CRYPTOLOGIC COLLECTION EQUIPMENTS

NAVAL EDUCATION AND TRAINING COMMAND

NAVEDTRA 10251

PREFACE

CRYPTOLOGIC COLLECTION EQUIPMENTS, NAVEDTRA 10251 supersedes and expands on the information contained in chapters 7, 9, 10 and 15 of CT T-R-I 3&2, NAVEDTRA 10231-A, and is effective upon receipt. NAVEDTRA 10251 was prepared for Cryptologic Technician (T & R Branch) personnel at the E-4 and E-5 level. It provides operator-oriented training concerning the various types of receivers, ancillary equipments, antennas, and transmission lines in use throughout the Naval Security Group. It emphasizes the day-to-day operating aspects of the above equipments and antenna systems. The course will serve as a prerequisite to planned follow-on courses which will cover the various consolidated equipment systems in use throughout the Naval Security Group.

CRYPTOLOGIC COLLECTION EQUIPMENTS is based on authoritative sources; however, it is intended for training purposes and should not be considered a directive.

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THE UNITED STATES NAVY

GUARDIAN OF OUR COUNTRY

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

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

WE SERVE WITH HONOR

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

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

Our responsibilities sober us; our adversities strengthen us.

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

THE FUTURE OF THE NAVY

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

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

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

Never have our opportunities and our responsibilities been greater.

CONTENTS

NOTICE

Your comments and recommendations concerning this RTM are highly valued. You are encouraged to submit informal recommendations concerning publication content for review and consideration for inclusion in subsequent revisions. You may use a U. S. Government 2-way Memo for this purpose or discuss it on AUTOVON 922-6322. Your comments and recommendations should be forwarded to: Officer in Charge, Naval Education and Training Program Development Center Detachment, Box 1400, Corry Station, Pensacola, Florida 32511.

CHAPTER 1

INTRODUCTION

Over the past several years, methods of communications have undergone significant changes as a result of technological advances in science and industry. Because of this development, it is now possible for most countries of the world to build or buy sophisticated electro-mechanical equipments for use in their military and commercial communications networks. The old standby, manual morse, although still used extensively, is being replaced on numerous circuits by other methods of communications such as teletype and data systems which handle a higher volume of traffic. Radiotelephone, traditionally only a matter of intercept, recording, and transcription, is now being replaced by the more secure speech privacy systems. Needless to say, this progression to more advanced and complicated ways of communicating has required a higher level of knowledge and professionalism on the part of the Cryptologic Technician.

As members of the CT T, R, and I branches, we are very much aware of the demands that this new technology has placed upon the Naval Security Group. In order to do our jobs in today's Navy, we must learn things which, in the past, were thought of as being possible only in science fiction stories. Additionally, because of defense budget cuts and the resulting decreases in manpower authorizations, we now have to do an even bigger and more technical job than in the past—with less people. To help us with this task, we now have computers and other work-saving equipments which have proved to be very valuable. Also, our receivers are now built in such a manner that we can tie in several different types of equipment to save steps and, thus, do the job with less people and in a more efficient way.

Since you, as a radio equipment intercept operator, will be coming into contact with these new equipments in order to do your job at a field station, this publication has been developed to make your training easier and faster. Before going into the specific operation of these pieces of equipment, however, we will first introduce you to the categories and overall nomenclatures (symbol identification) of these equipments, as well as important areas of preventive maintenance which you, the operator, will be expected to perform.

COMMUNICATION EQUIPMENT CATEGORIES

The equipments that you will be learning to operate can be divided into six main categories. Because the operation branches (T, R, & I) of the Cryptologic Technician rating are primarily concerned with the collection of communication signals, only the receiving capabilities of the equipment will be explained. We will begin with the initial collection of signals and proceed through the various stages required to convert collected signals into a usable, intelligible form.

The first requirement in the collection process is to obtain a desired signal. This is accomplished by RECEIVERS which in turn require various other equipments. (These other equipments include antennas, multicouplers, and transmission lines, each of which will be addressed in chapter 2.)

RECEIVERS

You are already familiar with one type of receiver commonly referred to as a "radio." Yes,

the radio you use in your home or automobile is a receiver. Its basic operation is the same as that of those receivers you will be operating in your job with the Naval Security Group. The basic function of a receiver is to convert radio frequencies (RF) into audio frequencies (AF). Without a receiver, all other communications equipments are useless, regardless of their complexities or functions.

The receiver only allows us to "hear" a signal. When we intercept clear speech or manual morse transmissions, we need only a receiver to convert the signal into an intelligible form and enable us to understand the receiver audio output in the form of voice or "dits" and "dahs". This is not the case when we receive teletype signals (refer to figure 1-1). We can hear the teletype signal output from a receiver, but it is not humanly possible for us to understand it. Additional equipment is needed for further processing. For teletype signals, the audio frequency output must be routed from the receiver to a DEMODULATOR. (See figure 1-2.)

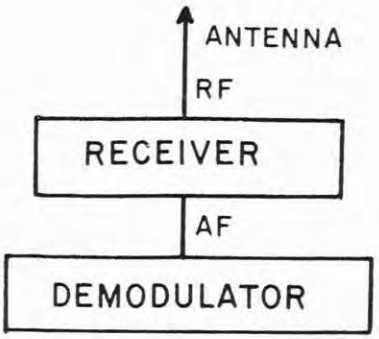

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Figure 1-2.—Signal flow of teletype signal from receiver to demodulator.

