | (2CR LF) |
| BT | (2CR LF) |
| MSG CK18 COMLE JOHN D | (2CR LF) |
| NICHOLAS 33Ø8 | (2CR LF) |
| SENATOR AVE SE DISTRICT | (2CR LF) |
| HEIGHTS MD | (2CR LF) |
| JOYCE AND KIDS ARRIVING | (2CR LF) |
| IDLEWILD 123Ø AM | (2CR LF) |
| OCT 15 PAA FLT 2Ø6 MEET IF | (2CR LF) |
| POSSIBLE | (2CR LF) |
| MARK VECELLIO NAVCOMMSTA | (2CR LF) |
| SAN JUAN | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12 LTRS) |

## READDRESSING

The procedure for readdressing NTX messages is the same as for readdressing radiotelegraph messages. That is, all procedure lines preceding line 5 (preamble) of the original heading and deleted, and a supplementary heading is inserted in front 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 this 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 15/Ø821Z | (2CR LF) |
| ZNR | (2CR LF) |
| P 15Ø911Z | (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 | (12 LTRS) |

The next example is the message as readdressed. Notice that COMFIVE has 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 34 15/1334Z | (2CR LF) |
| ZNR | (2CR LF) |
| R 151452Z | (2CR LF) |
| FM COMFIVE | (2CR LF) |

| | |
|---|---|
| INFO RUECTAJ/NTC BAIN | (2CR LF) |
| P 15Ø911Z | (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 | (12 LTRS) |

## SERVICE MESSAGES

Service messages are short, concise messages between communication personnel used to expedite the handling of messages. 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 upon whether the service messages must be relayed. If two stations are directly connected, service messages consist of only format lines 1, 2, 3 (less station serial number), 4 (when required), and 12. Service messages requiring relay contain all format lines except lines 5, 6, and 10. Lines 7 and 8 are used only when it is 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, including accounting data in format line 10.

The text of all service messages begins with the security classification or the abbreviation UNCLAS. Then follows the abbreviation SVC, which, 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 Ø2/1421Z | (2CR LF) |
| ZNR | (2CR LF) |
| UNCLAS SVC EUC128 RPT | (2CR 8LF) |
| EUC 128 ZES2 | (2CR 8LF) |
| NNNN | (12 LTRS) |

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 29 Ø7/Ø643Z | (2CR LF) |
| ZNR | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS SVC RUEPDA 15A | (2CR LF) |
| Ø7/Ø5Ø5Z Ø7Ø445Z | (2CR LF) |
| ZES2 | (2CR LF) |
| BT | (2CR 8LF) |
| NNNN | (12 LTRS) |

## 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. You 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) |

```
1234567890 RYRYRYRYRYRYRYRY   (2CR LF)
RYRYRYRYRYRYRYRYRYRYRYR       (2CR LF)
INT ZBZ K                     (2CR 8LF)
NNNN                          (12 LTRS)
```

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 08/1245Z             (2CR LF)
ZNR                           (2CR LF)
ZBZ5 K                        (2CR 8LF)
NNNN                          (12 LTRS)
```

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
1234567890 TEST DE RUHPC              (2CR)
THE QUICK BROWN FOX JUMPS OVER
THE LAZY DOG
1234567890 TEST DE RUHPC              (2CR LF)
RYRYRYRYRYRYRYRYRYRYRYRYRY
RYRYRYRYRYRYRYRYRYR
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. The responsibility for continuity of received messages rests with the station receiving the traffic. The 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. The 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 03/1605Z             (2CR LF)
ZNR                           (2CR LF)
UNCLAS SVC ZID PBA113         (2CR 8LF)
NNNN                          (12 LTRS)
```

(The channel number following the 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 03/1607Z             (2CR LF)
ZNR                           (2CR LF)
UNCLAS SVC SIC PBA113         (2CR 8LF)
NNNN                          (12 LTRS)
```

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                           (2CR LF)
UNCLAS SVC CHANNEL CHECK      (2CR LF)
RYRYRYRY                      (2CR LF)
ABCDEFGHIJKLMNOPQRSTUV        (2CR 8LF)
WXYZ 1234567890               (2CR 8LF)
NNNN                          (12 LTRS)
```

The preceding message, routed in 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, then 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 as near to 0001Z daily as practicable. Because of having many circuits on which the 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.

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 12/ØØØ2Z | (2CR LF) |
| ZNR | (2CR LF) |
| UNCLAS SVC ZID ECA164 | (2CR LF) |
| AWAITING ZDK ECA137 | (2CR 8LF) |
| NNNN | (12 LTRS) |

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 12/ØØØ2Z | (2CR LF) |
| ZNR | (2CR LF) |
| UNCLAS SVC ZID ECA558 | (2CR LF) |
| ECB62Ø ECC459 ECD7ØØ | (2CR 8LF) |
| NNNN | (12 LTRS) |

## TRACER PROCEEDINGS

Naval communications prides itself on reliability, but no communication system is absolutely perfect. For this reason there must be some provision 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 is nothing more than checking from station to station to find where the failure occurred. 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 our 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 following 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 that station, forwards the tracer to the next relay 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 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 RUEAHZ 25A 25/15ØØZ           (2CR LF)
ZNR                              (2CR LF)
UNCLAS SVC RUEAHQ 1Ø4C           (2CR LF)
24/Ø8ØØZ 24Ø75ØZ                 (2CR LF)
ZDE2 RUFPBW/HQ USAFE             (2CR LF)
ZDQ RUEA HQB115                  (2CR LF)
24Ø9ØØZ                          (2CR 8LF)
NNNN                             (12 LTRS)
```

(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 to RUFPSU (service desk of relay station RUFP) and RUEAHQ.

```
(TI) (5 SPACES 2CR LF)
RR RUFPSU RUEAHQ                 (2CR LF)
DE RUEASU 75A 25/1625Z           (2CR LF)
ZNR                              (2CR LF)
TO RUFPSU                        (2CR LF)
INFO RUEAHQ                      (2CR LF)
BT                               (2CR LF)
UNCLAS SVC RUEAHQ 104C           (2CR LF)
24/Ø8ØØZ 24Ø75ØZ                 (2CR LF)
ZDE2 RUFPBW/HQ USAFE ZDQ         (2CR LF)
RUFP JNB185                      (2CR LF)
24Ø955Z                          (2CR LF)
BT                               (2CR 8LF)
NNNN                             (12 LTRS)
```

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 1Ø9 25/17Ø5Z           (2CR LF)
ZNR                              (2CR LF)
TO RUFPBW                        (2CR LF)
INFO RUEAHQ                      (2CR LF)
BT                               (2CR LF)
UNCLAS SVC RUEAHQ 1Ø4C           (2CR LF)
24/Ø8ØØZ 24Ø75ØZ                 (2CR LF)
ZDE2 RUFPBW/HQ USAFE ZDQ         (2CR LF)
RUFPBW BWA234                    (2CR LF)
241ØØØZ                          (2CR LF)
BT                               (2CR 8LF)
NNNN                             (12 LTRS)
```

