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CLASS 22,054

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Training Center and School**

Fort Devens, Massachusetts



EQUIPMENT HANDOUT

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The purpose of this workbook is to provide a concise outline and reference book concerning this course. The information contained in this publication follows the instruction presented during the course and provides a convenient reference to the topics being discussed. As sufficient space has been provided through this workbook for notes, the student is encouraged to have it available in class. If properly maintained, this workbook will serve both as an excellent review for the final examination and as a good permanent reference.

This workbook is not classified and may be used in the student's quarters. However, it should be handled in a restricted manner and used only in conjunction with USASA activities. It should not be disseminated for public use or disclosed to unauthorized persons.

SECTION 50P

1. Sleeping in class: There will be absolutely NO sleeping in class. If anyone cannot stay awake while in class he will stand and go to the rear of the room and remain there until he is no longer drousy. If anyone is found sleeping, he will be awakened and proper steps will be taken to insure that he remains awake.
2. Questions: When asking or answering questions, the student will stand, give his rank and name and state his question or answer. He will remain standing until acknowledged by the instructor.
3. Seating: All students with the exception of the class leader will be seated by roster order beginning with the second seat in the first row on the instructors right. The class leader will be seated in the first seat.
4. Noise in class: We cannot tolerate any unauthorized noise in class. If anyone has any comments to make he should raise his hand and the instructor will allow him to address the entire class.
5. Equipment handouts: Each student will print his name, rank, serial number, class number and company on the front of his handout. Each student will make certain that he has the handout with him whenever he is scheduled for an equipment class. There is space provided in this book for taking notes. Each student will make certain that these notes are current at all times.

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INTRODUCTION TO RADIO EQUIPMENT

1. OBJECTIVES: To give the student an introduction to intercept equipment, outline of course, section SOP and definitions of common terms.
2. IMPORTANCE: It is impossible for anyone associated with the field of radio communications to accomplish his job efficiently without an understanding of the equipment used within radio communications. This lesson gives a general description of the basic types of equipment used in the intercept field, thereby preparing the student for the more intense training which will follow.
3. COMMON TERMS AND DEFINITIONS:

Resonant antenna: An antenna cut to a given wavelength so that it will respond best to the corresponding frequency. $\frac{468}{\text{Freq. IN MG'S}} = \frac{1}{2} \text{ wave ANT.}$

Nonresonant antenna: An antenna cut to no certain frequency so that it will respond to signals in a broad frequency range.

Unidirectional antenna: An antenna that will receive or transmit signals best in one direction. USE'S RESISTOR IN LINE

Terminating resistor: A load resistor connected to the end of an antenna in order to increase directivity. LOCATED AT OPPOSITE END OF TRANS. LINE.
500 OHM

Transmission line (feed line): Any conductor used to carry RF energy from one place to another.

Zero beat: The null between two frequencies beating together resulting in complete cancellation of frequency and signal.

Selectivity: The ability of a radio receiver to isolate a signal.

Sensitivity: The ability of a radio receiver to amplify weak signals.

INTRODUCTION TO RADIO EQUIPMENT

4. ABBREVIATIONS:

AF	Audio Frequency
AGC	Automatic Gain Control
BFO	Beat Frequency Oscillator
CW	Continuous Wave
FSK	Frequency Shift Keying
HFO	High Frequency Oscillator
IF	Intermediate Frequency
IPS	Inches Per Second
MCW	Modulated Continuous Wave
MGC	Manual Gain Control
OOK	On-OFF Keying
OSC	Oscillator
QRM	Man made Interference
QRN	Natural Interference
RF	Radio Frequency

ANTENNAS

OMNI - DIRECTIONAL - All ---

B1 --- 2

UNI --- 1

Receiver Calibration

*using electrical portions of receiver to
align mechanical portions*

ANTENNAS

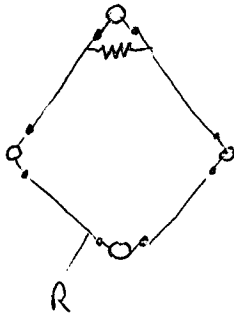
1. Fixed Antennas:

- a. The vertical tower is used to send and receive vertically polarized signals with high gain because of its height. It is difficult to erect, non-directional, and hard to camouflage.
- b. The beverage antenna is a unidirectional antenna used to receive very low frequency ground waves. It is of extreme length (sometimes several miles) and often resembles a telephone line. NOT TERMINATED USUALLY
VERTICALLY POLARIZED A WAVE ANT. USUALLY LOW FREQ
- c. The sloping vee antenna derives its name from its appearance. It does not have as high a signal-to-noise ratio over as wide a frequency range as the rhombic antenna. This antenna is used in mobile and semifixed units and in some field stations.

Full wave - DIRECTIONAL - HIGH GAIN - TERMINATED

HORIZONTALLY POLARIZED

- d. The rhombic antenna is ideal for permanent installations. It is efficient and highly directional over a very broad frequency range. The rhombic is a unidirectional antenna. Each of the rhombic antennas must be spaced at least 600 feet apart, UNLESS USING
SPACE DIVERSITY SYSTEM



ANTENNAS

2. Portable Antennas:

- a. The whip or vertical antenna can be from a few feet to over 100 feet high. It retains popularity because it is easily erected and still provides acceptable reception of signals over a wide frequency range. Usually used for mobile and semifixed operation. *1/2 wave VERTICAL polarize.*
- b. The doublet and double doublet antennas provide satisfactory results for horizontally polarized waves with maximum response in respect to directional properties, broadside to the antenna. The double doublet receives satisfactorily over a broader frequency range than the doublet; however, a doublet cut to a specific frequency is more efficient than the double doublet.



- c. The long wire antenna is usually erected in emergencies when no other antenna is available. The longer, in wavelengths, the more sharply bi-directional the antenna becomes.

$$\frac{468}{\text{Frequency in MC}} = \text{LENGTH OF ANTENNA IN FT. IN.} \quad , \text{ THIS IS A } \frac{1}{2} \text{ ANTI-WAVE}$$

NOTES

Cu 52 URR .1 -24 mcs
Cu 168 URR. 2 -32 mcs

MULTICOUPLERS

CU-168/FRR

FRONT

BACK

GENERAL DESCRIPTION: The Antenna Coupler CU-168/FRR is a piece of equipment that provides means for operating up to five receivers from a single receiving antenna.