Demodulator

The basic function of a demodulator is to change audio frequencies to keyed tone (KT) or keyed direct current (KDC). If the teletype signal contains two combined canals (streams) of intelligence, the canals must be separated in order to process either of them. Thus, the separation of canals is another function of a demodulator. If the signal is a single-channel system, it is routed through a REKEYER. If the signal is a multi-channel system, it must be routed through a DEMULTIPLEXER. (See figure 1-3.)

Rekeyer

As noted above, a rekeyer is used for single-channel system tones. A rekeyer converts the keyed tone output of the demodulator into direct current (d.c.) pulses of sufficient strength to drive a teletypewriter for printout.

Demultiplexer

Demodulated teletypewriter signals containing more than one channel will be routed to a DEMULTIPLEXER (see figure 1-4). If an unseparated, two-channel teletype signal were

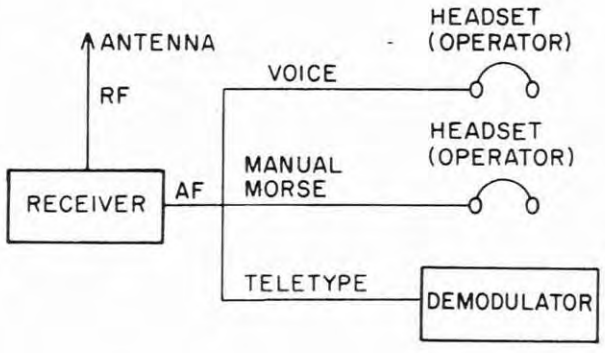

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Figure 1-1.—Flow of voice, manual Morse, and teletype signal.

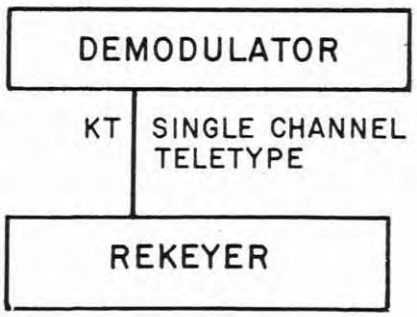

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Figure 1-3.—Signal flow of single-channel teletype signal.

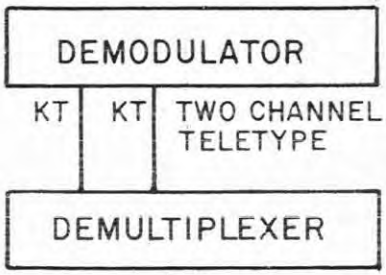

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Figure 1-4.—Signal flow of multi-channel teletype signal.

routed to two printers, the printers could not distinguish between the elements they were supposed to accept. The function of a demultiplexer is to separate multichannel signals into individual channels of intelligence. The demultiplexer also performs the function of a rekeyer by converting the individual channels of keyed tone into d.c. pulses which drive the teletypewriters for print-out (see figure 1-5).

TELETYPEWRITERS

After a teletype signal has gone through the process of being converted from audio frequency to d.c. pulses, it must be printed-out in order to read the transmitted intelligence. Teletypewriters, sometimes referred to as "teleprinters" or "printers," are used for this purpose. The teletypewriter is little more than an electrically-operated typewriter. The prefix "tele" means "at a distance"; coupled with the word "typewriter" it forms a word meaning "typewriting at a distance." There are two basic types of teletypewriters used to print-out intelligence: PAGEPRINTERS and PAPER TAPE PRINTERS.

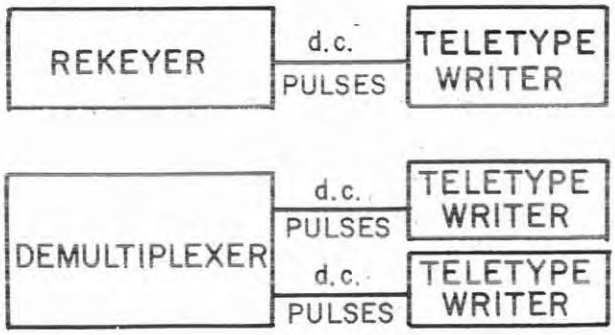

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Figure 1-5.—Signal flow of teletype signal to teletypewriter.

Pageprinters

Pageprinters print out teletype systems on paper somewhat like the operation of a typewriter.

Paper Tape Printers

Paper tape printers print out teletype systems on thin strips of paper called "perforator tape." As this type printer prints out the characters, it also punches holes into the paper tape. These holes correspond to the elements keyed by the signal. The perforated tape may be placed in a transmitter distributor (TD), a piece of equipment which "reads" the punched hole combinations to provide a pageprint. There are two types of perforated tape: CHAD and CHADLESS. CHAD tape derives its name from the small paper disks which result from the holes of the tape being fully cut out. CHADLESS tape, as the name indicates, is perforated tape with the holes partially cut out, leaving no chad in the collection tray (see figure 1-6).

Figure 1-7 illustrates the normal flow of a basic voice, manual morse, and teletype signal from the point of reception to an intelligible form. Complex signals require the same basic types of equipment for processing; but because of their unique characteristics, you will see many different types of receivers, demodulators, demultiplexers, teletypewriters, etc., used in the collection process.

RECORDERS

Once a signal is transmitted and received, it cannot be retrieved for later use unless it is recorded. The purpose of recording a signal is to put it into a permanent form for future reference or use. The media used for recording purposes will depend upon the use and type of signal being recorded.