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 25/1915Z          (2CR LF)
ZNR                              (2CR LF)
TO RUEAHQ                        (2CR LF)
INFO RUFPSU                      (2CR LF)
BT                               (2CR LF)
UNCLAS SVC ZUI RUEAHQ            (2CR LF)
1Ø4C 24/Ø8ØØZ                    (2CR LF)
24Ø75ØZ ZDE2 RUFPBW/HQ           (2CR LF)
USAFE RECEIVED                   (2CR LF)
ABK2. THISTA FAILED TO           (2CR LF)
INITIATE ZDK                     (2CR LF)
REQUEST. CORRECTIVE ACTION       (2CR LF)
TAKEN                            (2CR LF)
BT                               (2CR 8LF)
NNNN                             (12 LTRS)
```

## MANUAL TELETYPEWRITER PROCEDURE

Manual teletypewriter procedure is used on teletypewriter 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 the operator versed in radiotelegraph procedure. The two are closely related, and the message formats are essentially the same. Because of this similarity, the message format for manual teletypewriter messages is not given here.

The rules concerning calling and answering, repetitions, corrections, use of ending prosigns, and the like, in manual teletypewriter procedure are the same as in radiotelegraph procedure.

## MANUAL TELETYPEWRITER MESSAGES

In the ensuing message examples, you will see the similarities of the manual teletypewriter procedure 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 5-5, chapter 5, to follow 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 | (2CR LF) |
| GR3Ø | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| 1. EXCEPT FOR ABSENCE | (2CR LF) |
| OF SEPARATIVE SIGNS | (2CR LF) |
| IN HEADING, FORMAT OF | (2CR LF) |
| MSG IS IDENTICAL TO | (2CR LF) |
| RADIOTELEGRAPH | (2CR LF) |
| 2. NOTICE THAT END-OF- | (2CR LF) |
| MESSAGE FUNCTIONS ARE | (2CR LF) |
| THE SAME AS IN TAPE | (2CR LF) |
| RELAY PROCEDURE | (2CR LF) |
| BT | (2CR LF) |
| K | (2CR 8LF) |
| NNNN | (12 LTRS) |

Our 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 | (2CR LF) |
| FM USS RENSHAW | (2CR LF) |
| TO COMDESDIV 252 | (2CR LF) |
| INFO COMDESRON 25 | (2CR LF) |
| COMDESFLOT 5 | (2CR LF) |
| GR29 | (2CR LF) |
| BT | (2CR LF) |
| UNCLAS | (2CR LF) |
| 1. IF NOT MEMBERS OF TAPE | (2CR LF) |
| RELAY SYSTEM, MOBILE UNITS | (2CR LF) |
| TRANSMITTING UNCLAS MSGS TO | (2CR LF) |
| SHORE STATIONS VIA RATT MUST | (2CR LF) |
| USE PLAIN LANGUAGE DESIGNAT- | (2CR LF) |
| TORS IN ADDRESS OF SUCH MSGS | (2CR LF) |
| BT | (2CR LF) |
| K | (2CR 8LF) |
| NNNN | (12 LTRS) |

The following exemplifies 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 COUNT | (2CR LF) |
| ARE OMITTED FROM THIS MSG. | (2CR LF) |
| OTHER ELEMENTS THAT COULD | (2CR LF) |
| BE OMITTED AT THE DISCRETION | (2CR LF) |
| OF THE ORIG ARE PRECEDENCE | (2CR LF) |
| AND TIME GROUP IN MSG ENDING | (2CR LF) |
| BT | (2CR LF) |
| 1421Z | (2CR LF) |
| K | (2CR 8LF) |
| NNNN | (12 LTRS) |

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 | (2CR LF) |
| GR46 | (2CR LF) |
| BT | (2CR LF) |
| ENCRYPTED GROUPS | (2CR LF) |
| BT | (2CR LF) |
| C 12 XYTOP | (2CR LF) |
| K | (2CR 8LF) |
| NNNN | (12 LTRS) |

## TOUCH TELETYPEWRITING TEST

Before you can be recommended to take the fleet servicewide examination for advancement ot either RM3 or RM2, you must demonstrate your 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 your local examining board at least once each quarter, or four times a year. You 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 letters, or 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 you use a telegraphic typewriter for the typing test.

The time limits for the test include servicing each message by endorsing the time of transmission, the circuit used, and your personal sign. Servicing should not require much time, but be sure to include time for servicing in your practice runs.

Transmission of the touch teletypewriting test must be by direct keyboard method; you 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 you may have. But correcting errors takes time and, on examination, if you must stop to correct too many errors, you may disqualify yourself by failing to finish within the time limits.

Immediately before the official test you 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 you try your best on the practice test, it will help you overcome nervousness, and you will be better able to adjust your typing speed within the time limits on the official test.

Be sure to practice your teletypewriting in preparation for the performance test. Strive to improve both your accuracy and your speed. Remember that you may not be able to do your normal best typing on the day of the test. The examining board may hold the test in surroundings unfamiliar to you; 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 your nervousness in unfamiliar surroundings.

# CHAPTER 12

# ADMINISTRATION

Maintaining accurate records and observing good message-handling practices contribute toward an efficient communication organization. In this chapter you will learn what some of these records are and how they are used. You must bear in mind, however, that different stations may do things in different ways. There is no "one" way to log a message, for example; nor is there only "one" message blank form. Here we discuss mostly those practices and procedures that have become, through regulation or custom, fairly well standardized.

## MESSAGE FILES

Every message handled by a ship or station is placed in one or more files. Some of the 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 commonly used. Those marked with an asterisk (*) are required for all ships and stations; the remainder are optional. Following the table is a brief explanation of each type of file.

### 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 you do not know the file location of a message you need, check the communication center file. If the message is unclassified, you will find it 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.

For convenience of stowage, filing, and referencing, the communication center file may be combined with the station files described in the next topic.

### 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.

Table 12-1.—Summary of Message Files

| File | Contents | Disposition |
|---|---|---|
| *Communication center file. | 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. |
| *Crypto-center file. | 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 file. |
| *Radio station file. | Radio circuit copy of each message received, addressed to, transmitted, or relayed by radio. Filed in DTG order. | Destroy when 6 months old. |
| *Visual station file. | Copy of each message received, addressed to, transmitted, or relayed by visual means. | Destroy when 6 months old. |
| *General message file. | 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. |
| *Broadcast file. | Messages received by broadcast method. | Two months old, for ships over 1000 tons.<br>One month old, for ships 1000 tons or under. |
| Tickler file. | Messages awaiting reply or acknowledgment. | Reply or acknowledgment is sent or received. |
| "Rough" file. | Originator's rough drafts. | Destroy with regular file copy. |
| Press file. | Copy of daily press, as distributed. | Destroy when no longer of interest. |
| Awaiting signature file. | Messages awaiting signature by one or more information officers. | Given to information officer when signed for. |
| Box or 24-hour file. | Messages received since previous midnight (GMT). | Place in regular files. |

## 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. The messages, as they are received on the broadcast, 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 your ship moves from one broadcast area to another, it shifts the broadcast guard accordingly. As a result, more than one broadcast is 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.

Larger ships (over 1000 tons) are required to keep the broadcast file for 2 months. Ships under 1000 tons, such as most classes of minesweepers, net layers, auxiliary ocean tugs, submarine chasers, and patrol craft, are authorized to destroy broadcast files when 1 month old. This is because of extremely limited storage space aboard these small craft.

## TICKLER FILE

The tickler is a temporary file of copies of messages requiring a reply. It usually is kept on a clipboard near the CWO's desk.

Assume that your ship just received a BuMed message bearing DTG 081704Z. It reads: REPT QUANTITY PLASMA ABOARD IN EXCESS NORMAL REQUIREMENTS NEXT THREE MONTHS.

The BuMed message is routed to the medical officer for action, and a copy (flimsy) goes into the incoming section of the tickler file. The tickler copy is removed when the medical officer prepares a reply.

If the ship sends a message requiring a reply from another command, a copy goes into the outgoing section of the tickler, and is removed when the reply is received. If the message requires replies from several addressees, the outgoing section of the tickler will tell you who has or has not answered.

## ROUGH FILE

Sometimes the drafter of a message says something different from what he meant to say, or leaves out something he meant to put in. The rough file consists of originators' rough drafts, and is the communicator's evidence if an originator thinks his message did not go out as he wrote it. Some ships file these copies separately; others staple them to smooth copies in one of the permanent files.

At most shore communication centers, the originator's rough draft never enters the shack. Clerical personnel in the originator's office smooth-type outgoing messages and deliver them to the message center properly released and ready to go.

## PRESS FILE

Aboard ship, an important source of news is press broadcasts. Press material is copied by CW or RATT, then is duplicated and distributed throughout the ship. One copy is placed in the press file to be retained until no longer timely. One of the commanding officer's responsibilities is to keep himself informed of current events, with particular emphasis on the international situation and on happenings in countries the ship is scheduled to visit. For this reason, a duplicate press file sometimes is maintained for the captain's use.

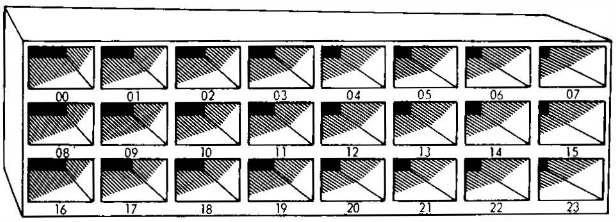
Press news transmitted on the general broadcasts is purchased by the Navy from the press associations with the provision that it will not be placed in competition with normal newspaper outlets and commercial subscribers. Where disclosure to unauthorized persons is a possibility, particularly at shore activities outside the United States, all copies of press should be marked: FOR OFFICIAL USE ONLY. DESTROY AFTER IT HAS SERVED ITS PURPOSE. THIS PRESS MUST NOT FALL INTO UNAUTHORIZED HANDS.

AWAITING SIGNATURE FILE

Information officers usually do not need to see a message as promptly as the action officer. If an information officer is asleep or ashore, his copy is placed in the awaiting signature file, to be signed for when he awakens or returns. The file is kept near the CWO's desk, or on the messenger's clipboard.

BOX OR 24-HOUR FILE

For convenience in locating current traffic, many message centers keep a box file for temporary stowage of messages (fig. 12-1). The box has 24 pigeonholes numbered by the hour. Copies of all messages received are stowed temporarily in the appropriate pigeonhole by DTG. A message with DTG 132146Z, for instance, goes in the 21 slot. Each day the messages are cleared from the box file and filed permanently. If the amount of traffic justifies it, separate boxes may be maintained for incoming and outgoing messages.




31. 57
Figure 12-1.—Box or 24-hour file.

## 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. You 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. A large shore station may file messages at the rate of 50, 000 or more a month. Hence, it is easy to see that a misfiled message often means a lost message.

## 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. Inasmuch as there is rarely occasion to refer to a message more than a few weeks old, DNC 5 (effective edition) authorizes destruction of sections of the files after a certain period of time elapses. 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 6 months.

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

You may recall from chapter 6 that of the four types of radio watches, three of them—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. (When occurring, a report must be forwarded to CNO.)

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, followed by 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 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 12-2 shows how a radiotelegraph log should appear.

Radiotelegraph logs are destroyed after 6 months, except when they relate to distress or disaster. Then, they must be kept for 3 years. If the logs are of historical or continuing interest, they must be retained indefinitely.

## RADIOTELETYPEWRITER LOGS

The radioteletypewriter 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 there is a need 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 radioteletypewriter 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 60 days.

## RADIOTELEPHONE LOGS

Aboard ship you are likely to discover 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. This is because 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 12-3.

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. You save time 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 as long as your log meets one simple test: It must be understandable.

**RADIO LOG**
**OPNAV FORM 2810-1 (Rev. 11-58)** Recorder from FPSO Cog. "I" Stock

| ACTIVITY | OPERATOR | CREW | CIRCUIT | FREQUENCY |
|---|---|---|---|---|
| USS ENTERPRISE | J.D. NICHOLAS RM2 | 3 | 27 | 3319 KC |

| TIME | TRANSMISSION |
|---|---|
| 1245 | NO SIGNALS |
| 125Ø | J.D. NICHOLAS RM2 OFF TO T. BROWN RM2. RCVR CHECKED WITH FREQ METER. |
| | NO TRAFFIC ON HAND. J.D. Nicholas |
| 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 - INFO NHDY GR18 BT (SEE FILES) |
| 1258 | NIQM DE NFFN R AR |
| | NIQM DE NHDY R AR |
| 1259 | NNQN DE NIQM INT R K |
| | NIQM DE NNQN AS |
| | NIQM 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 - 1313Ø8Z - FM NHDY - TO OJWN - INFO NBUV NGTA GR44 BT<br>36155 INDIA MIKE NOVEMBER ALFA JULIETT OYIBM OJCVH USGRI HXRON<br>YIGVL QOOGY STTHU TGKNV HUCHN NEIKE WQYYO QPEAX HXICJ AYPMZ<br>JACIM LEZSO CVDAE SXBLW ETSVO PQBHC UBTBN GYFHJ PBVDF IAKMB<br>VAPDI XCIRU SVJXN SNLVI JNIUL KNCMF BAWXH KFWJR UZPDE RQYNV<br>OEUCI FHADL XKCEW 36155 BT K |
| 1319 | NHDY DE NNQN INT 22 - LEZSO K |
| | 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 (AA TUNING XMTR) |
| 1347 | NO SIGNALS |
| 1348 | NFFN DE NNQN K |
| | NNQN DE NFFN K |
| | NFFN DE NNQN - O - 131347Z GR14 BT<br>UNCLAS CARQUAL PLAN CHANGED AS FOLLOWS. 1Ø A/C OVERHEAD 131445Z. 7 A/C OVERHEAD 13153ØZ BT K |
| 135Ø | NNQN DE NFFN R AR |
| 1355 | NO SIGNALS |
| 14ØØ | NO SIGNALS |
| 14Ø5 | NO SIGNALS |
| 141Ø | NO SIGNALS |
| 1415 | NO SIGNALS |

| DATE | PAGE NO. |
|---|---|
| 13 NOV 63 | 7 |

(OVER)

36.16

Figure 12-2. —Radiotelegraph log.

**RADIO LOG**
**OPNAV FORM 2810-1 (Rev. 11-58)** Recorder from FPSO Cog. "I" Stock

| ACTIVITY | OPERATOR | CREW | CIRCUIT | FREQUENCY |