BASIC CHARACTERISTICS:

1. Power Requirements: 115-125 230 50-400
2. Frequency Range: 2-32 MC-S
3. Number of Outputs:
 - a. To Receivers: 10
 - b. To TANDEM antenna coupler: 8

MULTICOUPLERS

CU-52/URR

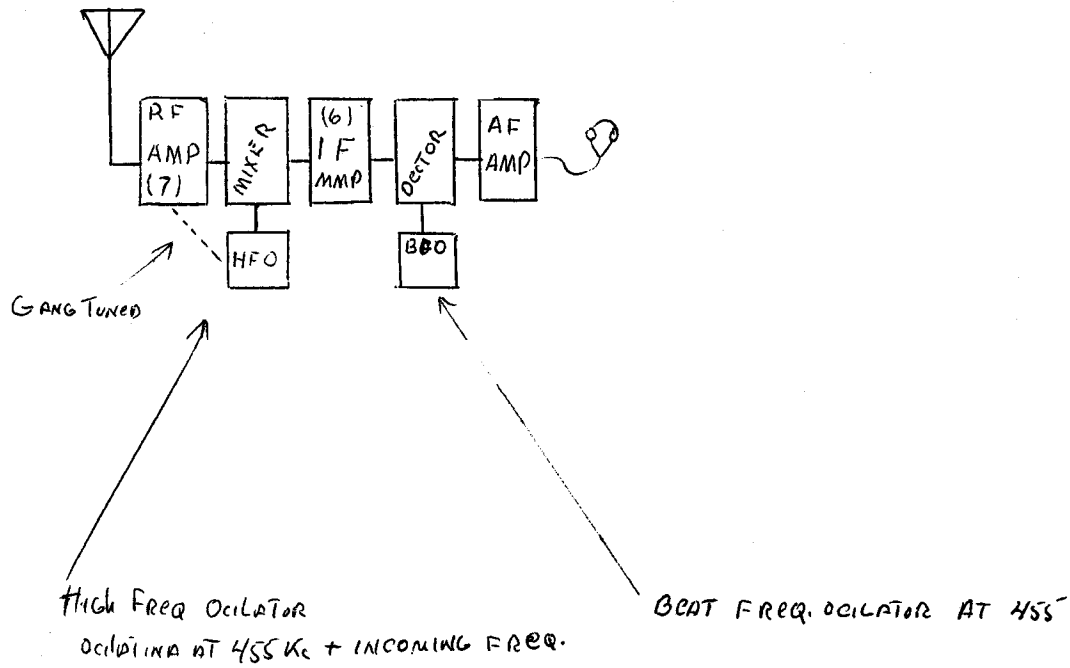
GENERAL DESCRIPTION: The antenna coupler CU-52/URR is a broadband coupling device designed to permit operation, from a single antenna and with a minimum of interaction, of 1 to 10 radio receivers having unbalanced antenna input circuits or 1 to 5 radio receivers having balanced antenna input circuits.

BASIC CHARACTERISTICS:

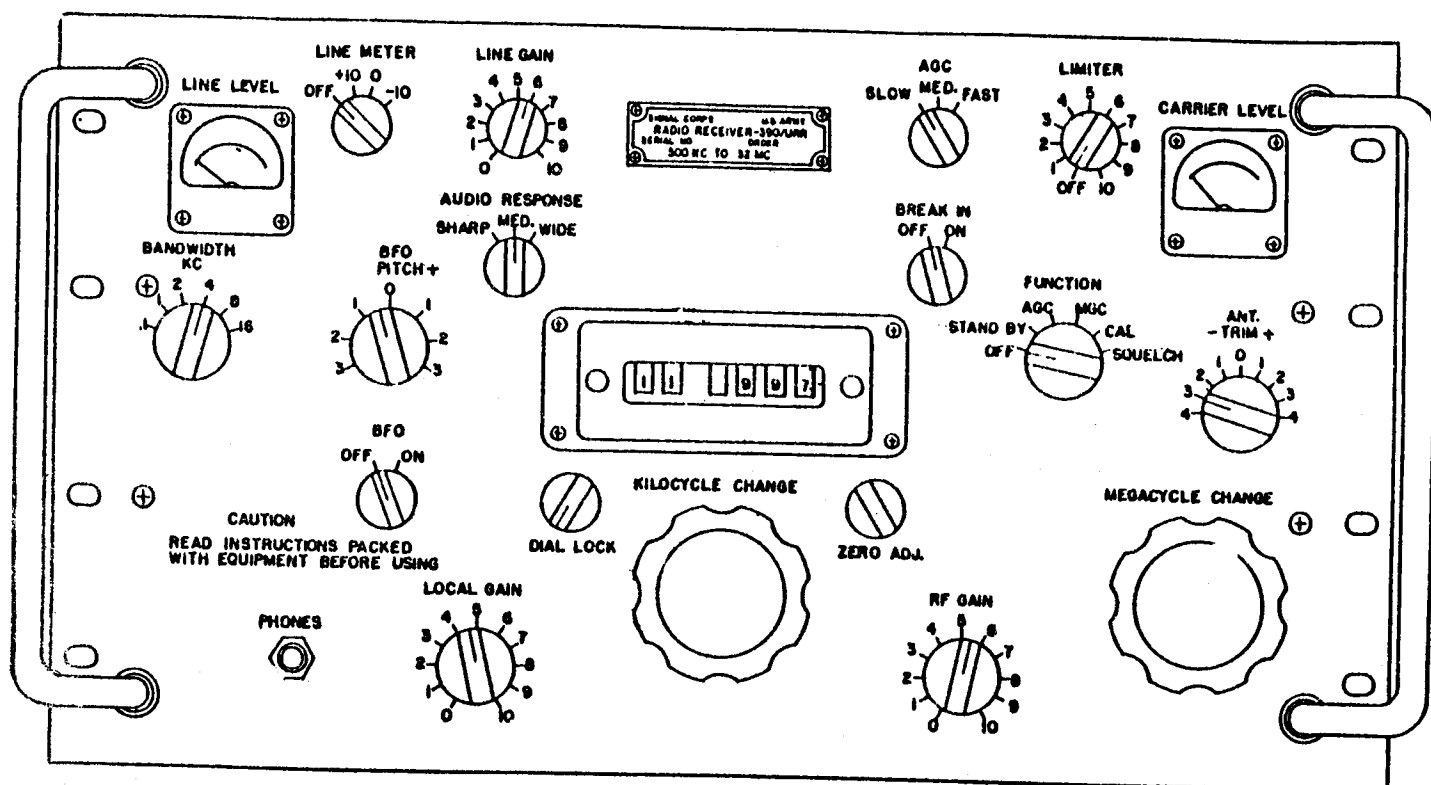
1. Power Requirements: 115-230
2. Frequency Range: 2-32 MGS
3. Number of Outputs:
 - a. Balanced: 5
 - b. Unbalanced: _____

BLOCK DIAGRAM OF THE R-390/URR

Super-Heterodyne theory; Beating together of ^{UN} Like Freq., Like F-frequency, CANCELING OUT, LEAVING US WITH A NEW AND LOWER FREQUENCY



RECEIVERS
R-390/URR



GENERAL DESCRIPTION: The Radio Receiver R-390/URR (COLLINS) is a commercial superheterodyne receiver. It has a built-in calibration oscillator which is accurate to within 3/10 of one kilocycle.