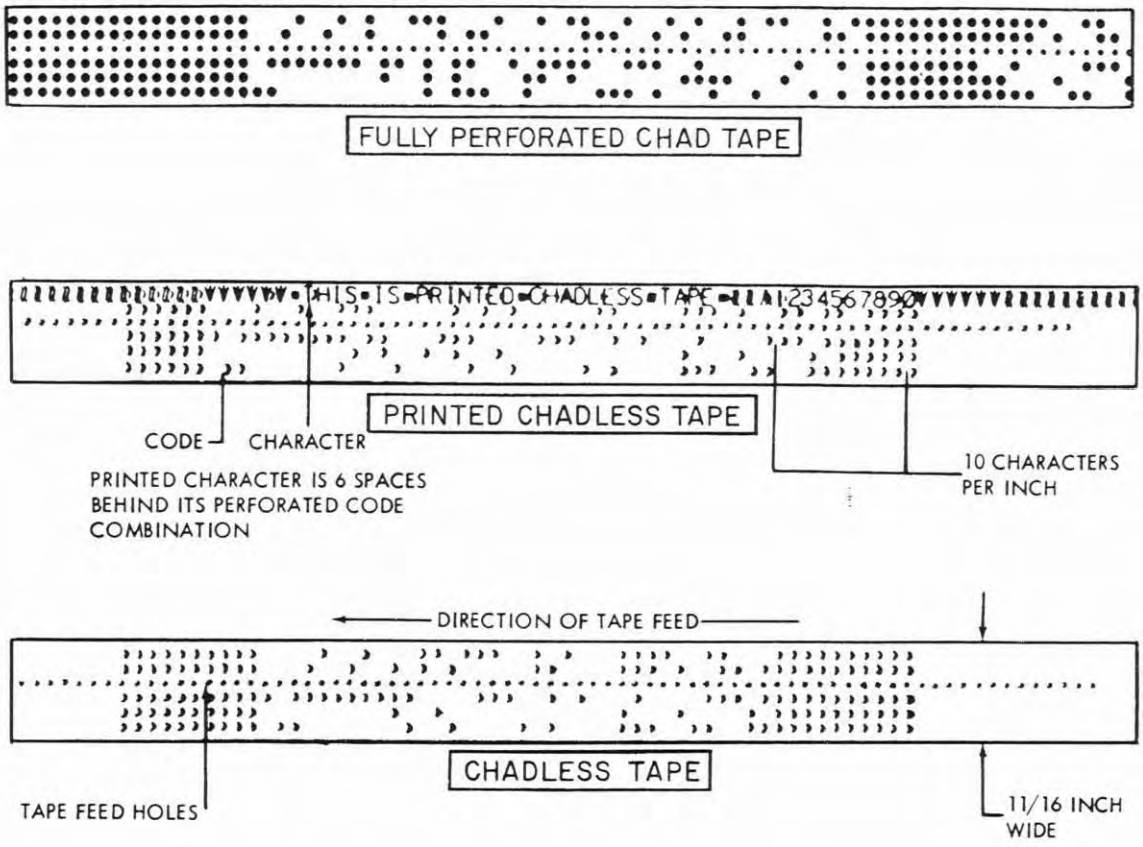

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Figure 1-6.—Chad and Chadless tape.

Magnetic Tape

Magnetic tape recorders are the most common type of recorders in use today. These recorders use magnetic tape which has a non-magnetic plastic or paper base with a coating of magnetic oxide on one surface. Magnetic tapes are our primary form of recording media because they can be stored for a long period of time without losing the intelligence recorded upon them. There are two basic types of magnetic recorders which we use: DIGITAL and ANALOG.

DIGITAL.—Computers are used to process many of the signals we collect. Computers accept information after it has been converted to data in the form of coded numbers. Digital magnetic tape recorders store numerical data in a format acceptable for computer processing.

ANALOG.—Analog magnetic tape recorders are used to record continuous, non-formatted information. This information may vary in frequency, amplitude, voltage, etc. (home and car tape recorders are of the analog type magnetic recorder).

Facsimile

A facsimile recorder produces a graphic portrayal, or picture, on specially treated paper. Weather maps and press wirephotos are recorded in this manner. (Because of their limited usage, facsimile recorders will not be discussed further in this training publication.)

Paper Tape

A paper tape recorder, commonly called an "undulator," responds to pulses of audio tone

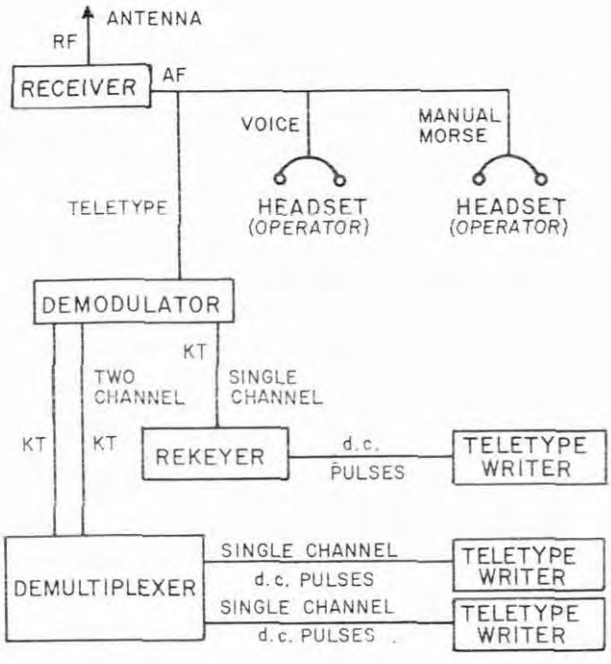

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Figure 1-7.–Signal flow for processing voice, manual Morse, and teletype signal.