|---|---|---|---|---|
| USS LONG BEACH | R. W. LESLIE RM 2 | 1 | 18 | 2272 KC |

| TIME | TRANSMISSION | |
|---|---|---|
| 15ØØ | SET WATCH—ASSUMED NET CONTROL | |
| | SHOEBLACK TI GIRLCRAZY | THIS IS A DIRECTED NET OF WHAT PRECEDENCE AND FOR WHOM ARE UR MSGS OVR |
| | TI HAYSTACK | NO TFC OVR |
| | TI SNOWCAP | 1 P FOR YOU OVR |
| | TI WESTWIND | 1 R FOR HAYSTACK OVR |
| | TI SUNSHINE | NO TFC OVR |
| 15Ø2 | SHOEBLACK TI GIRLCRAZY | RGR SNOWCAP SEND UR MSG OVR |
| | GIRLCRAZY TI SNOWCAP | MSG FOLS P TIME Ø71455Z FM SNOWCAP TO GIRLCRAZY INFO BEACHNUT GR15 BT (SEE FILES) |
| 15Ø6 | SNOWCAP TI GIRLCRAZY | RGR OUT |
| | WESTWIND TI GIRLCRAZY | SEND UR MSG OUT |
| | HAYSTACK TI WESTWIND | OVR |
| | TI HAYSTACK | OVR |
| | HAYSTACK TI WESTWIND | R TIME Ø71452Z GR6 BT UNCLAS REPORT SHACKLE IDPQ RNZT UNSHACKLE BT OVR |
| 15Ø8 | WESTWIND TI HAYSTACK | RGR OUT |
| 1513 | NO SIGNALS | |
| 1518 | NO SIGNALS | |
| 1523 | NO SIGNALS | |
| 1528 | NO SIGNALS | |
| 153Ø | R.W. LESLIE RM2 OFF TO J.D. NICHOLAS RM3—ROUTINE ON HAND FOR SNOWCAP | |
| | | RWLeslie |
| 1532 | SNOWCAP TI GIRLCRAZY | R OVR |
| | TI SNOWCAP | OVR |
| | SNOWCAP TI GIRLCRAZY | R TIME Ø71527Z GR18 BT (SEE FILES) |
| | TI SNOWCAP | IMI WA AT OVR |
| | TI GIRLCRAZY | I SAY AGAIN WA AT FIGS 183ØZ OVR |
| 1537 | GIRLCRAZY TI SNOWCAP | RGR OUT |
| 1542 | NO SIGNALS | |
| 1547 | NO SIGNALS | |
| 1552 | NO SIGNALS | |
| 1557 | NO SIGNALS | |
| 16Ø1 | GIRLCRAZY TI SNOWCAP | OVR |
| | TI GIRLCRAZY | OVR |
| | GIRLCRAZY TI SNOWCAP | R TIME Ø71554Z GR4 BT (SEE FILES) |
| 16Ø3 | SNOWCAP TI GIRLCRAZY | RGR OUT |
| 16Ø8 | NO SIGNALS | |
| 161Ø | GIRLCRAZY TI SUNSHINE | ROUTINE FOR HAYSTACK OVR |
| | SUNSHINE TI GIRLCRAZY | SEND UR MSG OUT |
| | SUNSHINE TI HAYSTACK | SEND UR MSG OVR |
| | HAYSTACK TI SUNSHINE | R TIME Ø716Ø1Z GR9 BT UNCLAS REQ CANCEL EVENT Ø712 DUE ROUGH SEAS BT OVR |
| 1613 | SUNSHINE TI HAYSTACK | RGR OUT |
| 1618 | NO SIGNALS | |
| 1623 | NO SIGNALS | |
| 1628 | NO SIGNALS | |

| DATE | PAGE NO. |
|---|---|
| 7 DEC 63 | 1 |

(OVER)

36.16
Figure 12-3. —Radiotelephone log.

Retention and disposal requirements of radiotelephone logs are the same as for radiotelegraph logs.

## MESSAGE BLANKS

Commands very widely in message-handling procedures and systems of internal routing. Each 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. It is retained in the communication center file after distribution is completed.

Figure 12-4 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 test. Across the bottom are spaces for the releasing officer's signature (for outgoing messages), the time of receipt (if the message is incoming), time of delivery (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 timesaver 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.

The row of 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.

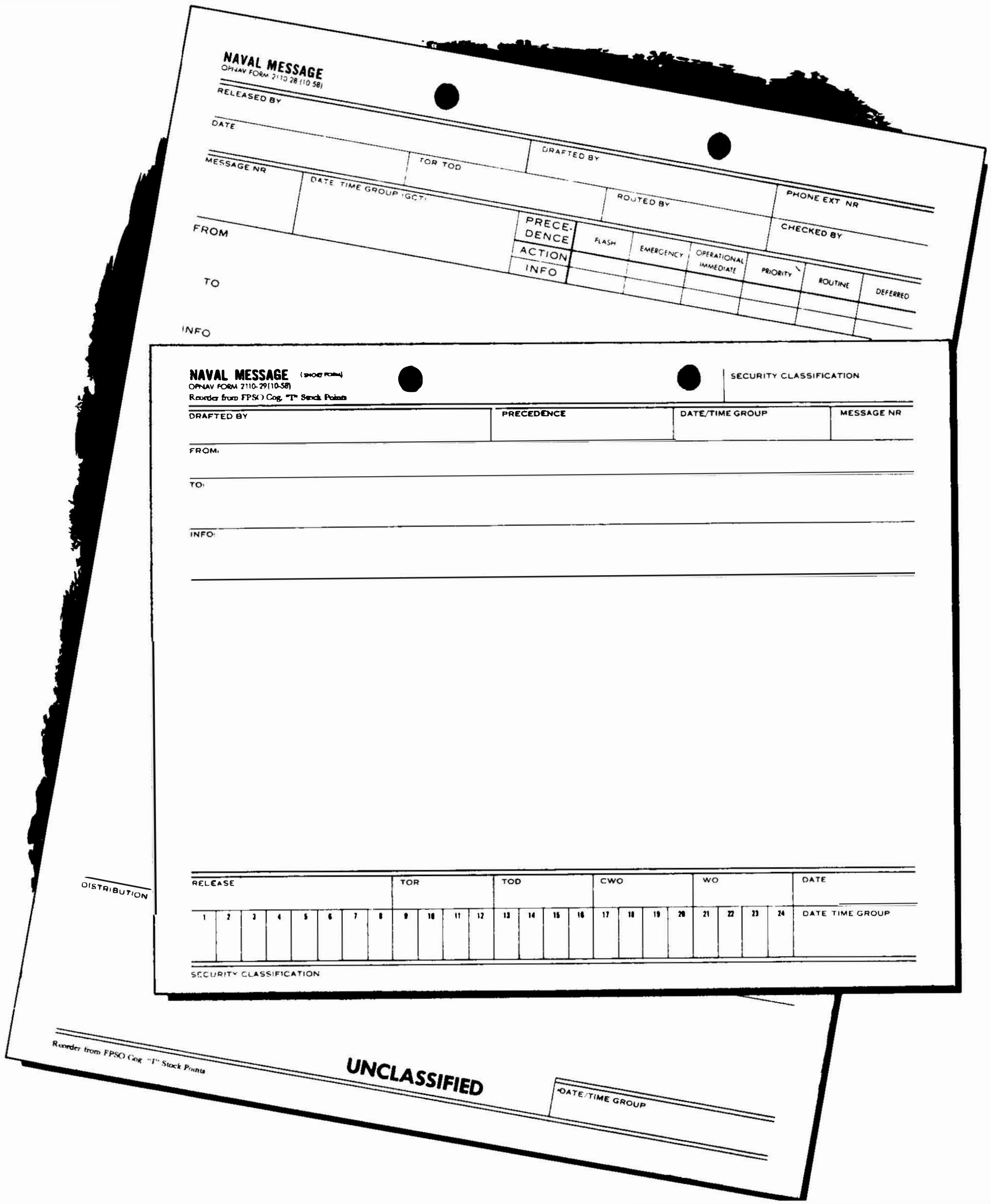
## INCOMING MESSAGES

All CW, RATT, and FAX traffic addressed to your ship is processed through the message center. Except for tactical signals that must be executed within a few minutes, visual and radiotelephone messages are handled similarly. 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 as many copies as are required. 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




31.47
Figure 12-4. —Two typical message blank forms.

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 the 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 the 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. Refer to the incoming message shown in figure 12-5. The routing ("A" for action, "I" for information) is as follows:

| 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 engineroom power panels; must see that shaft alleys, workshops, and storerooms are ready for heavy weather. |

**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 | | Jn | | 11 OCT 63 |

| 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 12-5.—Incoming message. 31.47

| Block | Assigned to | Routing | Explanation |
|---|---|---|---|
| 9 | Meteorological officer | I | Receives all messages concerning weather. Must advise command in matters relating to his specialty: 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 storerooms, and other spaces are secure 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. |

| Block | Assigned to | Routing | Explanation |
| --- | --- | --- | --- |
| 24 | OOD | I | Responsible for safety of the ship during period of his watch. (A message routed "OOD" is seen by all OODs.) |

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 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 at 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 usually go to offices, divisions, or sections—not to individuals—for action and information.

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 cognizance 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 the 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 teletypewriter 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. 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, 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 files. A filler, dummy, or encrypted copy goes into the communication center files. 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 file, as before, and another in the communication center file.

## RELEASING SIGNATURE

Before you accept any outgoing message for transmission, be certain that it is released properly. You will find the signature of the releasing officer 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 reference in an incoming message, look up the referenced message and show identifying extracts across the face of the routed copies. The same applies to outgoings. 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 you 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 the Checklist for Traffic Checkers.)

Shore stations often have from one to four men checking traffic full time. Usually there is some specilization to meet local needs—one or two men, for instance, may check only encrypted traffic, whereas the others 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. He must stay abreast of all of these.

## 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. Compare numbers in text with those in CFN line (if used).
8. If the message contains a ZFF, ensure that it has been answered. (ZFF: an operating signal means, in effect, "When did addressee receive message?")
9. Check operator's sign and servicing.
10. Check internal routing for omissions.
11. In shore stations, watch for duplicate messages. If your station receives the same message twice, someone else may have a nondelivery.
12. Watch for excessive in-station delays; compare the time your station received or accepted the message against the time it was delivered or sent.
13. Always be alert for security violations.

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.

### DNC 5

The effective edition of DNC 5, U.S. Naval Communication Instructions, is one of the most important communication publications to the man at the operating level. This unclassified, nonregistered publication is promulgated by DNC. It contains several hundred pages of information, advise, and instructions on virtually every phase of naval communications. About half the total contents of the publication deal with communication procedures.

You are required to have a knowledge of the contents of DNC 5. This is not as imposing a requirement as it may seem, because some of the information contained in it is so basic that you will soon learn it by just being around a communication office. You also will refer to it frequently in the course of your work, and further your acquaintance with its contents in that manner.

The index in the back of the book is arranged alphabetically by subject matter, with references both to the page number and the article number. If you are looking for information on radiotelegraph logs, you will find it indexed under "Logs, Radiotelegraph." Then you thumb to the page and article indicated.

In general, the communication procedures explained in DNC 5 are the same as those contained in Allied Communication Publications. You must remember, however, that DNC 5 is distributed only within the U. S. Navy, whereas ACPs are held by all armed services of the United States and allied countries. In cases of conflicting communication procedures between DNC 5 and any of the ACPs, DNC 5 is the governing publication for use within the U. S. Navy.

Many test questions in the fleetwide competitive examinations are based on information in DNC 5. If you need a considerable amount of study in that publication, you are advised to get an early start.

## CORRECTIONS TO PUBLICATIONS

One of your jobs as RM3 and RM2 is to help keep your 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. On 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.

Corrections to publications are issued in four ways: errata, change, memorandum, and message. An errata is a correction, usually 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 that may affect the status or accountability of a publication, or to amend serious errors in the 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.).

Memorandum corrections are of two kinds: Registered Publication Memorandum Corrections (RPMC) for corrections to RPS-distributed publications, and Navy Memorandum Corrections (NMC) for publications distributed by the Forms and Publications Supply Office of the Navy supply system. Memorandum corrections are used when time does not permit the preparation of a serially numbered change. The RPMCs and NMCs 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 (or RPMC), 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 or RPMC. 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 general message (or ALCOMLANT, ALCOMPAC when appropriate). Message corrections are used only when it is absolutely necessary to disseminate the correction by rapid means.

Entering corrections in publications is tedious work. It is a necessary chore, however, and is of such importance that it warrants your 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 in 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 the responsibility for keeping the 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 the information possible relating to circuit conditions; special orders; cruising disposition; traffic awaiting transmission, receipt, execution, or acknowledgement; 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 up to the captain.

Traffic usually is filed on the morning after the day it is handled. After the daily files are complete, 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 CWO and the radio 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.

## OPPLAN COMMUNICATION ANNEX

An operation plan (OpPlan) is a directive outlining procedures to be followed for some particular operation, such as an invasion, air strike, or convoy. That part of the OpPlan of interest to you 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 you are required to have from the annex is furnished you 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 OpPlan 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, but most 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. Acceptable frequency tolerance for shipboard stations varies from .01 to .05 percent, depending on the frequency band. Table 12-2 shows the frequency tolerances for both short-based and shipboard radio transmitters. Note that the requirements for frequency adherence for most frequency bands are more stringent for shore stations than for ships. There are no shipboard transmitters in the frequency range of 10 to 50 kc. Transmitters installed in motor vehicles must meet the same requirements as for ships.

Table 12-2. — Frequency Tolerances

| Type of station | 10 kc to 50 kc | 50 kc to 535 kc | 535 kc to 4000 kc | 4000 kc to 30 mc | Above 30 mc |
|---|---|---|---|---|---|
| Shore | .1% | .02% | .005% | .003% | .01% |
| Ship | -- | .05% | .015% | .015% | .01% |

A shipboard transmitter on 2716 kc, for example, must be kept within 2715.5926 to 2716.4074 kc. The tolerance is .4074 kc (or 407.4 cycles), which is found by multiplying 2716 by .00015.

Frequency tolerances are prescribed as operational standards in DNC 5 and must bemaintained. Naval frequencies are monitored by communication security activities. Unlessyour transmitters are kept within the frequency tolerances shown in table 12-2, you are certain to receive an off-frequency report by either message or memorandum.

The newer models of Navy transmitters are capable of greatly improved frequency stability. This feature means that, when correctly set on the desired frequency, they areunlikely 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. DNC 5 requires that frequency meters be checked at least once each week, and directs that a log be kept of the checks conducted.

The frequency of radio receivers on circuits were 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. Those 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. Too often someone stuffs a crystal into his pocket, forgets it, then it goes to the laundry in his clothes. Even if they are recovered, few crystals work after a trip through a washing machine. 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.

Bureau of Ships 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 you have all crystals allocated your ship.

## 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 at specific time intervals.

The supervisor's log is particularly useful as background information when turning the watch over 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 12-6 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.

## SOME 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?
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 use a frequency meter?
9. Are frequency meters calibrated weekly against radio station WWV?

10. Is all your equipment operative? If not, is something being done to put it 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?

PUBLICATION CUSTODY LOG

WATCH-TO-WATCH PUBLICATION INVENTORY FOR Radio Central

| Short Title | Reg. Nr. | 10 Dec 63 0000-0400 | 10 Dec 63 0400-0800 | 10 Dec 63 0800-1200 | 10 Dec 63 1200-1600 | 10 Dec 63 1600-1800 | 10 Dec 63 1800-2000 | 10 Dec 63 2000-0000 | 11 Dec 63 0000-0400 | 11 Dec 63 0400-0800 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Day-Month-Year Period of Watch | | | | | | | | | | | | | | | | |
| ACP 100 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 110 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 112 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 113 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| ACP 121 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| FXP 3 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| JANAP 119 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| JANAP 195 | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | | | | | | |
| (Full) Signature (in ink) | | R Leslie | Jack Colbert | Fred Cramer | R Leslie | Jack Colbert | Fred Cramer | R 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.

31.58

Figure 12-6. —Publication custody log.