BASIC CHARACTERISTICS:

1. Power Requirements: 115/230 V 48-62 CPS AC
2. Warm-up Period: 15 minutes.
3. Frequency Range: .5 - 32 mc. - 500 - 32,000 KC
4. Crystal Oscillator: produces steady tone current 100 KC

RECEIVERS

R-390/URR

Control Nomenclature.

1. LIMITER Control: Reduces QRN
2. AGC Switch: Automatic GAIN CONTROL (Slow-medium-Fast)
3. BREAK IN Switch: Used with TRANSMITTER
4. FUNCTION Switch: Select Type of operation
 - (a) OFF: Turns off Receiver
 - (b) STANDBY: WARMUP (NOT over 15 MIN) (Normally NOT used)*
 - (c) AGC: CONTROLS ~~AGC~~ CONTROL
 - (d) MGC: MANUAL GAIN CONTROL (Normally NOT used)*
 - (e) CAL: Activates Crystal OSC.
 - (f) SQUELCH: Silence Receiver between reception of voice TRANSMISSIONS*
5. ANTENNA TRIM Control: Tunes Receiver to ANTENNA for MAX RF INPUT
6. MEGACYCLE CHANGE Control: Allows selection Me BAND
7. KILOCYCLE CHANGE Control: Selects Kc BAND For specific FREQ
8. RF GAIN Control: Volume CONTROL For RF stage
9. DIAL LOCK Control: Locks INDICATOR DIALS
10. ZERO ADJUST Control: Disengages INDICATOR DIAL (used only DURING calibration)
11. LOCAL GAIN Control: Volume CONTROL For AF stage
12. BFO OFF/ON Switch: OFF - voice ON - code
13. BFO PITCH Control: VARIES pitch of signal
14. BANDWIDTH KC Switch: Used To ELIMINATE QRN
15. AUDIO RESPONSE Switch: Selects degree of FILTER in AF stage (sharp-sloops)
16. LINE GAIN Control: CONTROLS volume To Accessory EQUIP.
17. LINE METER Switch: CONTROLS sensitivity of Line Level meter
NOT USED TURNS ON LINE METER

* by osh

RECEIVERS

Control Nomenclature. (Cont)

18. PHONE JACK: For Headset
19. CARRIER LEVEL Meter: ^{*}Visual measurement in decibels of RF signal
20. LINE LEVEL Meter: " INDICATION IN DB's of volume To excessory Equip.

JOB SET-UP SHEET R-390/URR

STARTING POSITIONS

1. LIMITER	OFF	10. ZERO ADJ	counterclockwise
2. AGC	MED	11. LOCAL GAIN	5
3. BREAK IN	OFF	12. BFO	ON
4. FUNCTION	AGC	13. BFO PITCH	0
5. ANT TRIM	0	14. AUDIO RESPONSE	MED
6. MEGACYCLE CHANGE	none	15. LINE GAIN	0
7. KILOCYCLE CHANGE	none	16. LINE METER	OFF
8. RF GAIN	10	17. BANDWIDTH KC	8
9. DIAL LOCK	counterclockwise	18. PHONES	plugged in

RECEIVER CALIBRATION

1. Rotate MEGACYCLE CHANGE control to proper band.
2. Turn KILOCYCLE CHANGE control to check point nearest desired frequency.
3. Place FUNCTION switch in CAL position.
4. Place BANDWIDTH KC switch in .1 position.
5. Turn ZERO ADJ to maximum clockwise position.
6. Zero-beat tone with KILOCYCLE CHANGE control.
7. Place FUNCTION switch in AGC.
8. Release ZERO ADJ control, turn counterclockwise.
9. Place BANDWIDTH KC in 8 position.

RECEIVER TUNING

1. Tune to approximate frequency of signal.
2. Search for signal with KILOCYCLE CHANGE control.
3. Zero-beat signal with KILOCYCLE CHANGE control.
4. Adjust pitch of signal with BFO PITCH control.
5. Adjust ANT TRIM control for maximum deflection on CARRIER LEVEL meter.
6. Adjust RF and LOCAL GAIN controls for proper volume.
7. Place AGC in SLOW position for hand sent Morse code.

INTERFERENCE - QRM

1. Rotate BANDWIDTH KC switch to a narrower position.
2. Place AUDIO RESPONSE in SHARP position.
3. Readjust BFO PITCH control for maximum volume.
4. Readjust RF and LOCAL GAIN controls.