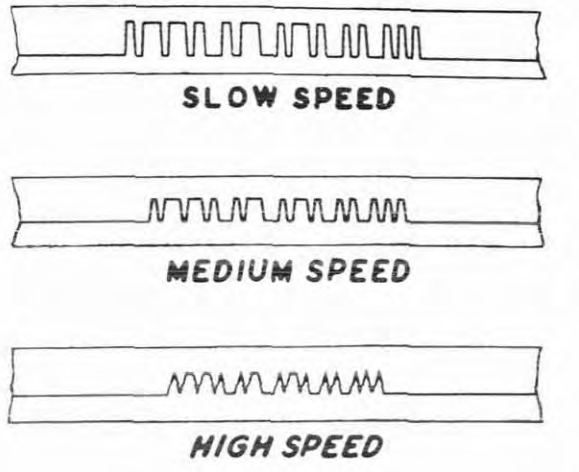

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Figure 1-8.–Example of undulator tape.

and prints a reproduction on paper tape (see figure 1-8). Paper tape recorders are used to record both automatic morse and high speed manual Morse, and in signal analysis research. There are currently two types of paper tape recorders being used: INK PAPER TAPE RECORDER and ELECTROSENSITIVE PAPER TAPE RECORDER.

INK PAPER TAPE RECORDER.–As the name implies, this paper tape recorder uses ink to reproduce a graphic display of the audio tones on thin strips of paper tape.

ELECTROSENSITIVE PAPER TAPE RECORDER.–The electrosensitive paper tape recorder reproduces a graphic display in exactly the same manner as the ink paper tape with the exception that the audio tones are reproduced in a graphic display by an electrical stylus passing over specially treated electrosensitive paper.

SOUND SPECTOGRAPH

The distinct sound of a signal may be recorded and graphically reproduced on sensitized paper by a device called an "audio spectrum analyzer," or what is more commonly called a "sonagraph." (Note: "Sonagraph" is a trade name.) This type of recorder is widely used for in-depth analysis of signal modulation components (i.e., frequency shift, amplitude, phase, etc.)

OSCILLOGRAPH

Although there are various types of direct-recording oscillographs, our concern in this discussion is with the optical oscillograph. This oscillograph simultaneously reproduces numerous channels of information or signals on light-sensitive paper. It is extremely useful when it is desirable to display the time/amplitude relationship of several signals or portions of one complex signal in graphic form.

DIGITAL COMPUTERS

The term "digital" refers to calculations by numerical methods or by coded units; thus, a digital computer is a device which solves problems by manipulating the numerical equivalents of information in accordance with mathematical and logical processes. These numerical equivalents may be expressed as decimal numbers, binary numbers, octal numbers, etc. In an electronic digital computer

the numerical equivalents are generally expressed as binary numbers. Coded values of voltage and current are used to represent the 1's and 0's of the binary numbers. The instructions for processing the data may also be in the form of numerical equivalents. Digital computers are discussed in more detail in separate training publications devoted to unique systems.

SPECIAL PURPOSE EQUIPMENT

As indicated by the title, this category is a "catch-all" into which individual equipment not classifiable into any of the other five categories are placed. Some of the special purpose equipments with which you may become involved are the OSCILLOSCOPES, ELECTRONIC COUNTERS, FREQUENCY OSCILLATORS, TIME CODE GENERATORS, FILTER ASSEMBLIES, and AMPLIFIERS.

Oscilloscope

Oscilloscopes present a visual picture of a signal which you, as an operator, may use to make tuning adjustments, correctly diagnose signal conditions, or analyze complex waveforms.

Electronic Counter

Electronic counters are used to measure frequencies and to provide fast and accurate signal parameter readouts.

Frequency Oscillator

Frequency oscillators are used to generate a periodic waveform. The simplest form of frequency oscillator is a crystal controlled sine wave generator. Through the use of additional circuitry, the sine wave can be distorted to produce square, rectangular, sawtooth, triangular and other wave forms.

Time Code Generators

Time code generators place an exact time reference onto a tape so that the exact time of a signal occurrence is known. "Exact Time" is invaluable for analysis purposes.

Filters

Modern electronic receiving equipments are being made with increased sensitivity. Consequently, the problem of radio interference generated by electromechanical devices such as motors, generators, relays, and the like, has become more significant. Additionally, the interaction between the various equipments can cause major interference problems. To assist in eliminating undesired signals/interference, modern receiving equipments normally have built-in filtering circuits. Some of the basic filter circuits are described in general terms below.

LOW-PASS FILTERS—A low-pass filter allows the low-frequency components of an applied signal to pass, while the high-frequency components are attenuated, or reduced, in the output; therefore a circuit can be made to operate at a predetermined frequency of attenuation (or "cutoff frequency"). Frequencies below the cutoff will then be passed and frequencies above the cutoff will be attenuated.

HIGH-PASS FILTERS—A high-pass filter passes all frequency components of an applied signal which are higher than the cutoff, and attenuates all frequency components below the cutoff frequency.

BAND-PASS FILTERS—A band-pass filter attenautes all signal frequencies except for those in a predetermined band of frequencies. These filters have special applications and are seldom used for noise elimination.

Amplifiers

Amplifiers increase the amplitude of signal current or voltage. For example, the signal voltage picked up by a receiving antenna is too weak to be useful until it has been increased in amplitude. In this case, an amplifier circuit built into the receiver is used to increase the amplitude of the signal to many times its original value so that the signal may be demodulated and the intelligence recovered. Amplifiers are also used to increase small current

signals to higher values in order to operate receivers, headphones, speakers, and other minal equipments.

EQUIPMENT NOMENCLATURE

With the rapid increase in the use of electronic equipment systems by the military, it became necessary to develop a system whereby equipment could be easily identified. There are two designation systems employed by the Naval Security Group and throughout the Navy: The "AN" System and the MANUFACTURER SYMBOL DESIGNATION systems.