# CHAPTER 13

# SAFETY

When working with radio, or with any electronic equipment, one rule that cannot be stressed too strongly is: SAFETY FIRST. Dangerous voltages energize most 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 before touching the gear. Additional safety information is contained in—

1. Electronic Installation Practices Manual, NavShips 900, 171.
2. Electric Shock, Its Causes and Prevention, NavShips 250-660-42.
3. Electric Shock and Its Prevention, NavShips 250-660-45.
4. U.S. Navy Safety Precautions, OpNav 34P1.

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.

## READ THE SIGNS

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 trunk, 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.

### HOW MUCH DOES IT TAKE?

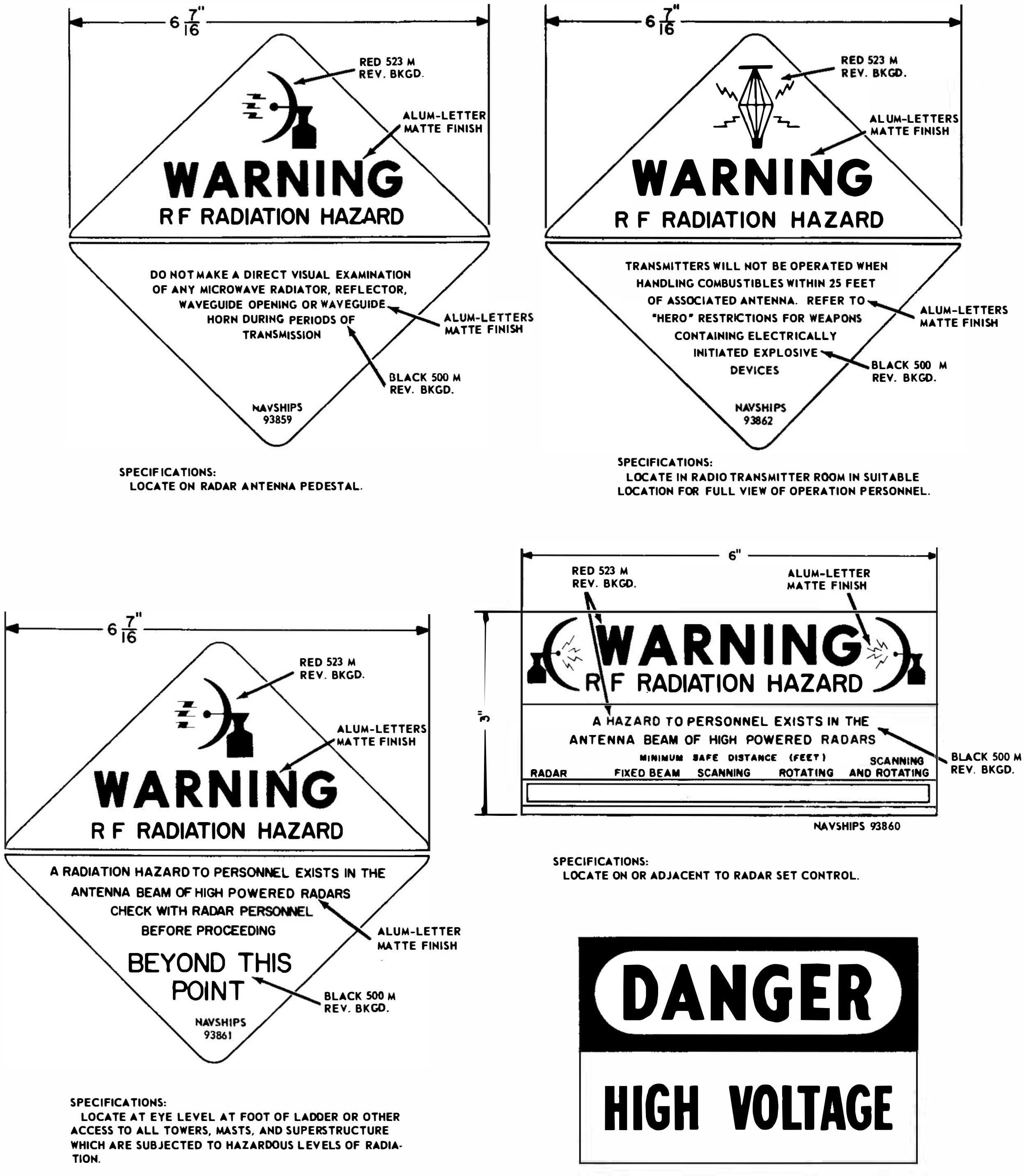
If a 60-cycle alternating current is passed through a man from hand to hand or from hand to foot, the effects when current is increased gradually from zero are as follows:

1. At about 1 milliampere (0.001 ampere) the shock can be felt.
2. At about 10 milliamperes (0.010 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 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




40.67(76)

Figure 13-1.— Hazard warning signs.

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.

Don't go aboard ship with a casual regard for the deadly potentialities of electric current. Few people would handle electric appliances while in the bathtub, or stand ankle-deep in a flooded basement and fumble for the 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 failure or 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. Actually, 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

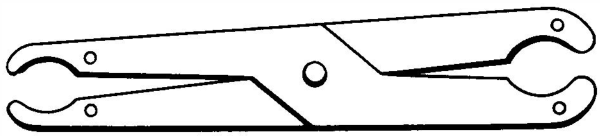
When repairing or overhauling any electronic equipment, make sure the main supply or cutout switches in each circuit from which power could possibly be fed are secured in the OPEN (or SAFETY) position and tagged. Switches should be secured by locking, if possible. The tag should read; "This circuit was 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 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, with the working of the tags changed.

### 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 the consequences of possible damage to the equipment. When possible, a circuit should be checked before the fuse is replaced, because a blown fuse usually indicates a circuit fault.



1.32A
Figure 13-2. — Fuse puller.

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 bake lite or fiber, and can handle a range of fuses up to 60 amperes. Grasp 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.

## WORKING ON ENERGIZED CIRCUITS

Insofar as possible, work on energized circuits is NOT undertaken except in time of emergency, and then only under proper supervision. Proper supervision is considered to mean supervision by experienced electronics maintenance personnel. In all such work, care is taken to insulate the workman from ground and to observe every known safety precaution. Here are some of them:

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 operating handle usually are good conductors of electricity. When working with circuit breakers, remember these rules:

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 while power is on.

## HIGH-FREQUENCY OPERATING HAZARDS

Aside from the danger of shock, the hazards involved in the operation of electronic equipment in the high-frequency range may be divided into 3 categories: (1) radiation hazards to personnel (RADHAZ), (2) hazards of electromagnetic radiation to ordnance (HERO), and (3) hazards associated with volatile liquids (SPARKS).

### RADHAZ

Generally, the possibility of biological injury from radiation at the operating frequencies of most radio communication equipment is slight. 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 will rise. This 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 permature 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 gets 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 relative to these objects governs the amount of induced voltage present. 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. Consequently, during refueling, the arming of aircraft, and the handling of ammunition or volatile liquids and gases, extreme care must be exercised by working personnel. Additionally, all transmitting equipment should be deenergized. If this is impossible, a separation of at least 25 feet must be maintained between the work area and an energized antenna as a safety precaution.

## SOLDERING IRONS

The 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 the 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 teletypewriter 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 test. 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 blood stream. 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. (These precautions also apply when removing tube from equipment socket.) 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.

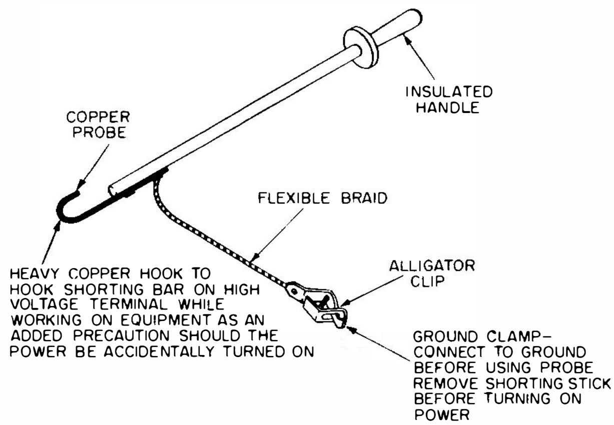
## RUBBER MATTING

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 the 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 way to ground 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 a deenergized circuit, or 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 spaces, 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. Such vapors should be exhusted 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. Place rags, sweepings, and waste that may be contaminated with paint in a covered metal container or in a bucket of water.

Never eat, drink, or store food in a compartment where painting is being done. 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. Prior to 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 the 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 the dirt as it is loosened by the brush.

A hand bellows may be used to blow dirt out of 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 the 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 the 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:

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

In many cases, it is necessary to rescue the 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 thing to do 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. If circumstances are such that power cannot be shut off quickly, use some dry material such as line, cloth, canvas, rubber, or wood to lift or pull the man away from the conductor. DON'T USE METAL OR MOIST MATERIALS. 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.

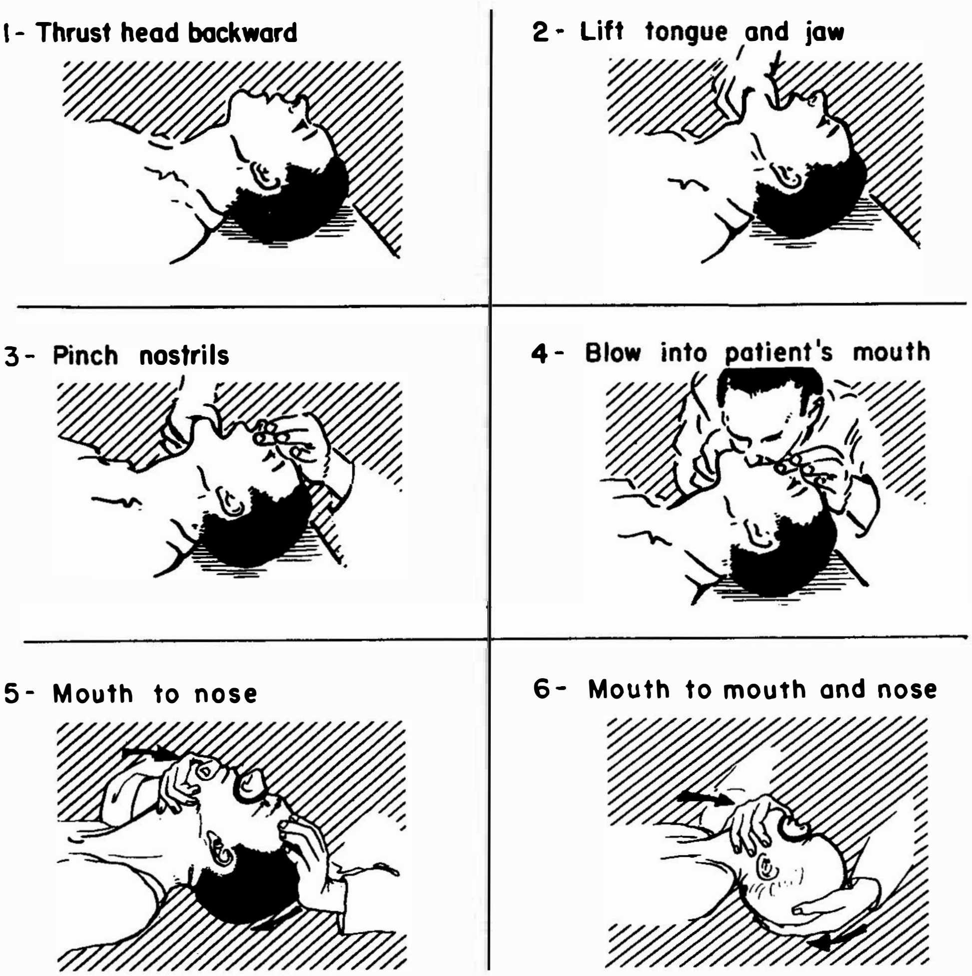
### ARTIFICIAL RESPIRATION

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 alternation, 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.




4.224
Figure 13-4.—Mouth-to-mouth method of resuscitation.

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. 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 the electricity.

The following six steps are easy to learn:

1. Place the victim on his back. Loosen collar and belt.

2. Clear the mouth of any foreign matter with your fingers or a cloth wrapped around your fingers.

3. Tilt the head back so the chin is pointing upward. With one hand push the jaw forward into a jutting-out position. Tilting the head and pushing the jaw forward should relieve obstruction of the airway. With the fingers of one hand, pinch the victim's nostrils shut to avoid any air leakage.

4. Take a deep breath. Place your mouth over the victim's mouth and breathe into him. The 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 the 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.

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 the 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 aid kit. Use of the plastic tube makes it easier to keep the victim's tongue from blocking the air passage, and avoids the 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 the 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 the victim's head on his hands, with his face turned to one side.

2. Kneel on one knee, facing the 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 this, have one knee on each side of the victim's head. Next,

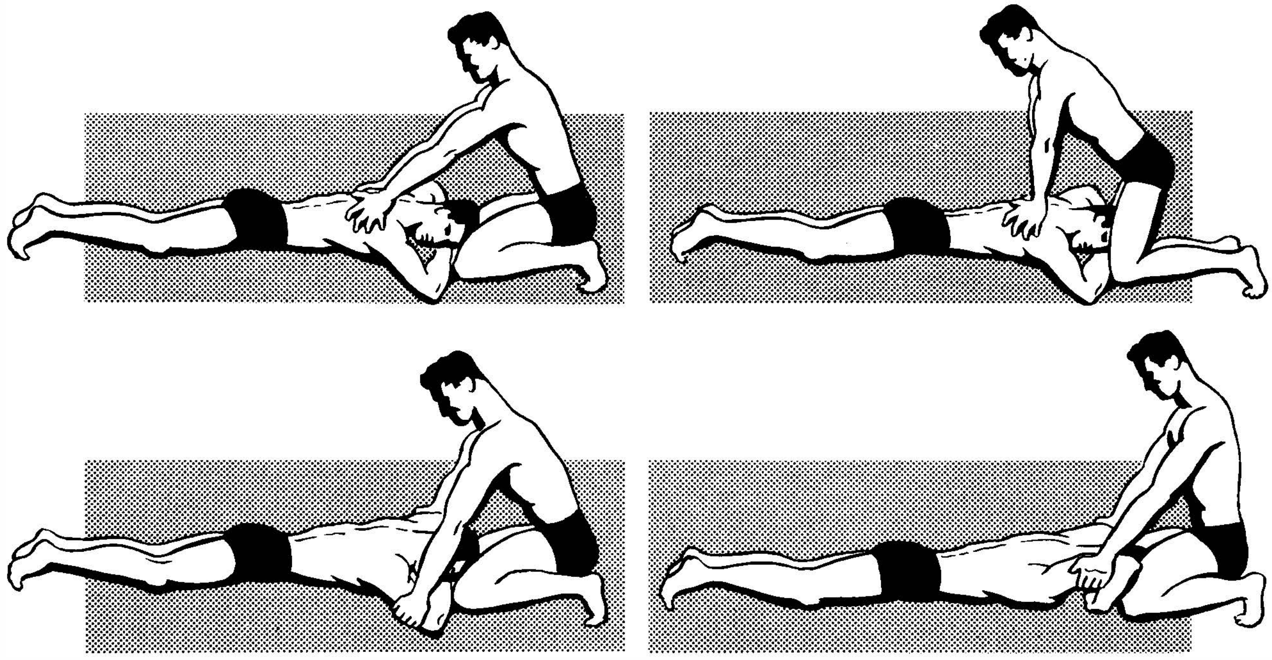


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Figure 13-5.— Back-pressure arm-lift method of resuscitation.

place your hands on the middle of his back, just below the 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 the 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 the pressure quickly by peeling your hands from the victim's back.

5. Now rock backward, and allow your hands to come to rest on the victim's arms just above his elbows. As you swing backward, lift the 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, and 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 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 the 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. Clear his mouth of any objects or materials that might

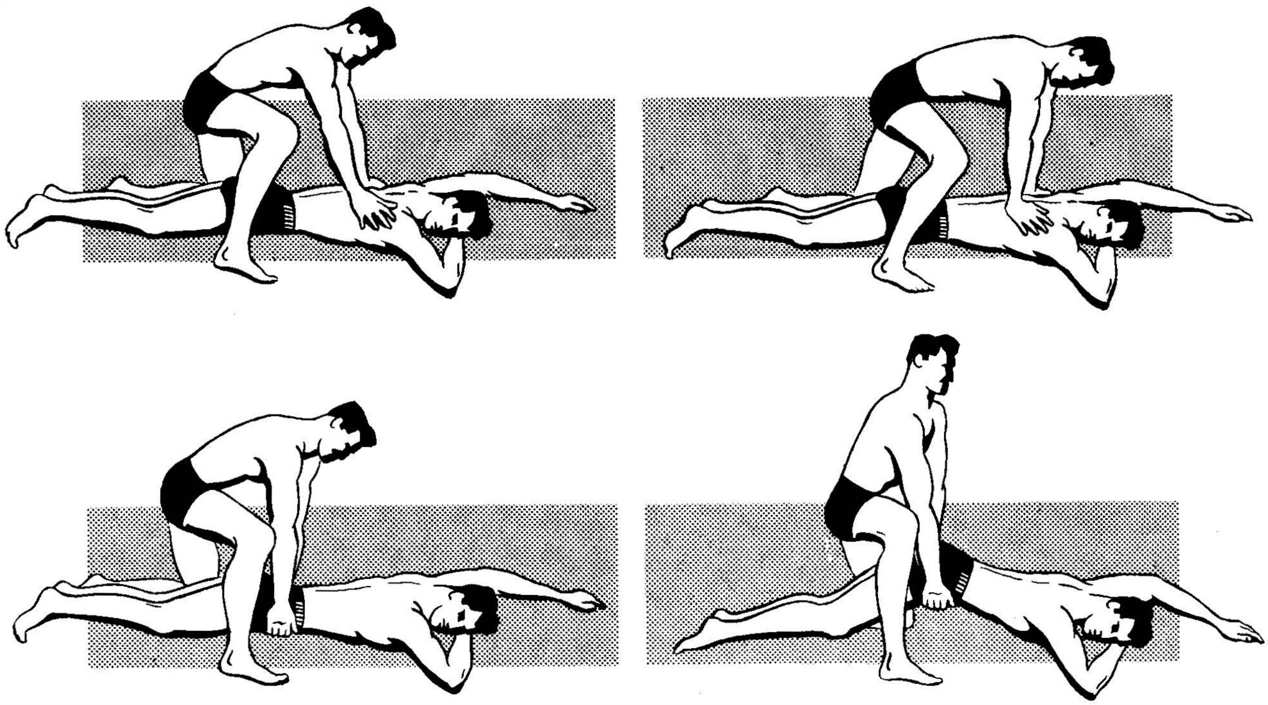

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Figure 13-6. —Back-pressure hip-lift method of resuscitation.

obstruct his 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 the 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 the 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 the pressure is exerted almost directly downward. Do not exert sudden pressure, or any more pressure than is required to feel a firm resistance.

4. Release the pressure quickly by peeling your hands from the patient's back.

5. Now rock backward and let your hands come to rest on the victim's hips, well below his waist. Slip your fingers underneath his hip bones.

6. Lift the victim's hips 4 to 6 inches. The lifting allows the abdomen to sag downward and the diaphragm to descend, causing his chest to expand and fill with air. Lower the victim's hip's and you 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. Then his muscles 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 very 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 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 the 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. The pulse is weak and rapid. Breathing is likely to be shallow, rapid, and irregular, because the poor circulation of the 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 extremely important, therefore, that you begin the treatment 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 it is impossible to do this, it might still be feasible for you to raise his feet and legs enough to help the blood flow to the 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 of 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 the 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 is shock is in need of liquids. But liquids given by mouth are not absorbed—and therefore ineffective—except in very mild cases of shock. In moderate or deep shock, intravenous administration of fluids is necessary; but this is a medical procedure and cannot, under any circumstances, be performed by a person giving first aid.

One final precaution must be given concerning the use of liquids: Never give alcohol to a person who is in shock or who 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 heat generated by fire, bomb flash, hot solids, liquids, and gases, and contact with electric current.

Burns usually are classified according to the depth of injury to the tissues. A burn that reddens the skin is called a first-degree burn. One that reddens and blisters the skin is called a second-degree burn. When the skin is destroyed and the tissues actually are charred or cooked, the injury is described as a third-degree burn.

It is easy to see that a deep burn (third-degree) is more serious than one not so deep. Remember, however, that the size of the burned area may be far more important than the depth of the burn. A first-degree or second-degree burn which covers a very large area of the body is nearly always more serious than a small third-degree burn. A first-degree sunburn, for example, can cause death if an extensive area of the body is involved.

It should be noted that burns and scalds are essentially the same type of heat injury. When the injury is caused by dry heat, it is called a burn; when caused by moist heat, it is referred to as a scald. Treatment is the same for both.

The chief dangers from burns are shock and infection. All first aid treatment for burns must be directed toward relieving the victim's pain, combating shock, and preventing infection.

Minor burns should be dressed immediately. Apply a thin coat of sterile petrolatum (vaseline) to the burned area and cover with a sterile bandage. The pain will be lessened if the bandage is airtight and fairly firm.

Serious burns should be treated as follows:

1. Relieve the pain. Burns are painful, and the pain contributes to the severity of shock. For a person who has suffered extensive burns, first give 1/4 grain of morphine to relieve the pain.

CAUTION: Remember that the victim may have other injuries besides the burns. Do NOT give morphine to any person who has a head injury, even if he is suffering from extensive burns.

2. Treat for shock. Any badly burned person 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 victim's pain is, of course, an important part of the treatment for shock. When you have done this, try to place him in position so that his head is slightly lower than the rest of his body. Make sure that he is warm enough. Do not remove his clothing immediately. Cover him with a blanket if he appears to be cold. Do not overheat him, but remember that exposure to cold will cause shock to become even worse.

The general rule that liquids should not be given in first aid treatment for shock was emphasized earlier. In serious burns, however, an exception must be made to this rule. A seriously burned person has an over whelming need for fluids; and administering liquids is an important part of the treatment for shock. Give small amounts of warm water, warm tea, or warm coffee if the victim is conscious and able to swallow and if he has no internal injuries.

3. Treat the burn. In cases of extensive burns, the first aid treatment depends upon the probable length of time that must elapse before the victim receives medical aid. If you believe that a medical officer will be available within a period of about 3 hours, simply wrap the victim in a clean sheet (or whatever clean material is available), continue to treat him for shock, but do no attempt any treatment of the burn itself.

If more than 3 hours may elapse before the services of a medical officer can be obtained, you will have to dress the burn. First remove the victim's clothing around and over the burn, being careful not to cause further injury. If clothing sticks to the burn, 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, tar, dirt, grease, etc., adheres firmly to the burn, do not try to remove it. Do not allow absorbent cotton, powder, adhesive tape, or any other substance that might stick to the burn to come in contact with it. Never put iodine or any other antiseptic on a burn.