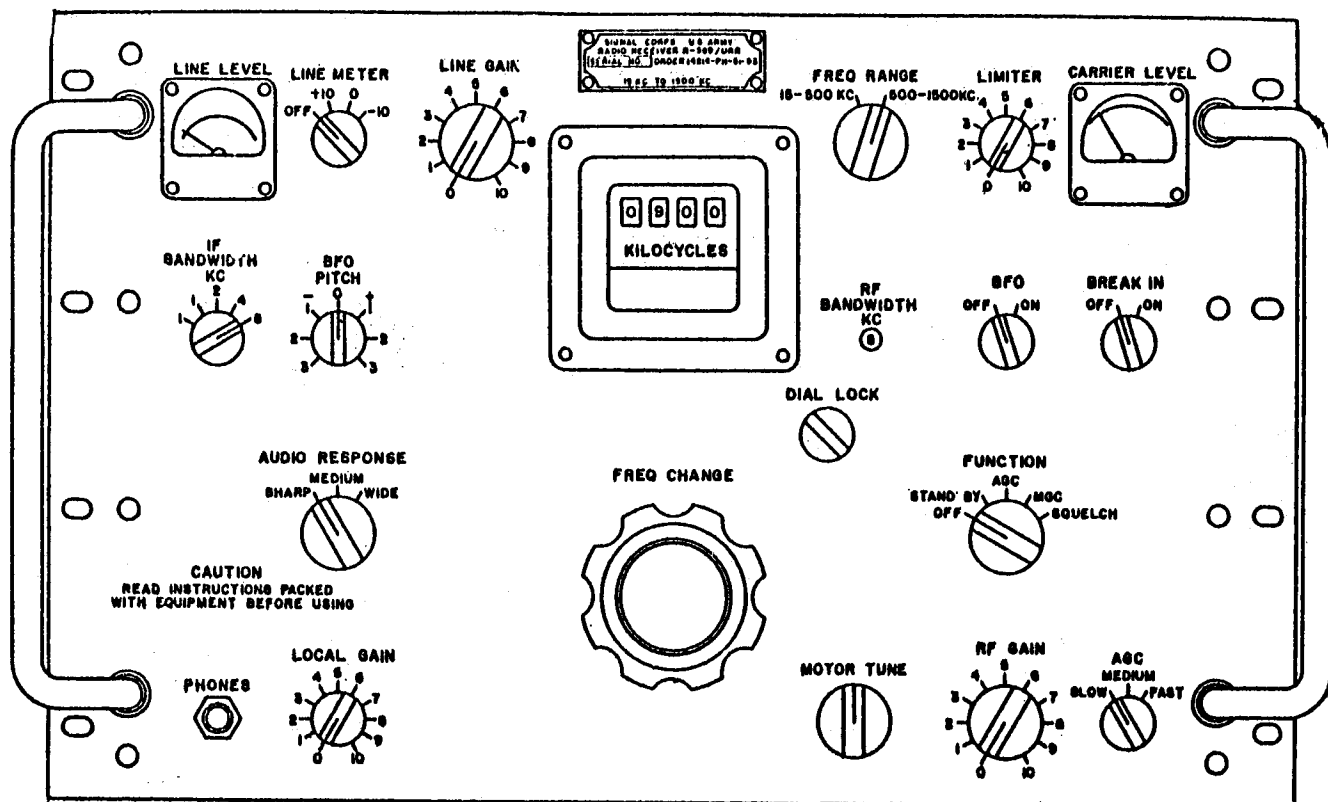
INTERFERENCE - QRN

1. Decrease RF GAIN control.
2. Rotate LIMITER control clockwise until interference is reduced.
3. Experiment with BANDWIDTH KC switch (widen or narrow bandwidth).

SHUT DOWN

1. Temporary:
 - a. Put volume controls to minimum (0) position.
 - b. Place all other controls and switches in starting positions.
2. Permanent: Place FUNCTION switch to OFF position.

ASSOCIATED RECEIVERS & EQUIPMENT
R-389/URR

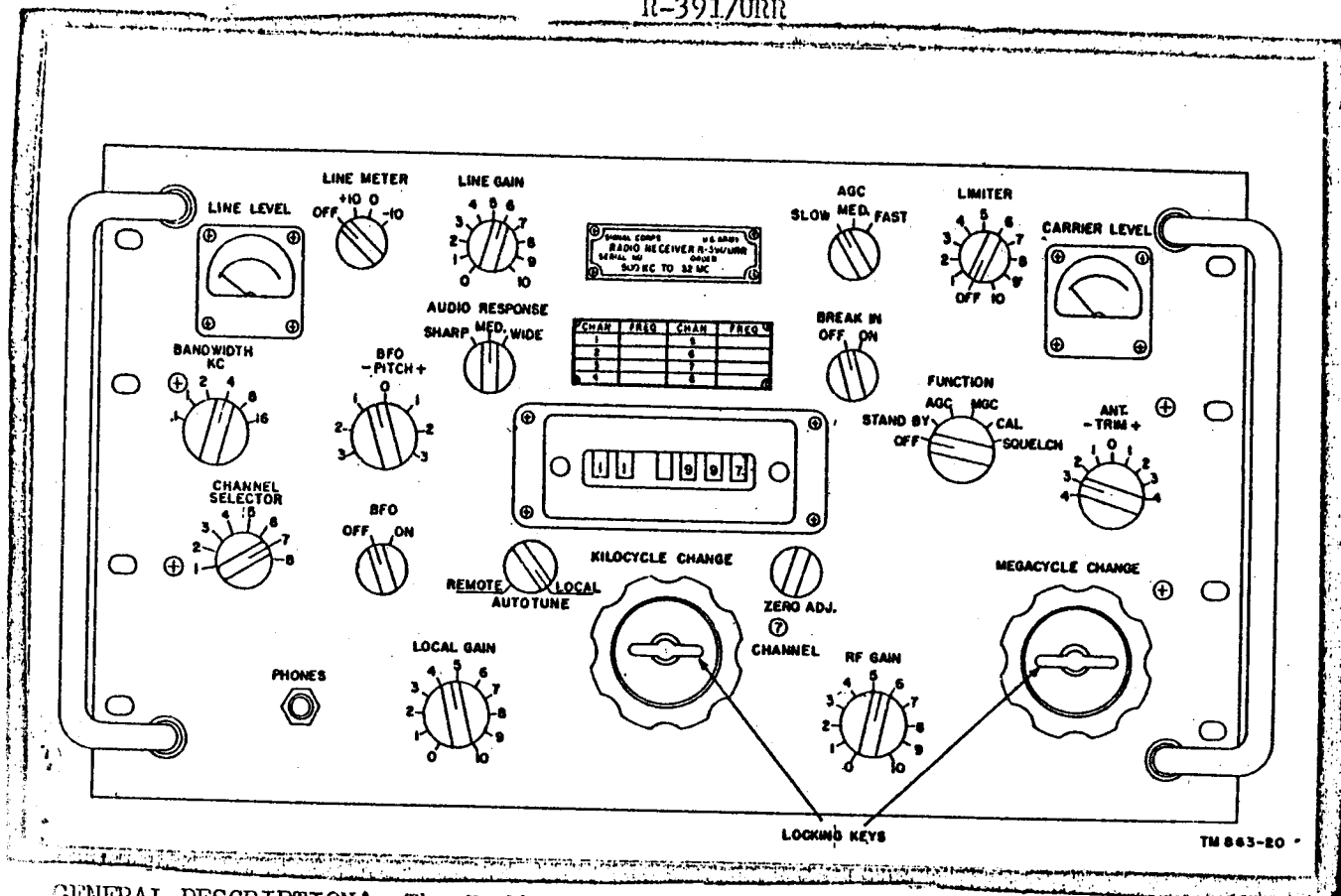


GENERAL DESCRIPTION: The Radio Receiver R-389/URR is a double conversion superheterodyne receiver. The types of signals received are A-1 (CW), A-2 (MCW), A-3 (voice), and F-1 (FSK). The frequency range is from 15 to 1,500 kc (2 ranges). This receiver does not have a calibration system built into the set. The reading has to be taken from the counter-type dial. The calibration error will not be more than 300 cps in the 15 to 500 kc range, and not more than 600 cps in the 500 to 1,500 kc range. The receiver is tuned manually or by motor tuning, with automatic band switching.