"AN" SYMBOL DESIGNATION SYSTEM

The primary designation system in use is the "AN" system. (The "A" and "N" are pronounced separately.) This system is used by all of the U.S. military services to designate various electronic systems and components employed within the Department of Defense. The "AN" system was established by the Joint Chiefs of Staff in 1943 and was designed to llow identification of systems or components .y simply reading the nomenclature tag. This system is divided into two separate identification systems–one for complete electronic systems and another for components of systems or for multipurpose components.

System Designation

A "complete system" is one whose nomenclature designator begins with "AN/—." The "AN" is the key which shows that the equipment is a complete system in itself. The next three letters identify the type of installation, type of equipment, and the purpose of the equipment, respectively. The letter nomenclature is then followed by a number to indicate a specific equipment in a series of similar equipments. For example, the "AN/FLR-11" is a fixed countermeasures receiver and is the eleventh system of this general type (refer to table 1-1). Modifications of the original system are designated alphabetically within the nomenclature. Hence, the "AN/FLR-11A" would be the first major modification of the "AN/FLR-11," "AN/FLR-11B" the second modification, etc. Additionally, the miscellaneous identifier symbols "X", "Y", and "Z" are sometimes used to indicate modifications to primary power. Systems whose installation configuration may change from station to station, depending upon the requirements of the station, are identified by the letter "V". An additional miscellaneous identifier symbol "X" may be used to indicate an experimental system or piece of equipment, and the bureau within the Navy that is sponsoring the experiment. The "AN/FLR-11A (XN-1)" would be an experimental fixed countermeasures receiver, modified once, sponsored by the Department of the Navy, and the first experimental model.

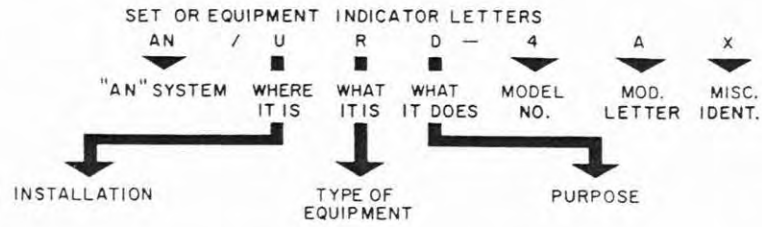
Component Designation

The component designation is the second part of the "AN" system and is used to identify components of systems or general usage electronic units. For example, the "R-390A/URR" is a receiver, the 390th adopted by the Department of Defense, modified once, and is a utility component for any radio receiving system with which it is compatible. The "RD-289/GSQ-76" is a recorder/reproducer, the 289th adopted by the Department of Defense, and is designated to operate primarily with the AN/GSQ-76 system. (Refer to Table 1-2 for a listing of common component indicators.)

MANUFACTURER SYMBOL DESIGNATION SYSTEM

The Manufacturer Symbol Designation System is used to identify electronic equipments or components that are purchased directly from a manufacturer who does not have a specific military contract for this equipment. Most of the equipments in this category are "special application equipments" which are readily available through normal commercial channels, and "test equipments" that meet military needs. An example of this is the "Tektronix model 545B oscilloscope." By referring to the MANUFACTURER DESIGNATION SYMBOLS MANUAL (NAVSEA 0967-190-4010), this

Table 1-1.—AN Nomenclature System



A--AIRBORNE (INSTALLED AND OPERATED IN AIRCRAFT).
B--UNDERWATER MOBILE, SUBMARINE.
C--AIR TRANSPORTABLE (INACTIVATED, DO NOT USE).
D--PILOTLESS CARRIER.
F--FIXED.
G--GROUND, GENERAL GROUND USE (INCLUDES TWO OR MORE GROUND-TYPE INSTALLATIONS).
K--AMPHIBIOUS.
M--GROUND, MOBILE (INSTALLED AS OPERATING UNIT IN A VEHICLE WHICH HAS NO FUNCTION OTHER THAN TRANSPORTING THE EQUIPMENT).
P--PACK OR PORTABLE (ANIMAL OR MAN).
S--WATER SURFACE CRAFT.
T--GROUND, TRANSPORTABLE.
U--GENERAL UTILITY (INCLUDES TWO OR MORE GENERAL INSTALLATION CLASSES, AIRBORNE, SHIPBOARD, AND GROUND).
V--GROUND, VEHICULAR (INSTALLED IN VEHICLE DESIGNED FOR FUNCTIONS OTHER THAN CARRYING ELECTRONIC EQUIPMENT, ETC., SUCH AS TANKS).
W--WATER SURFACE AND UNDERWATER.

A--INVISIBLE LIGHT, HEAT RADIATION.
B--PIGEON.
C--CARRIER.
D--RADIAC.
E--NUPAC.
F--PHOTOGRAPHIC.[1]
G--TELEGRAPH OR TELETYPE.
I--INTERPHONE AND PUBLIC ADDRESS.
J--ELECTROMECHANICAL OR INERTIAL WIRE COVERED.
K--TELEMETERING.
L--COUNTERMEASURES.
M--METEOROLOGICAL.
N--SOUND IN AIR.
P--RADAR.
Q--SONAR AND UNDERWATER SOUND.
R--RADIO
S--SPECIAL TYPES, MAGNETIC, ETC., OR COMBINATIONS OF TYPES.
T--TELEPHONE (WIRE).
V--VISUAL AND VISIBLE LIGHT.
W--ARMAMENT (PECULIAR TO ARMAMENT, NOT OTHERWISE COVERED).
X--FACSIMILE OR TELEVISION.
Y--DATA PROCESSING.