When you clear away as much clothing as you can, dress the burn. Cover strips of sterile gauze with a thin coating of petrolatum (vaseline). The petrolatum should not be applied too thickly. Wrap the gauze strips smoothly and gently around the burned areas, and cover with a roller bandage. The bandage must be firm, but it must not be tight enough to restrict circulation of the blood or to interfere with breathing. A smooth, firm bandage greatly reduces the victim's pain.

Once the bandage is applied, it should not be disturbed. Leave it in place until the victim receives medical treatment.

As we have seen, shock is the most immediate danger in burn injuries. Infection is the second danger that must be guarded against. Second-degree and third-degree burns are, in effect, open wounds. At first the burned areas are probably sterile, because of the intense heat that caused the burn. In handling and treating a person who has been burned, therefore, you must do everything possible to prevent contamination of the burn. Do not allow unsterile objects or materials to come in contact with the burn. Do not open any blisters. Contamination of the burn can cause serious (sometimes fatal) infections.

## ELECTRICAL FIRES

Any fire is a potential source of disaster. In electrical fires, observe the following procedures.

1. Deenergize the circuit for the equipment affected. Every radio transmitter has an EMERGENCY OFF switch that removes all power from the equipment. In addition to local power switches on the equipments, the power supply to all transmitters and receivers, converters, and teletypewriters can also be secured at the 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 the ship's fire bell.

3. Secure ventilation. Turn off the blowers; close the doors.

4. Report the fire to the OOD by telephone or messenger.

5. Attack the fire with equipment available in the immediate vicinity, such as portable 15-pound CO2 (carbon dioxide) extinguishers.

When extinguishing an electrical fire, remember that quick action is required only to deenergize the circuit. When this has been done, STOP! LOOK! THINK! The use of CO2 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 hand 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:

1. Carry the extinguisher in an upright position, and approach the fire as closely as the heat permits. (Keep the extinguisher erect while using it. Because of its construction, it should not be laid on its side.)

2. Remove the locking pin from the valve.

3. Grasp the nozzle horn by its handle. (It is insulated to protect your hand from the extreme cold of the discharging carbon dioxide.)

4. Open the valve by turning the valve wheel to the left (or squeeze the release lever), thus opening the valve and releasing the carbon dioxide, and at the same time direct the flow toward the base of the fire. Move the horn slowly from side to side, and follow the flames upward as they recede.

5. Close the valve as soon as conditions permit, and continue to open and close it as necessary. The firefighter may shut off the handwheel type of valve for brief intervals without an appreciable loss of carbon dioxide, but once the valve seal is broken, the 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 the 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 the flame is extinguished, coat the entire surface involved in the 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 CO2 systems for total flooding such as those installed in uninhabited spaces used for gasoline and paint stowage. Consequently, when using the 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 the snow blisters the skin and causes painful burns if allowed to remain on the skin.

In the event that all efforts with carbon dioxide fail to put out the fire, fresh water applied with a fog applicator may be used. Because of the fine diffusion of its particles, fog reduces but does not entirely remove the 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.

## 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, and 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 COD and men going aloft that all radio transmitters are secured.

Make entries in your radio log to show the time of securing, the time of opening up to resume operating, the name of the OOD granting permission to open up, and the time the 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:

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 them on your shipmates.
5. Ensure yourself of good footing and grasp at all times.
6. Remember the nautical expression of old seafarers: HOLD FAST.

# CHAPTER 14

# MAINTENANCE

Electronics maintenance is a broad field of endeavor. Maintenance includes both measures to reduce or eliminate failures and prolong the useful life of the equipment (preventive maintenance) and measures taken to correct damage incurred through long use, accident, or other causes (repair, also called corrective maintenance).

The 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 high 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 and the alignment, testing, and internal adjustment of equipment. Technical maintenance customarily is done by Electronics Technicians.

Tender/yard maintenance is maintenance that 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 the intent of the Bureau of Ships that operational maintenance be done by the operational ratings and technical maintenance by the technical ratings. The duties of the two ratings are summarized as follows:

1. 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.

2. Technical ratings — manipulation, technical and tender/yard maintenance, repair of electronic equipment, and preventive maintenance that requires realignment after accomplishment.

## POMSEE PROGRAM

To overcome weaknesses in local maintenance programs, the Bureau of Ships instituted the POMSEE program. The expression POMSEE stands for Performance, Operation, and Maintenance Standards for Electronic Equipment. The POMSEE consists of two publications. They are the Performance Standards Sheet and the Maintenance Standards Books.

Performance Standards Sheets provide the operational performance data and basic technical measurements indicative of the minimum acceptable level of performance for electronic equipment. A binder, titled "Electronics Equipment Performance Standards Sheets, NavShips 93000," is provided for incorporating all sheets required on a ship under one cover.

Maintenance Standards Books describe and illustrate standard procedures and tests for measuring the performance of a specific equipment. They include a list of test equipment required for taking these measurements, and provide space to record the results of the measurements. In addition, the books set forth a sound preventive maintenance schedule that ensures proper equipment performance.

Certain procedures (tests) in the Maintenance Standards Books are designated "Reference Standards Tests." These tests are accomplished by the installing activity when the equipment is operating properly. The recorded results provide a series of reference standards that collectively represent the equipment's normal performance. Comparison between the results of the scheduled preventive maintenance tests and the reference standards quickly reveals any significant change in the equipment's performance. Reference standards are reestablished by experienced technical personnel after each equipment overhaul.

Routine (preventive) maintenance tests of circuits and components are required at regular intervals (daily, weekly, quarterly, and so on.) Other routine maintenance, such as lubrication, also is required. The Maintenance Standards Books specify when and how the maintenance is to be performed.

Figure 14-1 shows opposing pages from the URC-32 Maintenance Standards Book. The procedures are presented in procedural tables. At the top of each procedural table is a list of operating conditions and control settings that apply to the entire table unless noted otherwise in the procedure of a given step. Step numbers on accompanying illustrations correspond to the procedural step numbers to which they relate.

In general, the same steps required for determining reference standards are repeated later by the ship's force in making routine checks for entry in the Maintenance Standards Books. The daily and weekly tests conducted by Radiomen include all items designated as routine or operational in the preventive maintenance checkoff list, plus increasingly technical items as your training and experience increase. The individual ship's electronics material officer determines which of the routine tests are done by the ETs.

The POMSEE program is being revised and incorporated into the Planned Maintenance System, which comprises maintenance of all types of equipment (hull, machinery, and the like). Main features of the present POMSEE program will be carried into the new program. Instead of employing Maintenance Standards Books, however, the System utilizes Maintenance Requirement Cards (MRCs) for the detailed guidance of personnel performing a specific preventive maintenance task on a particular item of equipment. Accompanying the MRCs are forms for scheduling the preventive maintenance and for recording the results. Descriptions of the MRCs and the various scheduling forms are contained in OpNav Instruction 4700.18.

## 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 as follows: (1) General information, (2) Installation, (3) Operation, (4) Troubleshooting, (5) Maintenance, and (6) Parts list.

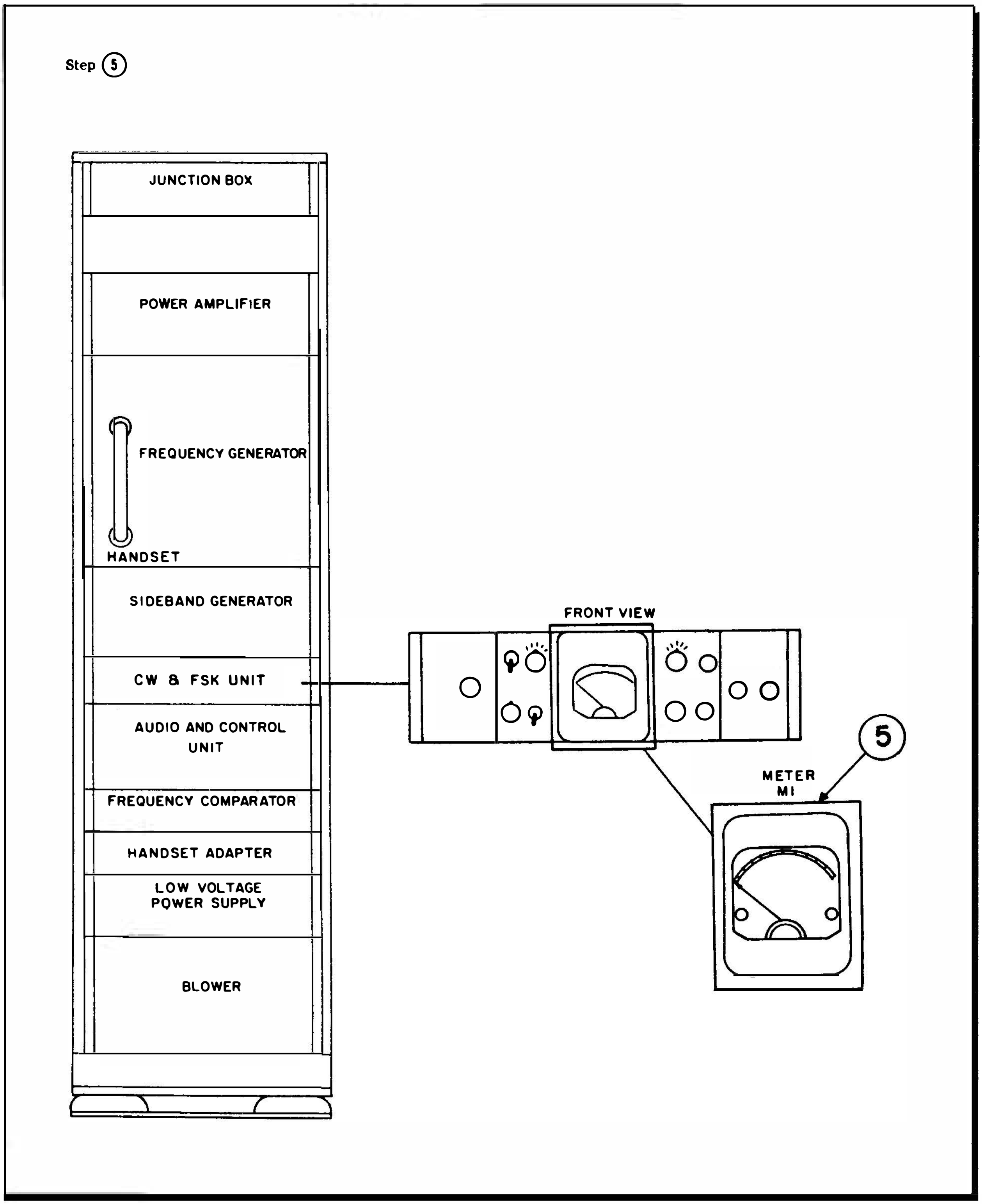
Section 3—Operation—is the section of most concern to you. It contains a description of the equipment's controls, tuning adjustments, and operating procedures. Always study this section before attempting to tune or operate any equipment with which you are unfamiliar. It also is a good idea to read section 1, which contains a general description of the equipment and its capabilities.

## ELECTRONIC EQUIPMENT FAILURE/ REPLACEMENT REPORTS

It is extremely important that the Bureau of Ships be informed promptly of all failures and deficiencies of certain electronic equipment. The Bureau selects the equipment on which it desires reports, and publishes a list of the equipment in the Electronics Information Bulletin (EIB) NavShips 900,022A. Only the equipment so designated is reported on.

Electronic Equipment Failure/Replacement Report, BuShips 10550-1, DD 787 (proposed), is the form on which failures are reported. (See fig. 14-2). This report serves several excellent purposes. It (1) provides the Bureau with a comprehensive presentation of the overall performance of electronic gear, (2) points out the weakest parts of any particular equipment, and (3) forms the basis on which to procure repair parts. Because new models (or modifications of old models) usually are in some stage of development, prompt receipt of failure reports enables BuShips to initiate immediate corrective action to eliminate similar or related deficiencies in subsequent production.

The forms must be filled out in conformity with the instructions printed on the covers and flaps of each pad of forms. The instructions include the following types of information:




36.101(76)
Figure 14-1.—Opposing pages from URC-32 Maintenance Standards Book.

Step (5)

**Operating Conditions and Control Settings:**

**Radio Set AN/URC-32 in full operation.**

| STEP | | |
|---|---|---|
| NO. | ACTION REQUIRED | PROCEDURE |
| (5) O.M. | Record meter (M1) reading. | With the Radio Set AN/URC-32 in normal operation (CW, FSK, or phone) note the peak indication of VU meter (M1) on the CW and FSK Unit. Set range switch (S2) to USB TRANS. If that type of operation is in use record the reading.<br>NOTE: When using meter (M1) on the CW and FSK Unit add range 0 dbm or +8 dbm to meter reading to give total in dbm. |

**Time Schedule: Record and initial.**

**1st Year of Operation**

| DAY | 19____ | 19____ | 19____ | 19____ | 19____ | 19____ | 19____ | 19____ | 10____ | 19____ | 19____ | 19____ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
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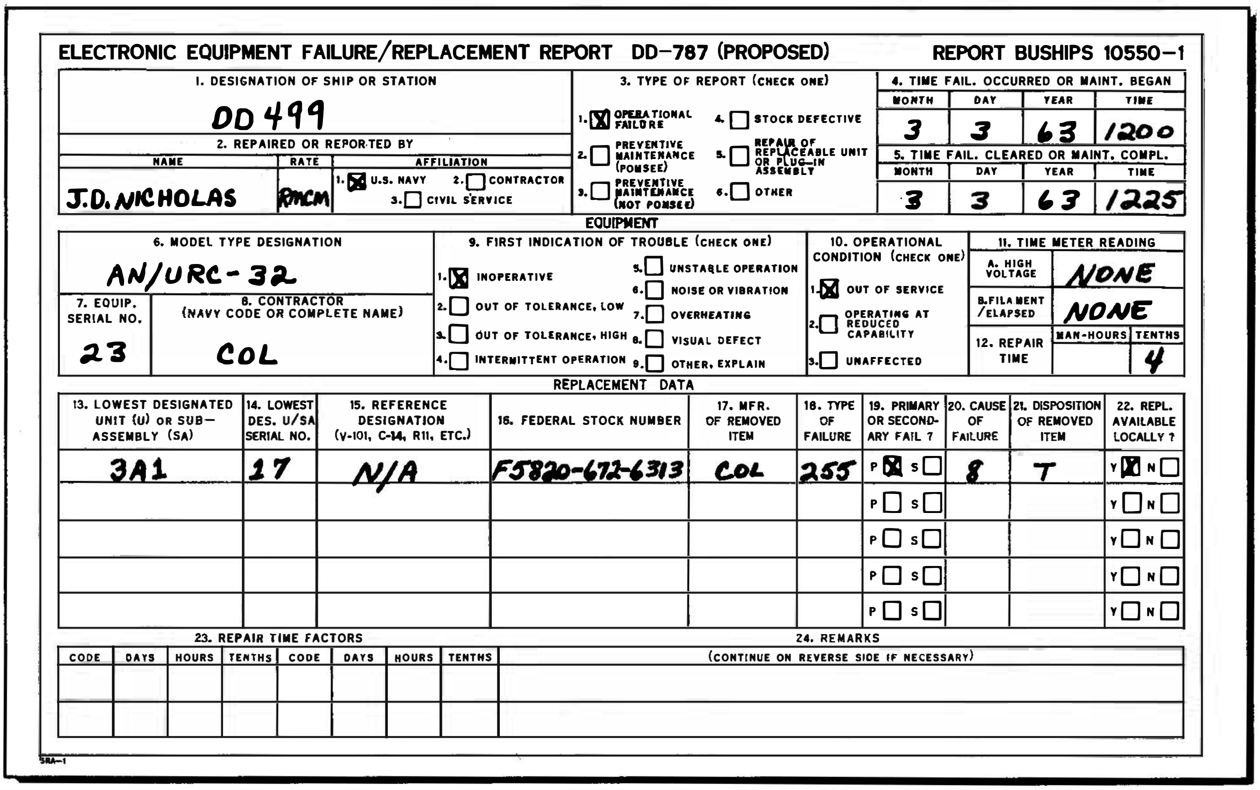
| 30 | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | |
| Initial | | | | | | | | | | | | |

Figure 14-1. —Opposing pages from URC-32 Maintenance Standards Book—Continued.


ELECTRONIC EQUIPMENT FAILURE/REPLACEMENT REPORT DD-787 (PROPOSED) REPORT BUSHIPS 10550-1

| 1. DESIGNATION OF SHIP OR STATION | 3. TYPE OF REPORT (CHECK ONE) | 4. TIME FAIL. OCCURRED OR MAINT. BEGAN |
|---|---|---|
| DD 499 | 1. [X] OPERATIONAL FAILURE; 2. [ ] PREVENTIVE MAINTENANCE (POMSEE); 3. [ ] PREVENTIVE MAINTENANCE (NOT POMSEE); 4. [ ] STOCK DEFECTIVE; 5. [ ] REPAIR OF REPLACEABLE UNIT OR PLUG-IN ASSEMBLY; 6. [ ] OTHER | MONTH 3, DAY 3, YEAR 63, TIME 1200 |
| 2. REPAIRED OR REPORTED BY — NAME: J.D. NICHOLAS; RATE: RMCM; AFFILIATION: 1. [X] U.S. NAVY 2. [ ] CONTRACTOR 3. [ ] CIVIL SERVICE | | 5. TIME FAIL. CLEARED OR MAINT. COMPL. — MONTH 3, DAY 3, YEAR 63, TIME 1225 |

EQUIPMENT

| 6. MODEL TYPE DESIGNATION | 9. FIRST INDICATION OF TROUBLE (CHECK ONE) | 10. OPERATIONAL CONDITION (CHECK ONE) | 11. TIME METER READING |
|---|---|---|---|
| AN/URC-32 | 1. [X] INOPERATIVE; 2. [ ] OUT OF TOLERANCE, LOW; 3. [ ] OUT OF TOLERANCE, HIGH; 4. [ ] INTERMITTENT OPERATION; 5. [ ] UNSTABLE OPERATION; 6. [ ] NOISE OR VIBRATION; 7. [ ] OVERHEATING; 8. [ ] VISUAL DEFECT; 9. [ ] OTHER, EXPLAIN | 1. [X] OUT OF SERVICE; 2. [ ] OPERATING AT REDUCED CAPABILITY; 3. [ ] UNAFFECTED | A. HIGH VOLTAGE: NONE; B. FILAMENT /ELAPSED: NONE |
| 7. EQUIP. SERIAL NO.: 23 — 8. CONTRACTOR (NAVY CODE OR COMPLETE NAME): COL | | | 12. REPAIR TIME — MAN-HOURS: ; TENTHS: 4 |

REPLACEMENT DATA

| 13. LOWEST DESIGNATED UNIT (U) OR SUB-ASSEMBLY (SA) | 14. LOWEST DES. U/SA SERIAL NO. | 15. REFERENCE DESIGNATION (V-101, C-14, R11, ETC.) | 16. FEDERAL STOCK NUMBER | 17. MFR. OF REMOVED ITEM | 18. TYPE OF FAILURE | 19. PRIMARY OR SECONDARY FAIL ? | 20. CAUSE OF FAILURE | 21. DISPOSITION OF REMOVED ITEM | 22. REPL. AVAILABLE LOCALLY ? |
|---|---|---|---|---|---|---|---|---|---|
| 3A1 | 17 | N/A | F5820-672-6313 | COL | 255 | P [X] S [ ] | 8 | T | Y [X] N [ ] |
| | | | | | | P [ ] S [ ] | | | Y [ ] N [ ] |
| | | | | | | P [ ] S [ ] | | | Y [ ] N [ ] |
| | | | | | | P [ ] S [ ] | | | Y [ ] N [ ] |
| | | | | | | P [ ] S [ ] | | | Y [ ] N [ ] |

| 23. REPAIR TIME FACTORS | | | | | | | | 24. REMARKS |
|---|---|---|---|---|---|---|---|---|
| CODE | DAYS | HOURS | TENTHS | CODE | DAYS | HOURS | TENTHS | (CONTINUE ON REVERSE SIDE IF NECESSARY) |
| | | | | | | | | |
| | | | | | | | | |

5RA-1

15.2

Figure 14-2.—Electronic Equipment Failure/Replacement Report (DD-787).

1. General instructions stating who is responsible for completing forms; what maintenance activities are covered; when, how, and why forms must be completed; and where forms are sent.
2. Lists of "type of failure" codes arranged for ease of use.
3. Explicit block-by-block instructions.
4. Sample completed forms.

The report forms are filled out in sets of three. The white original is submitted to BuShips; the yellow second copy is packaged with items forwarded to another activity for repair or analysis; and the pink third copy is retained by the originator.