BASIC CHARACTERISTICS:

1. Power Requirements: *115-230V 48-62 cps*
2. Warm-up Period: *15 MIN*
3. Frequency Range: *15-500 kc*
500-1500 kc

ASSOCIATED RECEIVERS & EQUIPMENT
R-391/URR

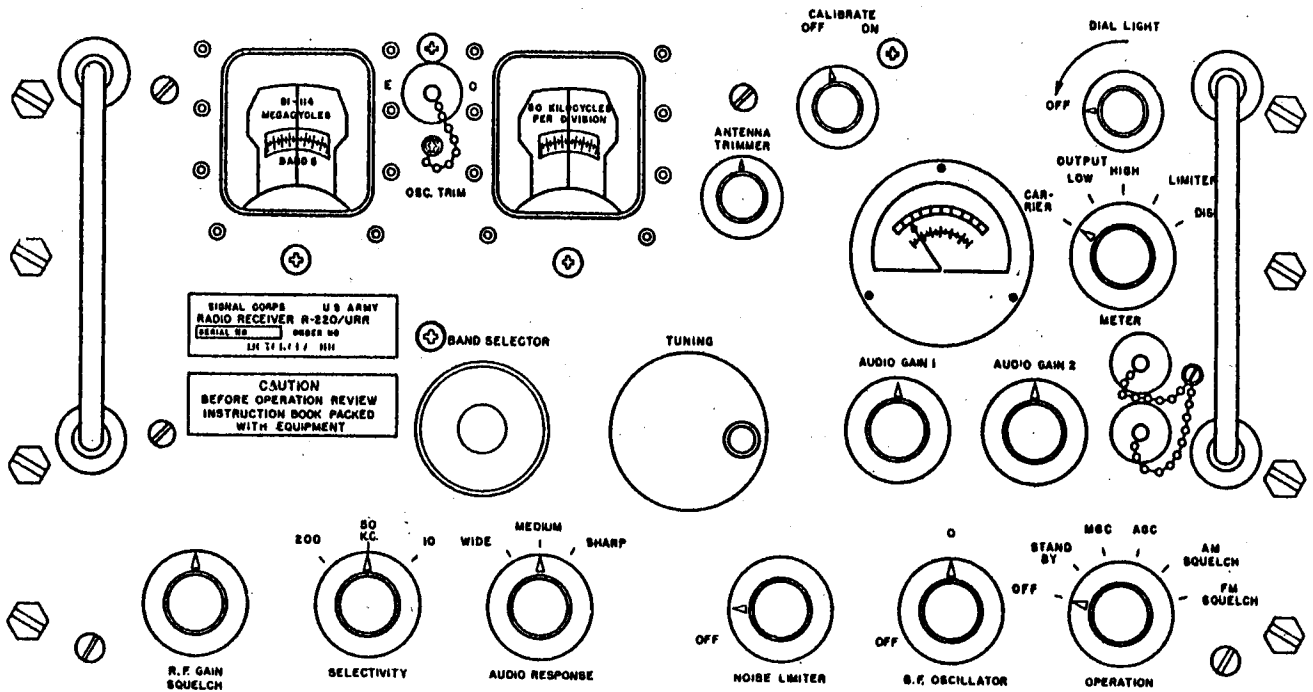


GENERAL DESCRIPTION: The Radio Receiver R-391/URR is a superheterodyne receiver. It is the same as the R-390/URR with the exception of three controls. The CHANNEL Selector, REMOTE-LOCAL AUTOTUNE, and the LOCKING KEYS. Designed for reception and monitoring of cw, mcw, voice and fsk signals.

BASIC CHARACTERISTICS:

1. Power Requirements: 110-220 48-62 cycles
2. Warm-up Period: 15 min
3. Frequency Range: .05 - 3.2 MGS
4. The purpose of the R-391/URR is to copy stations transmitting automatic Morse and radio teleprinter signals which have pre-set operating frequencies.
5. Crystal Oscillator:

ASSOCIATED RECEIVERS & EQUIPMENT
R-220/URR



GENERAL DESCRIPTION: The Radio Receiver R-220/URR is a superheterodyne receiver. It is designed for the reception and monitoring of AM, FM, and CW signals. It may be rack mounted using power supply PP-660/URR or operated mobile with a 26 volt dynamotor. It has a built-in calibration system used only by the maintenance man. The frequency range of 20 to 230 mc is covered in seven bands.

BASIC CHARACTERISTICS:

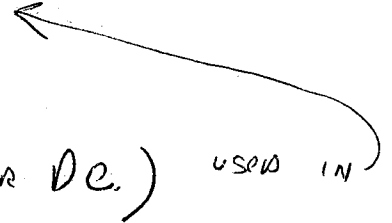
1. Power Requirements: 115-230 V
2. Warm-up Period: 15 min
3. Frequency Range: 20-230 MGS.
4. Found generally in low level teams of the USASA.
5. Many military nets, such as air-to-ground and tank-to-tank nets are presently within the frequency range of this receiver.

operates from

ASSOCIATED RECEIVERS & EQUIPMENT
AN/URR-29

PP660/URR - 115-23 & Accorant
DY 80 To work power supply (DYNAMOTOR)
with R220 becomes R64URR for mobile work