A--AUXILIARY ASSEMBLIES (NOT COMPLETE OPERATING SETS USED WITH OR PART OF TWO OR MORE SETS OR SETS SERIES).
B--BOMBING.
C--COMMUNICATIONS (RECEIVING AND TRANSMITTING).
D--DIRECTION FINDER, RECONNAISSANCE, AND/OR SURVEILLANCE.
E--EJECTION AND/OR RELEASE.
G--FIRE-CONTROL OR SEARCHLIGHT DIRECTING.
H--RECORDING AND/OR REPRODUCING (GRAPHIC METEOROLOGICAL AND SOUND).
K--COMPUTING.
L--SEARCHLIGHT CONTROL (INACTIVATED, USE G).
M--MAINTENANCE AND TEST ASSEMBLIES (INCLUDING TOOLS).
N--NAVIGATIONAL AIDS (INCLUDING ALTIMETERS, BEACONS, COMPASSES, RACONS, DEPTH SOUNDING, APPROACH, AND LANDING).

P--REPRODUCING (INACTIVATED, DO NOT USE).
Q--SPECIAL, OR COMBINATION OF PURPOSES.
R--RECEIVING, PASSIVE DETECTING.
S--DETECTING AND/OR RANGE AND BEARING, SEARCH.
T--TRANSMITTING.
W--AUTOMATIC FLIGHT OR REMOTE CONTROL.
X--IDENTIFICATION AND RECOGNITION.

[1]NOT FOR US USE EXCEPT FOR ASSIGNING SUFFIX LETTERS TO PREVIOUSLY NOMENCLATURED ITEMS.

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would cross-reference to "CBTV-545B." "CBTV" is the Navy's manufacturer's code for Tektronix, Inc. of Portland, Or., and "545B" is the manufacturer's own model number. In this system, there is no way of identifying the type or purpose of the equipment without referring to the equipment technical manual.

OPERATOR PREVENTIVE MAINTENANCE

Preventive maintenance is the systematic performance of certain functions which are necessary to reduce or eliminate failures and prolong the useful life of equipment. In short, operator preventive maintenance is nothing more than you, the operator, taking precautionary action to ensure that things which might fail—won't. Thousands of man-hours and millions of dollars are lost yearly because an operator fails to clean recording heads, spills coffee on the equipment, or overdrives amplifier circuits by disregarding signal level meters. Although the actual upkeep of the equipment is the responsibility of maintenance personnel, you, the operator, are in a position to assist them. Some of the areas in which you can contribute toward more efficient and effective use of equipments will now be covered.

PATCH CORDS

Audio frequency (AF) and radio frequency (RF) patch cords and headset cords are those

Table 1-2.—Table of Common Component Indicators

COMPONENT INDICATOR	FAMILY NAME	EXAMPLES OF USE
AM	amplifier	power, audio, video, etc.
AS	antennae complex	arrays, parabolic type, masthead, etc.
CU	couplers	impedance coupling devices, directional couplers, etc.
CV	converters (electronic)	electronic apparatus
GO	goniometers	for changing the goniometers of all types of phase, frequency, or voltage from one medium to another
IP	indicators (cathode ray tube)	azimuth, elevation, panoramic, etc.
PP	power supplies	self-contained unit used solely for the purpose of supplying power
R	receivers	receivers, all types except telephone
RD	recorder-reproducer	sound, graphic, tape, wire, film, facsimile, magnetic, etc.
RO	recorder	sound, graphic, tape, wire, film, facsimile, magnetic, etc.
SN	synchronizers	equipment to coordinate two or more functions
TT	teletypewriter and facsimile apparatus	miscellaneous tape, teletype, facsimile equipment

items most frequently damaged by operators. Strict compliance with the following rules should result in a longer life for patch cords and better service from the equipment with which they are being used:

1. Always grasp the rubber or plastic plug covering when making or breaking a cord connection.
2. Take worn or frayed patch cords to maintenance for repair. (They could cause an equipment malfunction or, become a safety hazard.)
3. DO NOT attempt to repair a broken cord or plug yourself. (This may also create a safety hazard or equipment malfunction.)

KNOBS AND SWITCHES

Most of our equipments have knobs and switches located on the front panels. These are always subject to pressure, either by the operator or through accidental contact with external objects, resulting in the knobs and switches becoming loose or broken. When this occurs, notify the maintenance personnel immediately, since this could result in erroneous operation of the equipment. NEVER use excessive force when rotating controls and DO NOT allow dirt or foreign matter to accumulate around knobs and switches.

METERS

Meters are delicate, precisioned, measuring instruments and, ordinarily, cannot be easily repaired. You should use extreme care to avoid overdriving these instruments to avoid damage to the indicator needles or hairsprings. Since meter movements are very delicate, they may be seriously affected if the transparent covers are broken or cracked, allowing dirt or moisture to accumulate inside.

CATHODE RAY TUBES

Cathode ray tubes (CRT) are used by operators to visually determine the characteristics of a signal and to ensure that the signal is properly tuned. The proper care of a CRT cannot be over-emphasized. The poorest habit that an operator can develop is misuse of the Intensity Control. This control should be adjusted so that the intensity of the presentation on the tube screen is comfortable to the eyes of the operator. If the intensity is too bright, the tube will become damaged and the operator subjects himself or herself to eye strain. Whenever the CRT is not in use, the intensity control should be turned down completely.

HEADSETS AND MICROPHONES

Exercising care while using these instruments is the basic preventive maintenance. They, too, are delicate instruments and are sensitive to rough handling.

VENTILATING BLOWERS

Electronic equipment becomes extremely hot during continuous operation; therefor ventilating blowers are installed in equipmen. bays to aid in cooling. Operators should check these blowers from time to time to ensure that they are operating and that no obstructions are blocking the air intake vents. In addition, operators should make frequent visual checks of the air filters for cleanliness. Clean air filters will improve the operating performance of the blower unit.