Reports must be mailed promptly to the Bureau of Ships. No covering letter is necessary.

## ELECTRONIC EQUIPMENT OPERATIONAL TIME LOGS

Another important source of equipment performance data is the Electronic Equipment Operational Time Log, NavShips 4855 (5-61), shown in figure 14-3. This log, maintained by the equipment operator, is a record of the periods of time an equipment actually is energized during a given month. At the end of each month, a copy of the log is forwarded to BuShips. There, it is used for evaluating equipment reliability and failure/replacement reports, and for other maintenance programing. It also keeps BuShips informed of the number of equipments actually in use.

Detailed instructions for completing and forwarding the Electronic Equipment Operational Time Logs are printed on the front and rear covers of each pad of forms. You can contribute toward better and more reliable equipment by carefully following these instructions.

Logs are required only for selected equipments, and these are listed periodically in the Electronics Information Bulletin.

## TESTING ELECTRON TUBES

The leading cause of failure or poor operation of electronic equipment (transmitters as

ELECTRONIC EQUIPMENT OPERATIONAL TIME LOG
NAVSHIPS 4855(5-61)

SUBMIT MONTHLY FOR EACH APPLICABLE EQUIPMENT WHETHER IN USE OR NOT IN USE

| 1. MONTH | YEAR | 2. DESIGNATION OF SHIP OR STATION |
|---|---|---|
| 6 | 63 | DD 499 |

| 3. EQUIPMENT MODEL TYPE DESIGNATION | 4. EQUIP. SERIAL NO. |
|---|---|
| AN/URR-35 | 64 |

COMPLETE THIS SECTION IF EQUIPMENT HAS TIME METER(S)

| READ DATA ON COVER | 5. FILAMENT OR ELAPSED TIME METER READINGS | | 6. LEAVE BLANK | 7. HIGH VOLTAGE (PLATE) TIME METER READINGS | | 8. LEAVE BLANK | 9. NO. OF OPERATIONAL FAILURES THIS MO. |
|---|---|---|---|---|---|---|---|
| | 1st DAY OF MO. | LAST DAY OF MO. | | 1st DAY OF MO. | LAST DAY OF MO. | | |
| | | | | | | | |

COMPLETE THIS SECTION IF EQUIPMENT DOES NOT HAVE TIME METER(S)

| 10. DAY OF MONTH | 11. STANDBY | | 12. LEAVE BLANK | 13. FULLY ENERGIZED | | 14. LEAVE BLANK | 15. CHECK (✓) IF OPR. FAIL. OCCURRED |
|---|---|---|---|---|---|---|---|
| | TIME ON | TIME OFF | | TIME ON | TIME OFF | | |
| 1 | N/A | | | 15ØØ | | | |
| 5 | | | | | 18ØØ | | ✓ |
| 5 | | | | 19ØØ | | | |
| 18 | | | | | 1427 | | |

DO NOT WRITE BELOW THIS LINE — CONTINUE ON REVERSE SIDE IF NECESSARY

SRA-2

15.3

Figure 14-3.—Electronic Equipment Operational Time Log, NavShips 4855.

well as receivers) is the electron tube. If all tube failures could be eliminated, the maintenance load would be reduced considerably. Tubes do not always fail completely. Their performance may deteriorate gradually but not to the extent that it will be apparent in a tube tester.

One reason for the failure of the average tube tester to give a full indication of the capabilities of a tube is the 60-cycle sine wave that is applied to the grid of the tube under test. In electronic equipment, all kinds of waveshapes may be applied at frequencies varying from a few cycles to several billion cycles per second.

The usual shipboard tube tester cannot determine accurately the ability of a tube to act as an oscillator or as an ultrahigh frequency amplifier.

The practice of wholesale removal and test of electron tubes on a periodic basis is no longer authorized by the Bureau of Ships. Action is being taken to revise equipment technical manuals that specify such routine. If routine test of an electron tube in a designated application is necessary, the manual will specify an exception to the rule.

The following maintenance routine is strongly recommended:

1. When a performance deficiency is detected, make an attempt to isolate the specific cause.

2. When the trouble is localized and a tube is suspected, remove and test that tube. If found good, replace in the same socket. Interchange of tubes between sockets should be avoided.

3. If repair by tube substitution is necessary as a last resort, test the new tube (within the capability of the tube tester) before placing it in service.

4. If a new tube tests good but does not work in a particular socket, make a note about it, and save the tube for use in another application where it will work. The Bureau of Ships is particularly interested in receiving information in instances where extensive selection of tubes for a particular socket is necessary for proper operation.

## MAINTAINING AIR FILTERS

The cleaning of air filters is exceedingly important for the proper operation of electronic equipment. The lack of proper servicing (cleaning or replacing) of air filters causes an enormous amount of trouble. 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, such as Models TED, AN/SRT-14, -15, and -16, AN/URT-7, and AN/GRC-27. Models AN/URR-13, -27, and -35 receivers, and AN/URA-8 converters also use forced air cooling, and this means moving 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. This dust and dirt tends to clog the filter and prevent the air from moving through. The result is that the equipment gets too hot 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. This condition cannot be overemphasized; and on the basis of this alone, it would appear that the maintenance man can reduce his workload substantially by ensuring that air filters are serviced properly.

## MAINTAINING HEADSETS AND MICROPHONES

The best way to maintain headsets and microphones is to ensure that they are handled properly. Proper handling includes, for example, hanging up earphones by the straps, not by the cord; removing a plug from a jack by grasping the plug, not the cord; avoiding kinks or other strains in the cord; avoiding rough handling of microphones and earphones, and avoiding exposure to moisture.

Repair consists largely of replacing or repairing plugs, jacks, and cords. In any event, do not place defective equipment with the ready spares. It should be repaired first.

## MOTORS AND GENERATORS

Keep interior and exterior of motors and generators free of metal dust, dirt, oil, or water. Take particular care to prevent metal dust from collecting inside the end windings of the armature—that means both the coupling and commutator ends. Dirt, aside from restricting the air flow, is a heat insulator. An excessive accumulation eventually grounds the coils and burns them out.

Compressed air, if dry, is the most effective means of cleaning interior parts of motors and generators. The hand bellows is preferred to a pressure hose for there is less chance that small particles will be driven into the insulation. When cleaning a machine, take care not to crowd dirt into the air ducts or into narrow spaces between conducting parts. Carefully wipe and clean brush holders, studs, and leads to remove all traces of metal dust worn from the commutator. Also guard against accumulation of carbon dust from the brushes.

## COMMUTATORS

The connection of the armature conductors to the individual commutator segments is made at the part of the segment referred to as the "riser." This connection is secured by hard solder or silver solder. Insulation of segments from each other and from the armature shaft and core is accomplished by thin sections of mica between each segment and between the segments and the clamps holding the segments to the shaft. The mica between the segments is cut to the same shape as the segments. That part of the mica directly under the brushes is cut below the surface of the commutator bars.

Commutators never should be lubricated. It is unnecessary for a commutator to present a bright, shiny appearance. During normal wear, a film develops on the commutator on the area spanned by the brushes. This film should show a dark brown or chocolate color. The film serves to lubricate the brushes and reduce the rate of wear. Therefore, it normally should not be disturbed.

Check for brush sparking as evidenced by rough and pitted commutator bars. Look for loose connections to the commutator risers. This condition may be indicated by specks of solder on the surrounding field coils and connections.

If the commutator is dirty, it must be cleaned. Remove the brushes, and pick up loose dirt with a vacuum cleaner, or blow it out with dry, compressed air, being careful not to blow it into the housing. Wipe out oil and grease with a lintless cloth moistened with cleaning solvent. Dirt can be removed from the commutator segments with canvas secured to a flat, thin stick and held in contact with the commutator. Rotate the shaft, moving the stick across the area of the commutator bars, applying a light, even pressure.

Oil and dirt tend to glaze the commutator surface with a high-resistance coating. If a high-resistance coating cannot be removed with the canvas stick, it can be removed with No. 0000 or finer sandpaper (not emery cloth) folded over a flat, thin stick to hold the sandpaper in contact with the commutator. Rotate the shaft slowly, moving the stick sideways to reach the entire width of the commutator bars. Do not hold the sandpaper in only one position, because this grooves the commutator. Use light, even pressure.

As the surface of the commutator gradually wears, the mica becomes flush with the brush surface of the segments. If this condition is not corrected by undercutting the mica, rapid brush wear results. Extreme care must be taken when undercutting, to prevent the cutting tool from leaving the slot and scoring the brush surface of the commutator. Also, great care must be exercised to avoid sharp edges on the commutator bars.

Excessive wear or grooving of the commutator is a serious trouble, requiring the services of qualified men in the electrical repair shop to redress the commutator.

## BRUSHES

The following checks should be made when checking generator brushes and brush rigging. Remove any accumulation of dust and dirt from the brush rigging and surrounding parts by wiping with a clean, dry cloth. Dirt may form an electrical path and short out the generator. Look for cracks in the brush holder yoke and check for tightness. Check for loose brush holders and for security of jumper leads between holders of like polarity. Check to see that no brush holder is bent out of alignment. Check for broken brush springs. Move the brushes in and out of the holders to assure that they move freely. Brushes must move to maintain contact with the commutator as they wear; however, they should not be so loose that they can "chatter."

Visually inspect brushes for wear. Replace brushes when they wear down so that the brush spring or pressure arm comes within one-sixteenth inch of resting on the brush holder. If brushes wear beyond this point, sparking may occur and damage the commutator and rotor windings.

Check the brushes to see that they are not cracked or chipped. Check for pits caused by sparking. Also check for oil-soaked brushes. If the brush is oil-soaked, it must be replaced. Oil acts as an insulator, so that terminal voltage is lowered.

When replacing the original brushes, make certain that they are replaced in their original holders; otherwise, it may be necessary to refit the brushes. When new brushes are installed or old brushes are replaced after a commutator is dressed, it is necessary to fit or seat the brushes to the commutator before the machine is used. The best way to do this is to run the generator without excitation for at least one-half hour before placing into service. Use of sand paper or other abrasive to seat brushes is not recommended.

SLIPRINGS

The sliprings of a-c generators must be inspected periodically for smoothness of surface, diameter of the rings, and alignment of the rings on the shaft.

In routine maintenance of sliprings, cleaning and polishing are done by using canvas or No. 0000 sandpaper secured to a flat stick and held firmly against the sliprings as the shaft is turned. Never use emery cloth or coarse sandpaper. Emery cloth is a conductor and can cause shorts. Coarse sandpaper grooves the metal deeply. When the desired polish of the sliprings is achieved, remove all particles of dust and sand with dry, compressed air or a vacuum cleaner.

LUBRICATION OF MOTORS AND GENERATORS

You should be familiar with and be able to distinguish between grease-lubricated and permanently lubricated ball bearings.

The grease-lubricated type requires periodic lubrication with grease. The permanently lubricated type is sealed, has been lubricated by the manufacturer, and requires no additional lubrication throughout its life. Equipment furnished with sealed bearings can be recognized by the absence of grease fittings or provision for attaching grease fittings.

Cleanliness is of prime importance in avoiding ball bearing failure. Owing to the extremely high pressures and close fit between balls and races, even minute particles of dust may cause bearing failure. Dirt may be introduced into the bearing housing by careless handling, or by inclusion with the lubricant. Or it may work its way into the housing along the shaft.

Improper greasing procedures are a frequent cause of trouble in rotating electrical machinery provided with grease-lubricated ball bearings. The trouble in general is caused by an excessive quantity of grease being forced into the bearing housing. When grease is forced through the bearing seals and into the windings (or onto the commutator), deterioration of the insulation is a likely result. Excessive grease in the bearing housing itself results in churning, increased temperatures, rapid deterioration of the grease, and ultimate destruction of the bearing.

The stock numbers of grease for ball bearings are listed in chapter 60 of the BuShips Technical Manual. Machines that require special high-temperature silicone grease have a plate with the words "Use high temperature grease" attached near the grease fitting.

Motors and generators provided with bearings that should be lubricated with grease are installed with the grease cups removed from the bearing housings and replaced with pipe plugs. The grease cups are delivered with the onboard repair parts or special tools. BuShips instructions require that grease cups be attached to motors and generators only when the bearings are being greased. When the grease cup is removed from the bearing housing after a bearing is greased, the hole that remains must be plugged with a pipe plug. The grease cups should remain in the custody of maintenance personnel. Care should be taken to make sure that a grease cup is clean before it is used to add grease to a bearing and that the pipe plug used to replace the grease cup after greasing is also clean.

To avoid the troubles caused by an excessive amount of grease, grease should be added only when necessary; and, when grease is added, it should be done as follows:

1. Wipe outside of grease fittings and drain (relief) plug free of all dirt.
2. Remove bearing drain plug, and make sure the passage is open by probing with a clean screwdriver blade.
3. Remove pipe plug at top of bearing housing and install the bottom part of a clean grease cup.
4. Fill the bottom part of the grease cup with clean grease.
5. Put no more grease into the top part of the grease cup (the part that is to be screwed down) than will half fill it.
6. Screw the top part of the grease cup down as far as it will go.