ASSOCIATED RECEIVERS & EQUIPMENT
AN/URR-29X



Uses R644 Receiver (R220 modified for DC.) used in

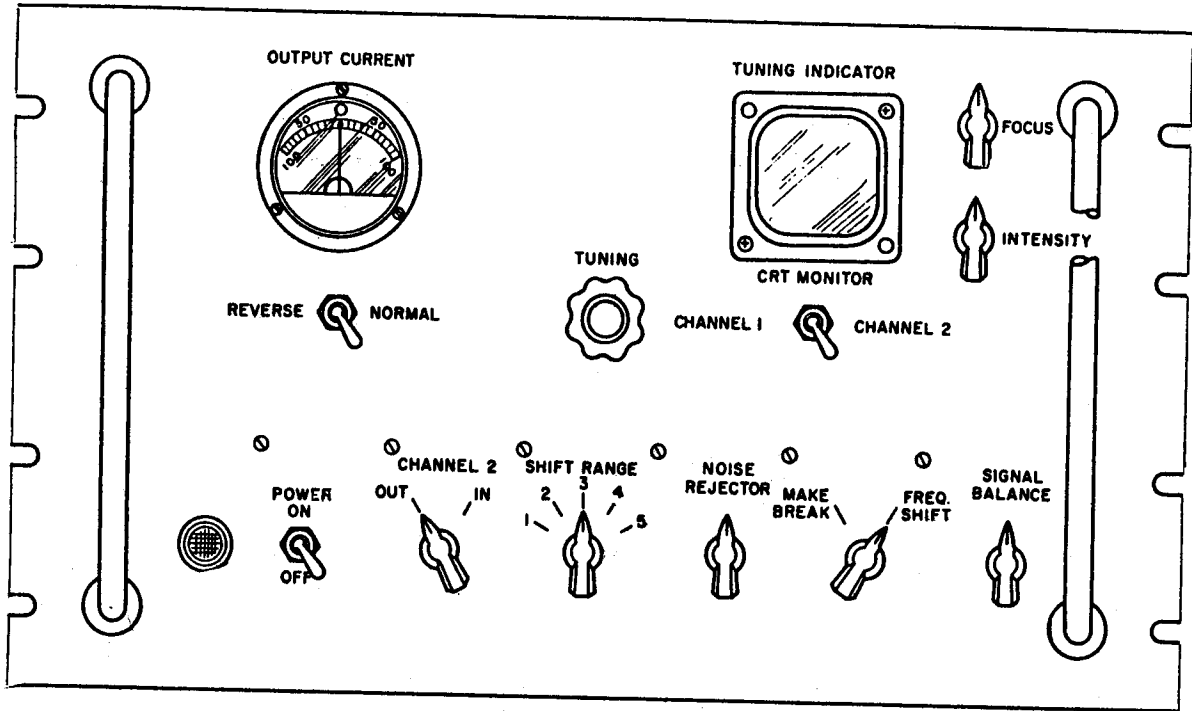
TYPES OF KEYING AND EQUIPMENT UTILIZED

ON OFF KEYING - OOK - common keying - (make break.)

Freq. Shift Keying - FSK - mark - space 100 cps to 6K, shift

Double Freq Shift. - mark - tone - space.

TYPES OF KEYING AND EQUIPMENT UTILIZED
CV-305/U

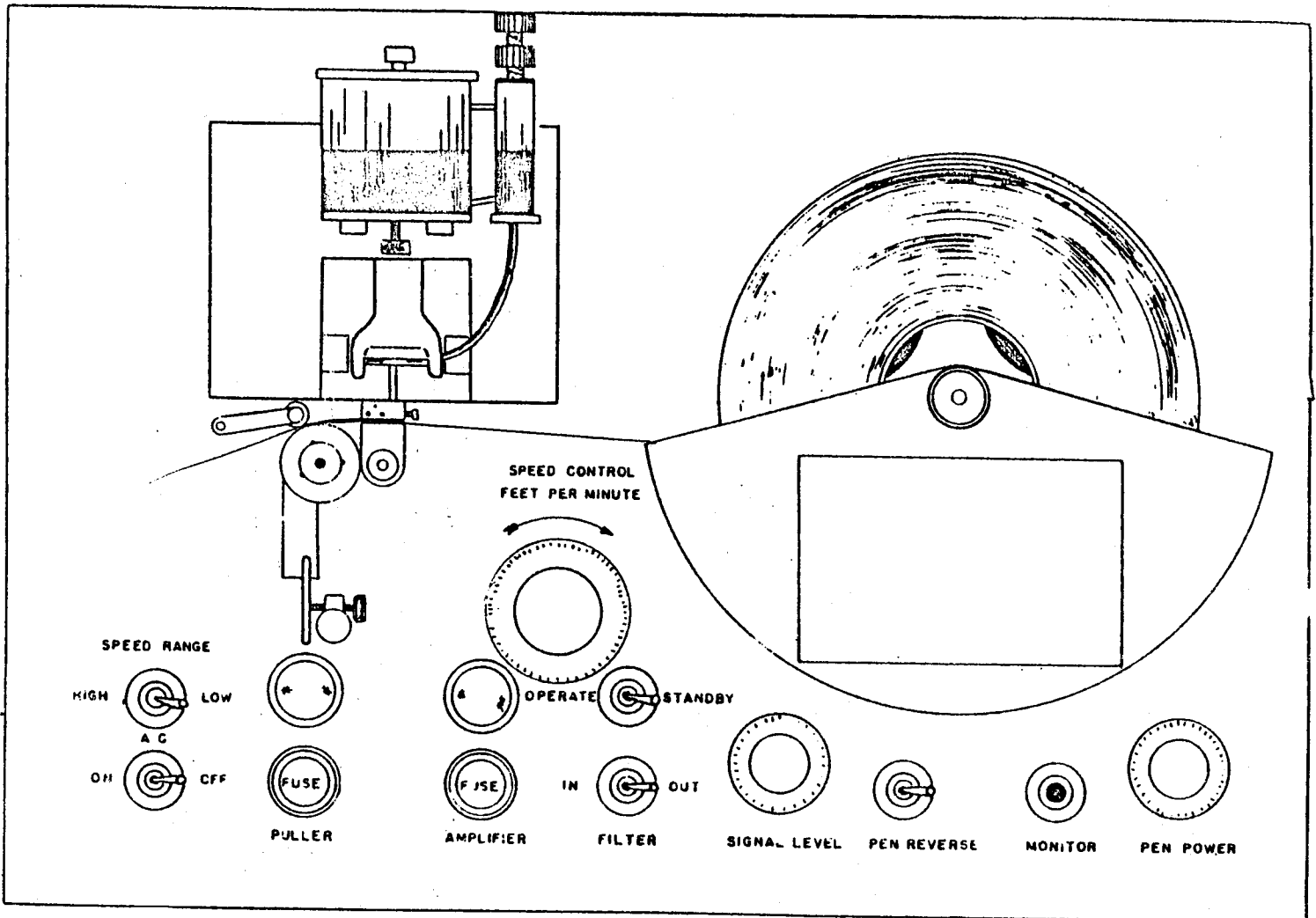


GENERAL DESCRIPTION: The Frequency Shift Converter CV-305/U is used to permit frequency shift signals to be copied either by a teletypewriter or by the Code Recorder RD-60/U, whichever would be applicable. Frequency shift transmission is used to overcome interference. The input signals to the CV-305/U are obtained from one or two radio receivers.