MAGNETIC TAPES

An operator who exercises care in the handling and storage of magnetic tapes, employs proper operational usage, and uses correct splicing techniques will improve the quality of a recording and extend the life of the tape.

Tape Handling, Storage, and Operational Use

The following techniques are recommended for the handling, storing, and operational use of magnetic tapes.

1. DO NOT DROP MAGNETIC TAPES. Dropping a magnetic tape that has already been recorded will cause a heavier saturation of oxide particles on the impact side. Thus, the particle distribution will be uneven and the frequency response will be unbalanced.
2. Keep hands clean in order to prevent body oils and salt from contaminating the tape.
3. Always handle magnetic tapes in such a manner that the fingers touch only the tape ends, and then only when threading the tape through a recorder's tape transport mechanism.
4. NEVER place markers of any type (i.e., slips of paper, nylon strips, tabs, etc.) between tape layers to identify a particular position on the tape. This will result in the deforming of succeeding layers of tape which can cause oxide particle flake-off and, eventually, self-contamination.
5. When not in use, enclose tapes in plastic reel bands or tape jackets.

6. Store magnetic tapes away from permanent magnets or strong magnetic fields. Permanent magnets and strong electromagnets will cause erasure if placed in the immediate vicinity of a magnetic tape.

7. Keep storage bins clean at all times.

8. Store tape reels separately and in an upright (vertical) position.

9. Working spaces should be thoroughly cleaned on a regular basis. Vacuuming is preferred to sweeping to ensure that dust circulation is kept to a minimum.

10. Ideally, magnetic tapes should be stored in a room at moderate temperature (68-72 degrees) with the relative humidity maintained between 40% and 60%. Just as woodwork shrinks in the winter and swells in the summer, magnetic tapes will expand or contract with changes in temperature and humidity.

11. DO NOT use worn out tape or defective reels except in an emergency. Defective reels which cannot be repaired before use should be marked so that their continued use will be discouraged.

12. Avoid excessive tensions in rewinding tapes. Tapes may become stretched or permanently distorted if wound too tightly.

Splicing Techniques

Despite the most careful handling by the operator, occasional breaks in magnetic tapes do occur. When this happens, you must either replace the reel or, if time permits, make a repair of the tape. This is a very simple procedure, but one which must be done properly.

Most pressure-sensitive tapes now on the market have adhesives which are unsatisfactory for use in splicing magnetic tape. Examples of tapes not satisfactory for splicing magnetic tape include the many brands of transparent cellulose tapes which are made for use on paper. Splices in the wound roll of tape are subject to considerable pressures and temperature variations, and the adhesives used in ordinary pressure-sensitive tapes will creep or bleed around the splice. This is a particularly serious condition, since not only the strength of the splice is impaired but also the adhesive invariably contaminates the magnetic side of the tape, causing adjacent layers to adhere, one to the other, with resultant loss of recorded intelligence in the contaminated area due to poor head contact. The adhesive may also transfer to the heads and guides of a recorder, and thus ruin a considerable amount of tape.

To prevent trouble from the adhesive, a tape specially formulated for splicing magnetic tape is available, guaranteeing trouble-free performance if properly used. These splicing tapes provide thin yet strong splices. The pressure-sensitive adhesive has these characteristics: the bond with the magnetic tape increases under the effects of time and temperatures encountered in use, and the adhesive will not ooze or bleed around the edges of the splice. Any tendency to gum up recording heads or cause the adjacent layers of magnetic film to stick together on the reel is eliminated.

For magnetic tape, the diagonal buttsplice is a tradition. Such splices, properly made, wear without fraying or loosening. To make a perfect splice, the ends of the tape to be joined should be held in some rigid fashion to prevent displacement while the splice is being made. There are three ways to do this:

1. By holding the tape securely between fingers and cutting with a pair of scissors.
2. By laying on a flat surface (soft wood block or slab of rubber) and cutting with a razor blade. This technique can be further improved by placing a straight edge along one side to position both tapes.
3. By using a commercially available splicing block.

The two ends of the magnetic tape to be spliced should be sufficiently overlapped to enable easy cutting and true alignment of both tape ends, providing the recorded information will allow this much tape to be removed. In some cases information recorded is of such a critical nature that no cutting should be done. In this case line up the ends of the tape so both sections are butted and are in alignment with each other, then apply splicing tape and trim. The splicing tape as outlined above, must always be placed on the backing (or shiny) side of the magnetic tape.

The angle of the cut ends is not critical but one must use a diagonal cut to avoid "pop" at

the splice point. All angles are measured from the edge of the tape. A 90° cut is always to be avoided. As the angle of the cut edge becomes smaller, the strength, flexibility, and magnetic invisibility of the splice becomes greater. A 45° angle is satisfactory although a 30° splice is approximately twice as strong and flexible.

A piece of standard splicing tape is centered over the butted ends parallel to the splice. After firmly pressing the splicing tape into position, rub firmly with the fingernail or other semi-hard object to press out all air bubbles. The excess splicing tape is trimmed by cutting parallel with but slightly into the magnetic tape. Thus danger of exposed adhesive from the splicing tape is eliminated.

MAGNETIC TAPE RECORDERS

Magnetic tape recorders are used almost continuously at field stations. Proper cleaning and periodic degaussing of magnetic tape recorders will improve the quality of recording and increase the life of the recorder.

