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CANADIAN ARMY
MANUAL OF TRAINING
VHF RADIO SETS
Characteristics and Employment

PREPARED UNDER THE DIRECTION OF
THE CHIEF OF THE GENERAL STAFF
BY THE DIRECTORATE OF SIGNALS

ARMY HEADQUARTERS
OTTAWA



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INTRODUCTION

Over the past several years a new range of radio sets, in the Very High Frequency (VHF) band, has been introduced into the Army. If properly used in the roles for which they are intended, these sets will prove much better than their predecessors.

This is not a technical manual. It is intended as a guide for the user. Liberties have been taken with technical details for the sake of achieving a ready understanding of the subject material by non-technical personnel.

This is not an operators handbook. Such handbooks are provided as an EIS item with the radio set when issued and are a "Q" not a GS publication.

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VHF RADIO SETS

CHARACTERISTICS AND EMPLOYMENT

SECTION 1—GENERAL

101. Aim

The aim of this manual is to give the user a non-technical, general introduction to Very High Frequency (VHF) radio and to outline the characteristics and capabilities of VHF radio sets now in use in the field army.

SECTION 2—INTRODUCTION TO VHF

201. Meaning of VHF

- a. Each portion of the frequency spectrum will do some job better than any other portion. The trick is to know the rules of how to get the best out of the portion you are using.
- b. A very high frequency is a frequency between 30 and 300 Megacycles (Mcs). It is in that part of the spectrum that lies between High Frequency (HF) 3 to 30 Mcs and Ultra High Frequency (UHF) 300 to 3000 Mcs.

202. Propagation

- a. To appreciate the use of VHF sets one should have an elementary knowledge of the propagation of radio waves. The next few paragraphs are a word picture of the necessary bits of the subject. Basically, what is meant by propagation is the way the radio wave gets from the transmitter to the receiver.
- b. A radio wave travels from transmitter to receiver in three different ways. These ways are:
 - (1) Surface wave
 - (2) Skywave
 - (3) Space wave
 - (a) Direct waves
 - (b) Deflected waves
- c. For our purposes, it can be assumed that surface waves and skywaves are produced by frequencies outside the VHF band. Since propagation in the VHF band is mainly by space waves, these are of main concern here. The space wave may be broken down into two components, see Figure 1:
 - (1) Direct waves
 - (2) Reflected waves

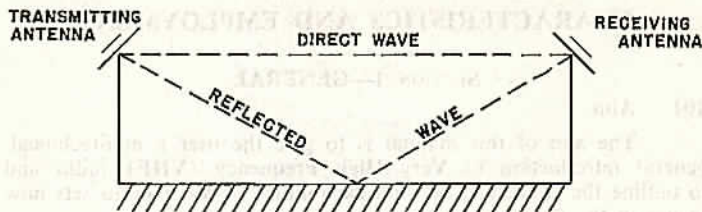


FIG. 1
SPACE WAVE

- d. A direct wave tries to follow a straight line between transmitting and receiving antenna. These waves will bend around obstacles but their strength is weakened by the extent of the angle through which they are bent and by the number of times they are bent. They are only slightly affected by the surface over which they pass, however, they may be seriously affected by obstacles through which they must pass.
- e. The reflected wave has much the same characteristics as the direct wave. The reflecting surface may be the ground, houses, hills or some similar surface. The important point to remember is that these two waves travel different distances and therefore one wave will arrive before the other. Depending on the difference in path lengths between the two waves the signal received is either reinforced or weakened and the waves may even cancel each other out. If signals are very weak, moving the receiving antenna a few feet may increase the signal strength appreciably as the movement changes the differences in path length and a reinforced signal is received.
- f. When the position of the radiating antenna is approximately ground level, the general pattern of VHF radiation is hemispheric in shape. The strongest waves are those at the bottom of the hemisphere, ie those most nearly horizontal. The waves weaken as they move into the vertical. If a hill is in the path of the horizontal waves, they will be absorbed. A weaker wave will pass over the hill and the only portion of the wave that will get behind the hill are those bits of the weaker wave that bend. Again the greater the angle of bending the weaker the wave. Figure 2 diagrams these effects.
- g. Another characteristic of VHF propagation is that, in general, range cannot be stretched. If the transmitter is sending a sufficiently strong signal to work the receiver, communications are good. If the receiver is not getting a sufficiently strong signal, generally nothing is heard. Providing the sets are working within what might

be called normal working range the signal might be improved by moving the antenna. For example, in Figure 2 moving from point A to B.