BASIC CHARACTERISTICS:

1. Power Requirements: 105-125 V 50-60 cps
2. Warm-up Period: 5 min.
3. Reception: OPF - FSK
4. Indicators: Necessary operating controls
5. Freq. Shift Range - 100-6000 cycles
 - 1A 100-400 cps
 - 2B 400-1200 cps
 - 3C 1200-2500 cps
 - 4D 2500-4000 cps
 - 5E 4000-6000 cps

ASSOCIATED RECEIVERS & EQUIPMENT UTILIZED
RD-60/U



GENERAL DESCRIPTION: The Code Recorder RD-60/U is an ink tape recorder used to record high speed CW signals.

BASIC CHARACTERISTICS:

1. Recording Speed: _____
2. Tape Length: 1000 FT
3. Tape Width: 3/8 inch
4. Character Size: VARIABLE
5. Power Requirements: 115-230 V 50-60 cycles A c
6. Warm-up Period: 45 seconds
7. Pens:
 - (a) Fine Line: High speed
 - (b) Medium Line: NORMAL speed 4-500 cph
 - (c) Broad Line: FOR RETRANS MISSION

NOTES

UNDULATION Tape Recorder (INU) Type

5-1000 RPM

~~Tape~~

AC line feed - power switch

Speed Range Switch - used w/ speed control knob
operate - standby

Filter - overcome QRM

SIGNAL Level control - activates pen

Pen Reverse

MONITOR - Power headset

ASSOCIATED RECEIVERS & EQUIPMENT UTILIZED
DIVERSITY FUNDAMENTALS

GENERAL DESCRIPTION: "Diversity" is a term applied to radio receiving systems designed to overcome "fading" in radio communications. The term "fading" commonly refers to variations in received signal strength whereby the sound produced decreases, i.e., "fades out" periodically to such a low level or becomes so distorted that it is hardly usable. The volume may remain at this low level for a time, or it may immediately become loud again, repeating the variation every few seconds. This periodic fading in signal strength is generally a localized condition. It may be found that while the signal has faded out in one location, it might at the same time be strong in a nearby location. Thus, fading may not occur simultaneously at two locations even though they are fairly close together. This characteristics of fading has given rise to what is known as "space diversity reception" whereby two or three antennas widely spaced are used to feed individual receivers, so that at least one of them will always be producing a usable output regardless of the individual strengths. To gain the full advantages of diversity reception, the individual receiver outputs must be connected to circuits which automatically select the output of that receiver producing the best signal at the particular instant, the outputs of the other two receivers being automatically eliminated.

TYPES OF DIVERSITY RECEPTION:

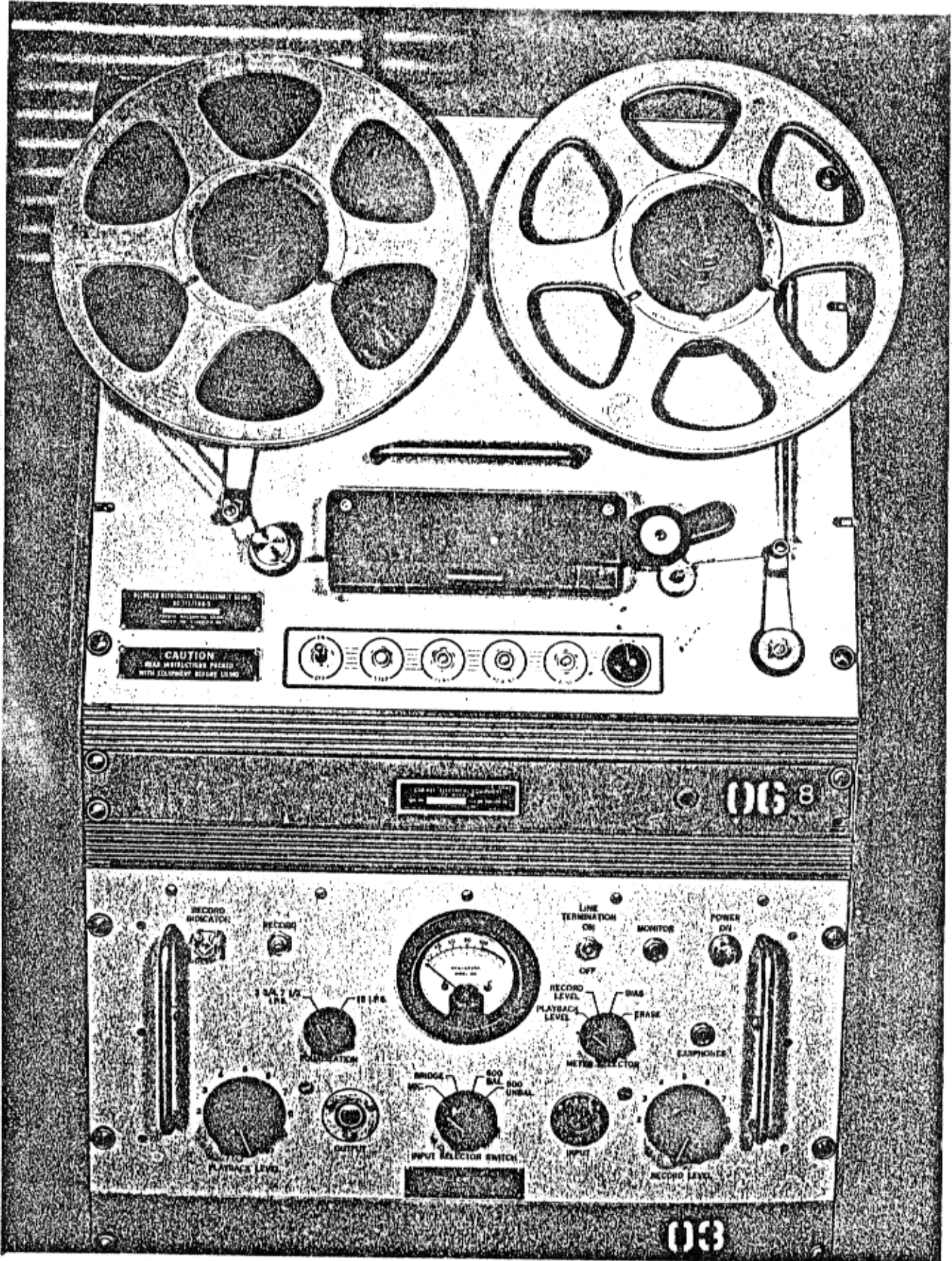
1. Frequency Diversity: Same Traffic on 2 or More Frequencies
2. Space Diversity: _____