7. Run the machine and let the grease run out of the drain hole until drainage stops (normally about 30 minutes). Remove grease cup and replace the pipe plug and the drain plug.

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 systems. Paint that has a metallic base is a good 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 deposits.

Antenna maintenance is not complicated. It consists mainly of simple visual inspections for physical damage and resistance tests for leakage resistance or insulation breakdown.

## 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 wire-brushed, whereas insulated-type receiving 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 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. Hard-Film Corrosion Preventive and Gun Slushing Compound, Grade B are satisfactory compounds.

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 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. It often 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.

The megger is the test equipment commonly used for testing an antenna system. Essentially, the megger (fig. 14-4) is a hand-driven d-c generator and an ohmmeter combined. 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 weak spots in the insulation if any exists. Chapter 12 of <u>Basic Electricity</u> (NavPers 10086-A) explains the megger in detail.

Before testing an antenna, the antenna 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 a constant and misleading resistance reading from being obtained, 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

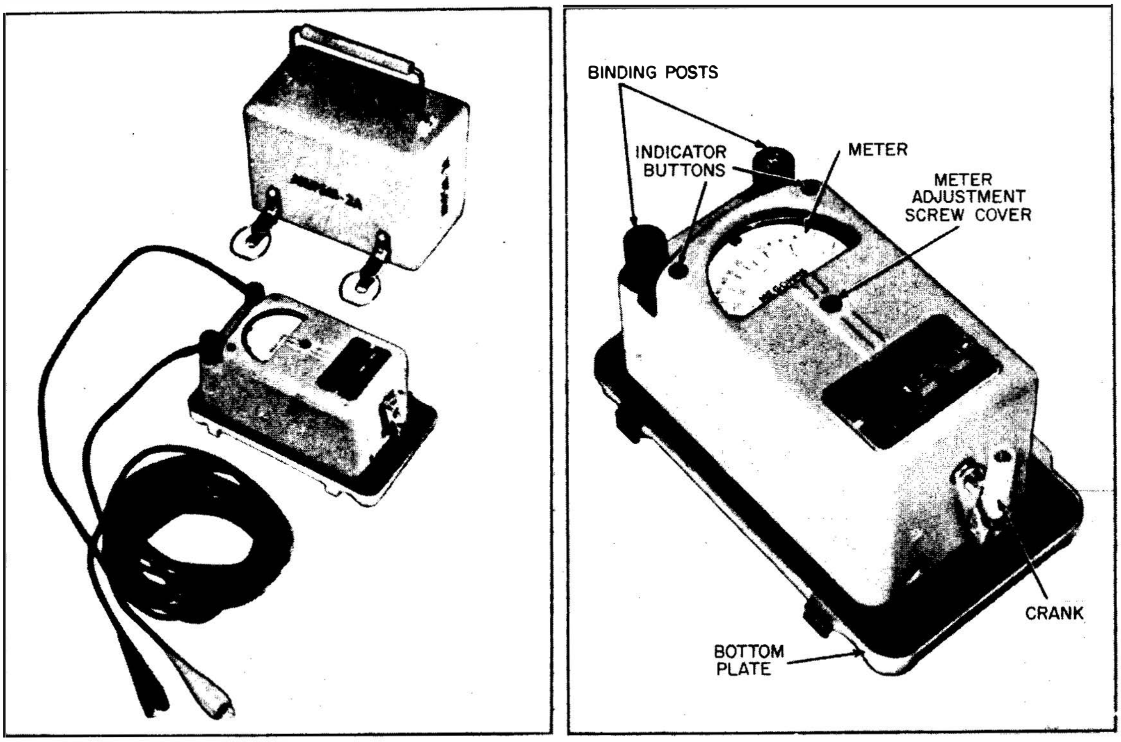



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Figure 14-4.—The megger.

connection) of the megger to the inner conductor of the transmission line. (Do 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. Abrupt changes in the weather, high humidity, or other natural causes often result in low readings. 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, and which tends to wash clean during rainstorms. Although helpful, we cannot depend upon an occasional rain 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—such 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 paint that may be on the insulators. Wash them with soap and water, and follow this with several rinsings with clean, fresh water. The 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 touchup 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 the 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 extent 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 you 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 your 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 thing to do 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, you will find an absence of power to the unit to be the cause of the trouble.

If there is an absence of power, you can 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. Their condition determines your next move. If a circuit breaker is tripped or a fuse blown, power should be turned off immediately, because this 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. Assure yourself that the equipment in question actually is faulty before beginning any wholesale removal of components.

## VISUAL INSPECTION

The visible condition of a unit is usually the first detail to check in any process of troubleshooting. If certain parts obviously are not in proper condition, correct these faults before going any further in your tests. Such conditions include parts burned, loose from mounting, disconnected, dented, or any other obviously improper condition.

Crude as it may seem, your nose can be a good pinpointing device for certain troubles. A part that overheats usually gives off an odor that is readily detectable, and sometimes can be located by the combined use of eyes and nose only. Of course, location of a burned part does not necessarily reveal the cause of the trouble.

In determining the cause of the trouble, it usually is necessary to refer to the equipment technical manuals. These manuals will be your 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, and 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 given for tracing signals in communication receivers and audio amplifiers. This general procedure, with modifications, can be applied to most electronic troubleshooting.

Signal tracing is a very effective method for locating defective stages in many types of electronic equipment. It is especially useful when servicing communication receivers, audio amplifiers, 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 circuit in question. The signals that result from this application then are checked at various points in the stage, using test instruments such as voltmeters, oscilloscopes, output meters, or other appropriate devices.

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.

The 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.

As an example, suppose the signal generator applies a voltage of 400 microvolts 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 microvolts to cause the output meter to indicate the same reference value. The gain of the stage is 4000 divided by 400, or 10.

If similar measurements made in the remaining stages of the receiver reveal one in which the 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 the applied signals must be low enough to prevent the automatic volume control system from functioning; otherwise, the measurements are inaccurate. In equipment technical manuals, the 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 the observed voltage values then are compared with the normal voltage values given in the equipment technical manual. From this comparison, the 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. This is true because modern electronic equipment is complex, and a great deal of time is required to check all the voltages present in all the stages.

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 the 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 the power is removed from the set and resistance values are measured with an ohmmeter. The resistance values then are compared with the 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 the 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 then 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. The resistance values registered in the normal electrolytic capacitor result from leakage being present between the electrodes. Because the electrolytic capacitor is a polarized device, the 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 your ohmmeter has a very high resistance scale, you will not see a deflection of the meter 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 the 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 the measurements first were made. A typical condition might be: "Power switch off--all controls fully CCW (counterclockwise.)" It is important that you 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 that some of the old standards be revised. Among the new techniques are methods of soldering special parts, such as transistors and crystal diodes. Unless a heat shunt is used, these conductors 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 the sockets before any soldering of the 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 sick bay or hospital when they no longer are usable for surgical purposes. You will find them an invaluable addition to your toolbox.)

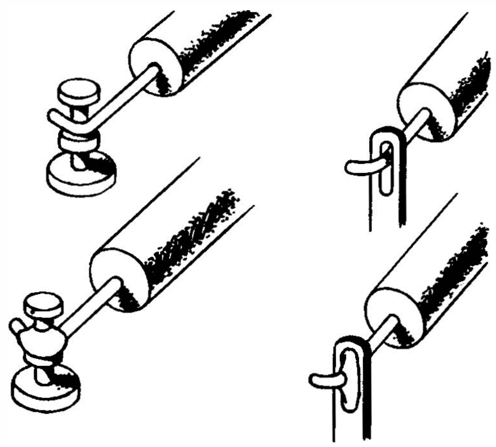
## STRENGTH OF SOLDERED CONNECTIONS

For years, the various radio and electronics handbooks have emphasized the necessity of wrapping wires tightly around terminals before soldering. This practice is required by Federal specifications, but efforts are now being made to revise the requirements in the light of recent investigations on solder strength.

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.

The 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 the wire is wrapped before soldering; less heat required in soldering and unsoldering; and less strain on parts because their leads do not get 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. 14-5.)



76.39

Figure 14-5.—Soldering method recommended by Navy Electronics Laboratory.

## 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 you would not try to solder a heavy metal box with the 25-watt iron. But you would find that iron quite suitable for replacing a small resistor in 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 light and easy to handle and has a small tip that is inserted easily into close places. Also, 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 from 1/4 inch to 1/2 inch (diameter) in size 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 your 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 high as 1000$^{o}$ 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. On the other hand, 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 proven to be 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. The exposure of the printed circuit is similar to a photographic exposure. The 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 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 and are repaired as 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.

Should it become necessary to remove a tube socket or any other part that requires 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 the 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 the repairs are completed.

## CLEANING ELECTRONIC EQUIPMENT

All electronic equipment should be cleaned, not just for appearance, but to assure good performance. Be sure to secure the power to the equipment before starting any kind of cleaning. 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 these contacts is disclosed sometimes by erratic "jumping" of the plate current meters as the circuit is tuned through resonance. The contacts and the surface of the inductors must be clean and smooth. If necessary to prevent scoring the copper surface, a tiny amount of vaseline may be applied.

Steel wool or emery in any form must not be used on electronic equipment. Sandpaper and files are to be used only on competent advice, or not at all.

Uses of solvents and their necessary safety precautions were discussed in chapter 13.

## TELETYPEWRITERS

The most important consideration in maintenance of teletypewriter equipment is proper lubrication and cleaning of the machines. Lubrication does not mean drenching the teletypewriter with oil or swabbing it with grease. Too much lubricant will, in a short time, collect dust and grit and oil-soak the wiring. A machine in this condition will be subjected to excessive wear and deterioration of insulation. Such machines are a fire hazard as well as a source of constant trouble.

It is important that you understand your cleaning and lubricating responsibilities. On most shore stations the operators are not required to clean or lubricate equipment. These duties are assigned to the station's maintenance force. On small stations or on some ships, however, it may be necessary for the operator to clean and lubricate. You should not attempt the job alone until you have done it several times under supervision of an experienced hand. Even so, be sure to consult references that give exact lubrication specifications.

Before beginning to clean or lubricate a machine, be sure that you remember: ALWAYS DISCONNECT THE POWER.

At this point, you must consult the equipment technical manual for instructions in disassembling the equipment into its major units (such as removing the printing unit from its base).

After you have the equipment broken down, begin by wiping all old grease, oil, and dirt from the machine. Use a clean, dry piece of cheesecloth or other lint-free cloth for wiping. The cloth may be wrapped around a screwdriver or stick to reach points not readily accessible. Take care not to disturb springs or adjustments. Troubles frequently develop as a result of careless cleaning.

If a cleaner (solvent) is used to remove hardened grease, be sure that any unit on which you use it is not allowed to stand more than 1 hour before grease or oil is applied to the cleaned surfaces. A good cleaning mixture is kerosene and SAE-10 oil. This mixture leaves a rust-preventing residue of light oil on the metal. NEVER use a paraffin base oil, for it leaves the parts gummy and results in sluggish action of moving parts.

To clean the type on model 15 and 19 machines, insert a doubled piece of cheesecloth between the type bars and backstops to catch dirt and excess cleaning fluid. Clean the type thoroughly with a piece of cheesecloth moistened with Varsol or patented type cleaner. Use the cleaning fluid sparingly to avoid getting it on other parts of the machine. Then brush the type with a dry typewriter brush.

Do not use cleaning fluid on the model 28 typebox. Remove the typebox from the machine and clean the type with a dry typewriter brush or soft cloth. Should it be necessary to disassemble the type box, be careful not to lose the small springs that are inside the box.

Clean key caps with a cloth slightly moistened with water. Do not use solvent on key caps.

After a thorough cleaning, the equipment is ready for lubrication. Here, again, you will have to consult the technical manual for explicit instructions on points to lubricate and the type and quantity of lubricant to use.

In general, Teletype KS-7470 oil and type MIL-C-3278 grease are used to lubricate teletypewriter equipment. The grease is applied to wearing surfaces, gears, and heavy moving parts, and the oil is applied to bearings and small moving parts. All springs, wicks, and felt washers must be saturated thoroughly in oil.

When lubricating, exercise special caution to prevent any oil or grease from getting between the armatures and the pole pieces of the magnets. Electrical contacts must be kept free of oil.

A teletypewriter must be lubricated more frequently as the operating speed increases. Thus, a machine geared for an operating speed of 100 wpm requires lubrication oftener than one operating at 60 wpm. Here is the recommended lubrication schedule:

| Operating Speed (words per minute) | Lubricating Interval (whichever occurs first) |
|---|---|
| 60 | 3000 hours or 1 year |
| 75 | 2400 hours or 9 months |
| 100 | 1500 hours or 6 months |

Regarding the lubricating interval, an important point to remember is the expression "whichever occurs first." To illustrate, a machine in continuous use at 100 wpm accumulates 1500 operating hours in only 2 months. For machines used occasionally or intermittently, you need a log to keep track of the total operating hours. The Electronic Equipment Operational Time Log (NavShips 4855), described and illustrated earlier in this chapter, is for this purpose.

## TYPEWRITERS

A typewriter that is used with care will give many years of service. Typewriter manufacturers claim that the 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. Put out your cigarette before you start.

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. The waste then will drop on your desk from where it can be brushed away.