Cleaning

Cleanliness of recording heads and tape transport mechanisms is of particular importance because the lubricants placed on the tape by the manufacturer collect on these recorder elements. These lubricants gradually form an oxide coating on recorder parts and cause distortion of the recorded signal. The record and reproduce head assemblies, tape guides, capstan, and pinch roller assembly should be cleaned after each recording (see figure 1-9). The head assembly, tape guides, and capstan must be cleaned with an approved "head cleaning" solution (methyl chloroform or Freon). The pinch roller assembly, however, should be cleaned with isopropyl alcohol because "head cleaning" solution will cause the rubber rollers to "breakdown" or deteriorate. (IMPORTANT—alcohol should never be used on any of these elements other than the pinch roller assembly.) Apply the cleaning solution to a cotton swab or a soft, lintless cloth and carefully wipe the items to be cleaned so that all oxide and dirt is removed.

Air filters should be washed periodically with either a detergent or soap and water. If extreme environmental conditions are encountered, or if maintenance of the filters has been neglected, more intensive cleaning may be necessary to remove long accumulation of hard grease or caked-on dirt.

DEMAGNETIZING HEADS

Occasionally the heads may become permanently magnetized, usually caused by improper use of the equipment. Magnetized heads can cause a substantial increase in background noise and can impair previous recordings by partially erasing high frequencies during playback.

The operator can help prevent head magnetization by observing the following two rules:

1. Do not connect or disconnect the input leads or the head leads while recording.
2. Do not saturate the record amplifiers with abnormally high amplitude input signals.

If the heads do become magnetized, the procedure for demagnetizing them is as follows:

1. Turn the power switch of the recorder OFF.
2. Select the proper demagnetizing coil for the recorder. Plug the demagnetizing coil into a standard 115V a-c outlet.
3. Bring the tips of the demagnetizing coil to within about 1/8 inch of the record head stack. Straddle the head gap with the demagnetizer tips and draw them up and down the length of the stack three or four times.
4. Remove the demagnetizer slowly from the head stack to a distance of about 3 or 4 feet to allow the a-c field to diminish gradually. This slow removal is very important. Never unplug the demagnetizer while it is near the heads. The

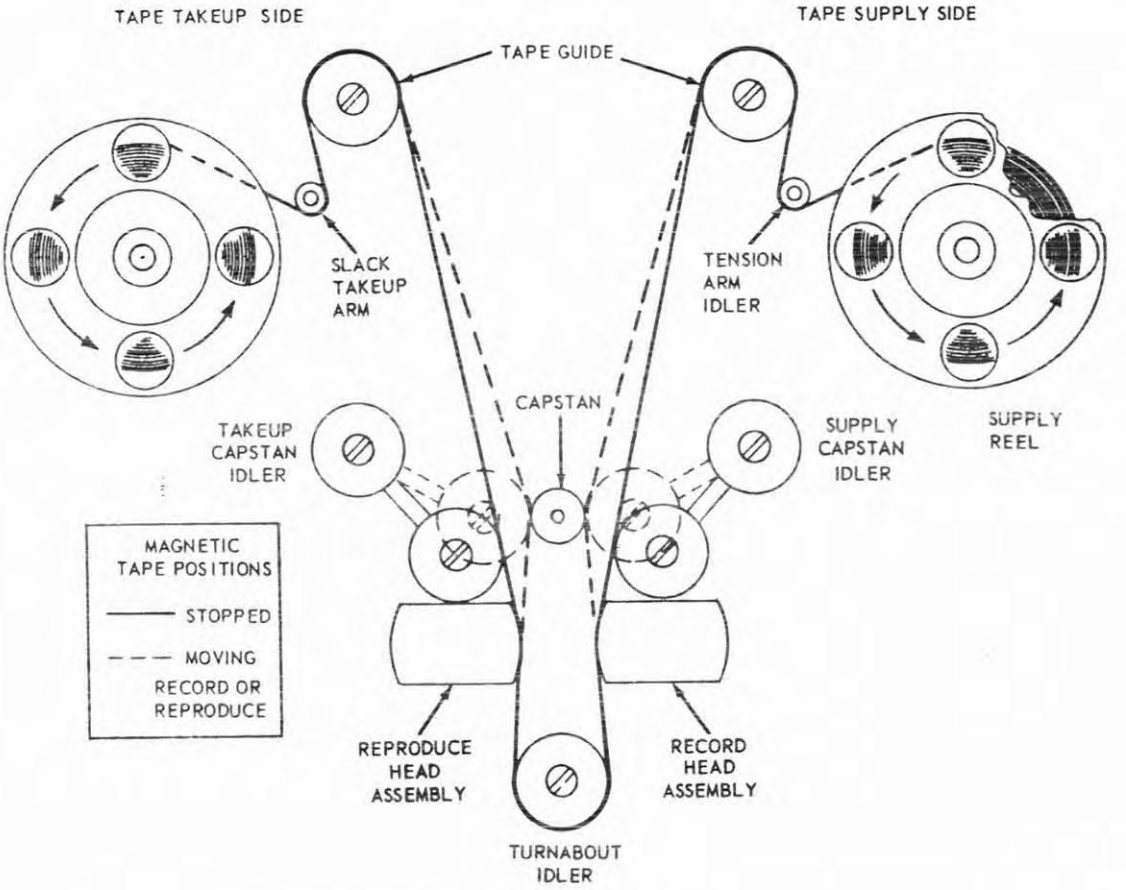

Figure 1-9.—Tape deck layout of a typical multitrack magnetic tape recorder.

collapse of its magnetic field will remagnetize them.

5. Repeat steps 3 and 4 at the reproduce heads and at the erase heads if the recorder is equipped with them.

If the Capstan, tape guides, or other metal parts become magnetized, a few passes of the demagnetizer along their lengths with the slow withdrawal method should demagnetize them.