DIVERSITY RECEPTION SYSTEMS:

1. ^{space} ~~DUAL~~ Diversity:
 - a. Antennas: 2 or More TERMINATED Rhombics
 - b. Receivers: 2 R390 or equivalent
 - c. Frequency Shift Converter: CV305 to R160 a Printer

ASSOCIATED RECEIVERS & EQUIPMENT UTILIZED
DIVERSITY FUNDAMENTALS

MAGNETIC TAPE RECORDER
AN/TNH-5



MAGNETIC TAPE RECORDER
AN/TNH-5

GENERAL DESCRIPTION: The AN/TNH-5 is a versatile magnetic tape recorder capable of recording and reproducing at three standard tape speeds using two standard size reels. It can be operated from its case, or installed in either a rack or console.

BASIC CHARACTERISTICS:

1. Power Requirements: 105-125 50 cps
2. Warm-up Period: 30 sec
3. Tape Travel and Recording Time: 3 1/4 7 1/2 15 ips
4. Tape and Reels: 7" = 1200' Tape 10 1/2" = 2400' Tape
5. Recording and Reproducing: MIKE OR PATCH CORD

CONTROL NOMENCLATURE:

1. ON-OFF Switch: _____
2. STOP Switch: Stops Tape
3. PLAY Switch: _____
4. REWIND Switch: _____
5. WIND Switch: _____
6. Tape Speed: Selects
7. Safety Switch: _____
8. Tape Gate: _____
9. PLAYBACK LEVEL Control: Volume
10. EQUALIZATION Switch: corresponds To Tape speed control 4 pos.
11. OUTPUT Jack: _____
12. INPUT Jack: connect MIKE OR PATCH CORD
13. INPUT SELECTOR Switch: MATCH impedance To input
14. RECORD LEVEL Control: Volume control FOR RECORDING
15. EARPHONES Jack: _____
16. METER SELECTOR Switch: 4 pos.

MAGNETIC TAPE RECORDER
AN/TNH-5 (cont)

- 17. POWER ON Light: _____
- 18. MONITOR Jack: _____
- 19. VU METER: _____
- 20. RECORD Button: START RECORDING
- 21. RECORD INDICATOR: _____
- 22. OUTPUT "B" Jack: _____
- 23. Line Termination: ON when using other than 600 ohm input eqpt.

ADVANTAGES

1/2 TRACK RECORDER

3 SPEED 3 1/4 7 1/2 15" cps
10" & 7" Reels
\$550

Speed	Reel 7"	10" Reel
3 3/4	60 / 120	120 - 240
7 1/2	30 / 60	60 - 120
15"	15 - 30	30 - 60

RECEIVERS AND RECORDER-REPRODUCER JOB SHEET
R-390/URR & AN/TNH-5

STARTING POSITIONS

1. ON-OFF	ON	8. INPUT Jack	connect cable
2. Tape Gate	closed	9. RECORD LEVEL	0
3. Tape Speed	$7\frac{1}{2}$	10. METER SELECTOR	RECORD LEVEL
4. PLAYBACK LEVEL	0	11. LINE TERMINATION	ON
5. EQUALIZATION	$7\frac{1}{2}$	12. MONITOR Jack	none
6. OUTPUT Jack	none	13. EARPHONES Jack	none
7. INPUT SELECTOR	600 unbal		

RECEIVER TUNING

1. Calibrate receiver.
2. Locate signal.
3. Zero-beat signal.
4. (a) For CW reception (recording) adjust BFO PITCH.
(b) For voice reception (recording) place BFO switch to OFF.
5. Adjust the following for best reception.
 - (a) ANT TRIM for maximum volume.
 - (b) RF GAIN and LOCAL GAIN for comfortable volume.
 - (c) BANDWIDTH for clearest signal.
 - (d) AGC (FAST) for voice signals.
 - (e) AUDIO RESPONSE (SHARP) for extremely bad interference on cw signals.

PRELIMINARY RECORDING PROCEDURE

1. Unplug headsets from receiver.
2. Plug headsets in to EARPHONES jack on recorder.
3. Plug other end of INPUT jack connecting cable into PHONES jack of receiver or the audio output jack from rear of receiver.
4. Adjust RECORD LEVEL of recorder until meter indicates 100 or 0 vu.

RECORDING

1. Depress PLAY and RECORD switches.
2. Adjust RECORD LEVEL to 100 on sound peaks.
3. Monitor signal with headsets plugged in the EARPHONES jack on recorder.
4. To check operation of recorder, place METER SELECTOR switch in the following positions.
 - (a) BIAS - meter should read between -1 and +1 vu.
 - (b) ERASE - meter should read between -2 and +2 vu.
 - (c) PLAYBACK LEVEL - Adjust PLAYBACK LEVEL volume control for comfortable listening level.
 - (d) RECORD LEVEL - normal position for recording and monitoring.
5. To stop recording depress STOP switch.

PREVENTIVE MAINTENANCE AND ITS APPLICATION

GENERAL: Preventive maintenance is the everyday care of equipment to insure its continuous satisfactory operation.

PRINCIPLES OF THE MAINTENANCE SYSTEM.

1. Maintenance should be accomplished at the lowest echelon consistent with the nature of the repairs.
2. The determining factors of repairs are: authorized spare parts, tools, time and equipment.
3. Each echelon will perform the maintenance of the lower echelon not having the necessary spare parts, tools, time or equipment.
4. Repairs will be accomplished as soon as possible and the equipment returned to the user.

ECHELONS:

1. First Echelon: OPERATOR
2. Second Echelon: UNIT MAINTENANCE
3. Third Echelon: POST MAINTENANCE
4. Fourth Echelon: FIXED FIELD SHOP (ARMY AREA)
5. Fifth Echelon: DEPOT

CATEGORIES:

1. Organizational: 1 & 2
2. Field: 3 & 4
3. Depot: 5

BASIC MAINTENANCE OPERATIONS:

1. F E E L
2. I N S P E C T
3. T I G H T E N
4. C L E A N
5. A D J U S T
6. L U B R I C A T E