The cylinder and rollers should be cleaned occasionally with alcohol. This 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 your typewriters will become coated with wax from the stencils.

The typewriter should be oiled occasionally, but do it 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 getting on rubber parts, the ribbon, and any place in the machine where it might stain the paper.

Keep your typewriter covered when not in use. No matter how clean the office, a certain amount of dust is always in the air. When the machine is uncovered for long periods, dirt gets into the moving parts of your machine and causes wear.

## FREQUENCY MEASUREMENTS

It is very important to keep Navy transmitters on their assigned frequencies. To aid you in keeping the transmitters within the frequency tolerances, the Navy provides each ship and station with accurate frequency meters. Of course, the frequency meter is of little value 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.

DNC 5 requires that frequency meters be checked against radio stations WWV or WWVH at least once weekly and a log kept of the checks conducted. You must consult the equipment technical manual for your particular model frequency meter for instructions on adjusting the frequency to coincide with the primary standard.

### RADIO STATION WWV

The technical radio services broadcast by radio station WWV include:

1. Standard radiofrequencies. Six frequencies are broadcast continuously, day and night—2.5, 5, 10, 15, 20, and 25 mc.
2. Time announcements.
3. Standard time intervals.
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 the standard frequencies, which are accurate to better than 1 part in 100,000,000. Any of the 6 radiofrequencies can be used for checking your frequency meters.

#### Time Announcements and Standard Time Intervals

When you tune in WWV you will hear the audiofrequency of 440 or 600 cycles as a steady tone. Superimposed on the tone is a series of clocklike ticks. You can determine time and intervals of time to the finest degree through (1) regular interruptions of the audiofrequency, (2) 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. You 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 1655Z, or 11:55 a. m. eastern standard time, you 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 you were correcting the message center clock, you would preset hour, minute, and second hands to exactly 1655 while the announcements were going on; you 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 the ship's chronometers. The Radioman's duties in this regard are limited to tuning the receiver and making the 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 the 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

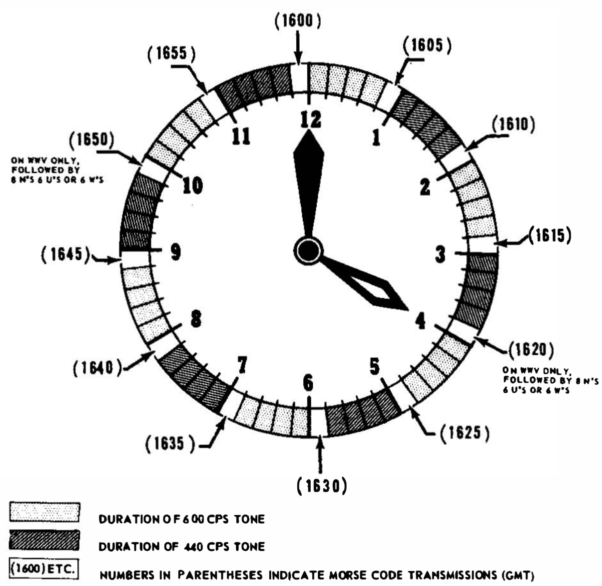
Radio propagation disturbance warnings are notices that tell users of radio transmission paths over the North Atlantic the condition of the ionosphere at the time of the announcement, and also how good or how bad communication conditions are expected to be for the next 12 hours. They are prepared four times daily and are sent at 19.5 and 49.5 minutes past the hour. Report of current conditions is made by one of the letters N, U, and 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, for example, propagation conditions at time of forecast are normal, 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.




76.40

Figure 14-6.— Structure of WWV and WWVH signals.

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 the 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.

Figure 14-6 shows the structure of WWV and WWVH signals.

## OTHER STATIONS

Many of the Navy radio stations rebroadcast the signals of WWV. In addition, radio stations in several other countries broadcast signals comparable to those broadcast by WWV and WWVH. The system employed by the foreign stations may differ somewhat from that of the United States, but usually you can obtain time signals 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 are contained in H. O. Pubs. 117A and 117B.

# APPENDIX I

# TRAINING FILM LIST

Training films that are directly related to the information presented in this training course are listed below. Under each chapter number and title the training films are identified by Navy number and title and are briefly described. Other training films that may be of interest are listed in the United States Navy Film Catalog, NavPers 10000 (revised).

## Chapter 2

### NAVAL COMMUNICATIONS

MN-2621A — Radio Operator Training—The Radio Man Fights. (7 min. —B&W—Sound—Unclassified—1944.) Follows course of message from NSS in Washington, D. C., to Guadalcanal, and a task force flagship. Explains that radio is the nerve system of the Navy. Presents an overall picture of training and duties expected of each radioman.

MN-8099A — Radio Teletype Systems Afloat - General Principles of Operation. (15 min. —B&W—Sound—Unclassified—1956.) Explains the reason for radio teletype systems afloat and describes briefly two different systems of transmitting and receiving.

MN-8157A — The Naval Communications System—Types of Communication Centers and Services Rendered. (12 min. —B&W—Sound—Unclassified—1955.) Shows the functions of the four kinds of communication centers and tributaries.

MN-8157B — The Naval Communications System - Typical Communication Center Operation. (15 min. —B&W—Sound—Unclassified—1955.) Shows how a typical primary communication center performs its functions.

MN-9235 — The Communicator's Job. (10 min. — B&W — Sound — Unclassified—1954.) Shows the various aspects of the communicator's job on ship and shore stations and the equipment necessary to keep communications flowing swiftly and efficiently.

## Chapter 3

## COMMUNICATION SECURITY

MN-2621D Radio Operator Training—Transmission Security. (19 min.—B&W—Sound—Unclassified—1944.) Cautions radio operators against any action which might reveal a location or aid enemy in any way. Points out danger in sneaking through messages, sending unauthorized messages, and cutting in.

MN-6947 Security Control—You Never Can Tell. (36 min.—B&W—Sound—Unclassified—1951.) Teaches security by following a naval security officer through the offices, laboratory, and production plant of manufacturer producing a classified device for the Navy. The security officer, in search of information leaks which caused the device to be ineffective during a naval engagement, discovers and points out existing conditions which would enable an espionage agent to operate in the factory.

MA-7993 Cryptosecurity. (18 min.—B&W—Sound—Confidential—1952.) US Army TF30-1739.

MN-8333 Radio Transmission Security. (28 min.—B&W—Sound—Unclassified—1955.) US Army TF11-1976. Dramatizations of violations of radio transmission security in a task force operation involving Ground Forces, Air Forces, and Navy.

MA-8580 Defense Against Radio Jamming. (24 min.—B&W—Sound—Unclassified—1956.) US Army TF11-1995. Teaches how to recognize radio jamming and how to minimize its effectiveness. Outlines several precautions to reduce the possibility of jamming including: desirable radio location; use of dummying antenna for tune-up; operating with the least power required; and keeping transmissions as short as possible.

## Chapter 4

## INTERNATIONAL MORSE CODE

MN-2621B Radio Operator Training—The Technique of Hand Sending. (9 min.—B&W—Sound—Unclassified—1944.) States that important parts of transmitter are knob, contacts, tension spring, adjusting contacts, and adjusting springs. Studies elements of Morse code, timing, and parts of body that function when transmitting code. Stresses importance of correct position and operation.

MN-2621C Radio Operator Training - Rhythm, Speed, and Accuracy in Hand Sending. (11 min. — B&W — Sound — Unclassified — 1944.) Discusses sequence in rhythm and timing. Points out that clear, distinct sending is essential in order to assure proper receiving at destination. Compares several senders' ability by means of the recording tape. States that it is best to be accurate and progress slowly rather than be a speed demon who sends jumbled messages.

## Chapter 8

## ANTENNAS AND RADIO WAVE PROPAGATION

MA-1704 Radio Antennas - Creation and Behavior of Radio Waves. (11 min.—B&W—Sound—Unclassified—1942.) USAF TF1-474. Demonstrates how electromagnetic fields are formed, and illustrates behavior of sky and ground radio waves. Animated diagrams are used almost exclusively.

MA-1705 Radio Antennas - Fundamentals. (13 min. —B&W—Sound—Unclassified—1942.) USAF TF1-475. Shows how a standing wave is created; explains voltage and current strength at various areas along the antenna; shows how antenna length is determined; and demonstrates handling trailing antenna. Both straight photography and animation are used.

MA-6963 Effects of the Ionosphere on Radio Wave Propagation. (29 min. —B&W—Sound—Unclassified—1950.) US Army TF 11-1632. By means of animation, shows characteristics of propagated radio waves at various frequencies. Action and characteristics of both groundwaves and sky waves are shown, and advantages and disadvantages of each are discussed. Effect of ionosphere on the skywaves of higher frequencies is discussed in some length. Refraction of radio waves entering the ionosphere and effect of skip distance are shown and discussed for different frequencies and angles of transmission. Effects of favorable and unfavorable ionospheric conditions are shown.

## Chapter 9

## RADIO COMMUNICATION EQUIPMENT

MN-1679B Radio Operator Training—Superheterodyne Receivers. (14 min. — B&W — Sound — Unclassified — 1944.) Discusses manual procedure and principles involved in detailed operation of receivers; demonstrates typical errors and how to guard against them. (Accompanied by film strip SN-1679AB.)

MA-1706 Radio Transmitters - Principles and Typical Circuits. (18 min. — B&W — Sound—Unclassified—1942.) USAF TFL-476. Points out parts of several types of radio transmitters, describes functions, and illustrates action of the amplifier, microphone, and crystal oscillator. Both straight photography and animation are used.

MN-6836 Shipboard Radio Communications - Remote Control Transfer Switchboards. (11 min. — B&W — Sound — Unclassified 1951.) Describes new communications switch-type remote control panels designed to replace more cumbersome remote control transfer panels of patch cord type. Two panels are discussed: Radio Receiver Transfer Switchboard, and Radio Transmitter Transfer Switchboard.

## Chapter 10

## TELETYPEWRITER EQUIPMENT AND OPERATION

MN-7467A TT-47/UG Teletypewriter—General Principles and Operation (16 min. — B&W —Sound—Unclassified— 1953.) Outlines how teletypewriters are used in the Navy's communication system. The principal differences between the TT-47 and older, more familiar models are shown. Demonstrates for the operator the basic principles of operation, use of the various function keys, correct procedure for setting up messages, and securing machine.

MN-9237A Mechanical Operation of the Model 28 Teletypewriter—Keyboard Transmitting Mechansim. (12 min. —B&W—Sound—Unclassified—1954.) Shows the mechanical operation of the keyboard transmitting mechanism of the model 28 teletypewriter (TT-47A/UG). Action is traced from the key punched to the signal generator with the action of each part in the chain between keyboard and generator graphically explained.

MN-9237B Mechanical Operation of the Model 28 Teletypewriter—Automatic Typer Selecting Mechanism. (11 min. —B&W—Sound—Unclassified—1954.) Shows the chain of action in the automatic typer of the model 28 teletypewriter (TT-47A/UG) from the signal generator to and through the selecting mechanism that operates the code bars.

MN-9237C Mechanical Operation of the Model 28 Teletypewriter—Type Box Positioning Mechanism. (18 min. —B&W—Sound—Unclassified—1954.) Shows by means of close live photography the chain of action of the mechanical levers that position the type box of the model 28 teletypewriter (TT-47A/UG) in the proper position so that the letter or figure key that is punched may be printed.

MN-9237D Mechanical Operation of the Model 28 Teletypewriter—Function Mechansim. (13 min. —B&W—Sound—Unclassified—1954.) Shows the mechanical chain of action in the function mechanism of the model 28 teletypewriter (TT-47A/UG). Particular emphasis is placed on the operation of the function clutch as opposed to the main shaft clutch.

MN-8099A Radio Teletype Systems Afloat—General Principles of Operation. (15 min. —B&W—Sound—Unclassified—1956.) Explains the reason for radioteletype systems afloat and describes briefly two different systems of transmitting and receiving.

MN-8099B Radio Teletype Systems Afloat—Tone-Modulated System. (11 min. —B&W—Sound—Unclassified—1956.) Describes operation of the tone-modulated system for short-range radioteletype transmitting and receiving system.

MN-8099C Radio Teletype Systems Afloat—Carrier Frequency Shift Transmitting System. (6 min. —B&W—Sound—Unclassified—1956.) Describes the long-range frequency-shift transmitting system used in shipboard radioteletype systems.

MN-8099D Radio Teletype Systems Afloat—Carrier Frequency-Shift—Receiving System. (10 min. —B&W—Sound—Unclassified—1956.) Explains simply the reason and operation of radio-frequency shift system for radioteletype systems afloat.

## Chapter 13

## SAFETY

MN-6754 Safety Precautions for Electronics Personnel-Introduction. (15 min. —B&W—Sound—Unclassified—1951.) Shows electrical and mechanical hazards that Electronics Technician encounters in normal work and stresses precautions which should be employed to prevent accidents. Film content includes procedures for working on energized and deenergized circuits, handling of cathode ray tubes, preventive measures aboard ship, and hazards of carelessness and practical jokes. Stresses necessity for cultivation of safe working habits.

## Chapter 14

## MAINTENANCE

MN-1540P Radio Technician Training—Tube Tester Operation. (9 min. —B&W—Sound—Unclassified—1944.) Shows testers designed to check (1) cathode emission, and (2) dynamic mutual conductance of tube. Emphasizes use of instruction book supplied with tester and of tube manual. Testers are practically foolproof. Simply turn index scale to number of tube being tested, and follow lines to operate appropriate control or pushbutton.

MN-1540S Radio Technician Training - Volt-Ohmmeter Operation. (15 min. —B&W—Sound—Unclassified—1944.) Demonstrates use of various types of volt-ohmmeters (including the electronic meter), and gives cautions to be followed, such as using the large scale first (R x 1000; R x 10; R ranges available), and connecting the voltmeter in parallel (scales 600, 300, 30, 3 volts).

FN-7467C TT-47/UG Teletypewriter - Preventive Maintenance. (5 min. —B&W—Sound—Unclassified—1953.) Shows the importance of frequent checks and stresses the preventive maintenance technique which should be done by the operator rather than maintenance personnel. Cleaning, oiling, and minor adjusting of the machine are shown.

MN-6942 Lubrication of Electronic Equipment. (8 min. —B&W—Sound—Unclassified—1953.) The purpose of this film is to instill among key personnel an appreciation for the necessity and importance of routine and methodical lubrication according to tried and recommended procedures.

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