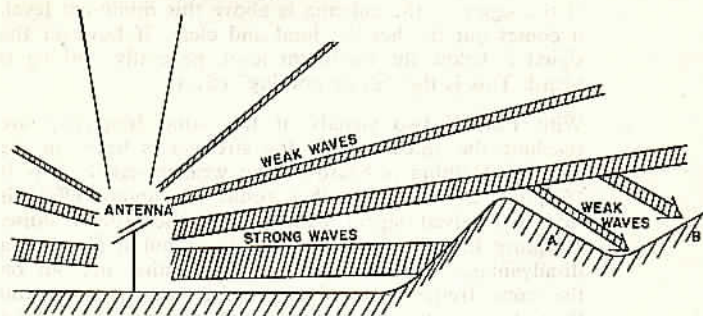


FIG. 2
PROPAGATION OF VHF WAVES FROM A VERTICAL ANTENNA

- h. VHF sets are much less liable to interference than HF sets. Skywave interference, and atmospheric noise is almost non-existent. VHF communications are as good by night as they are by day.
- i. There are other propagation effects which may be noticed on VHF. Freak changes in the atmosphere may cause the signal to disappear temporarily. Dead spots may be encountered where nothing is heard.

203. Siting

It will be clear from the above that the correct siting of VHF sets is of paramount importance. To choose the best site, a user must know the probable obstacles to propagation between his station and the station to which he is working. When working a net of a number of stations, all users should know the positions of every station on the net so that they can choose a site which will give them communications with the maximum number of stations. Since it is impossible to predict accurately propagation paths, if signals are non-existent after he has moved to his chosen site, the user should move his aerial a short distance (no more than a few feet). If this fails to improve signals, he should re-site his station, moving longer distances (50 to 100 yards at a time) until the signal is satisfactory.

204. Capture Effect

- a. An understanding of "Capture Effect" is important in the use of VHF. The explanation of this characteristic requires the use of the term "modulation". A simple explanation of modulation is that it is the method of putting the intelligence, i.e. speech, music, etc, on a radio wave. There are many types of modulation but the VHF sets discussed in this manual use Frequency Modulation (FM). FM produces an "all or nothing" effect, and the "Capture Effect".

- b. In an FM set the strength of the signal heard is, by and large, unaffected by the strength of the signal reaching the antenna provided it is above a certain minimum level. If the signal at the antenna is above this minimum level, it comes out the headset loud and clear. If however the signal is below the minimum level, generally nothing is heard. This is the "all or nothing" effect.
- c. With FM, if two signals of the same frequency are reaching the antenna, only the stronger is heard in the headset. Nothing is heard of the weaker signal. This is "Capture Effect". A further result of capture effect is that a received signal banishes all background noise. "Capture Effect" has many advantages but it also has a disadvantage. If a set operating on another net but on the same frequency produces a stronger signal to you than the stations on your own net, you might in effect have changed nets. The user must always be watchful of this.

205. Battery Power

Because of the "all or nothing" effect, as the batteries of a transmitter lose their effectiveness, the signal at the receiving end does not gradually disappear. Instead, the falling off of reception is dramatic. There is a few minutes of noisy and sometimes distorted reception followed by a complete loss of reception. The transmitting operator may not be aware that this is happening. Therefore, a receiving operator who hears this characteristic noise should warn the transmitting operator.

206. Summary

When using VHF, it must be remembered that success or failure depends on the propagation path between the antenna of the communicating stations and that the knob turning ability of the operator has but limited effect. Careful siting of VHF sets is of paramount importance. The user must be ever mindful of "Capture Effect".

SECTION 3—RADIO SET CPRC 26

301. Purpose and Facilities

- a. The Radio Set CPRC 26 is a light weight, manpack, FM, VHF radio telephone set designed for short range communications in the forward areas. It has a working range, under average conditions, of about one mile. It provides a choice of six channels in the 50-54.2 Mcs range. It can be used for voice transmission only. Details of operation are contained in the Operators Handbook.
- b. The receiver-transmitter and its dry battery are contained in two metal cases which clamp together. The complete radio set is contained in a web bag. The set may be carried in any one of several positions on the body. The weight of the complete station is 10 lbs 8 ozs. See Plate 1.

- c. The equipment is immersion proof and shock resistant. When provided with a special loop antenna the CPRC 26 can be used to 'home' on any other set, within working range, operating on the same frequency.
- d. For cold weather operation a remote battery cable is provided so that the battery can be carried inside the clothing.

302. Types of Set

- a. There are four types of radio set CPRC 26. The types differ only in frequency assignment. A letter suffix is attached to the control panel of each set for identification purposes. The frequency assignment of each type is given in Table 1.

CHANNEL	SET TYPE			
	A	D	E	F
	Mcs	Mcs	Mcs	Mcs
1.....	50.0	50.0	50.0	50.0
2.....	50.2	50.2	52.4	53.4
3.....	51.6	50.4	52.6	53.6
4.....	51.8	50.6	52.8	53.8
5.....	52.0	50.8	53.0	54.0
6.....	52.2	51.0	53.2	54.2

Table 1—Frequency Assignments—Radio Set CPRC 26

- b. It should be noted that the frequency assignments have been arranged to provide channels which may be used for working between different types of set.

303. Siting

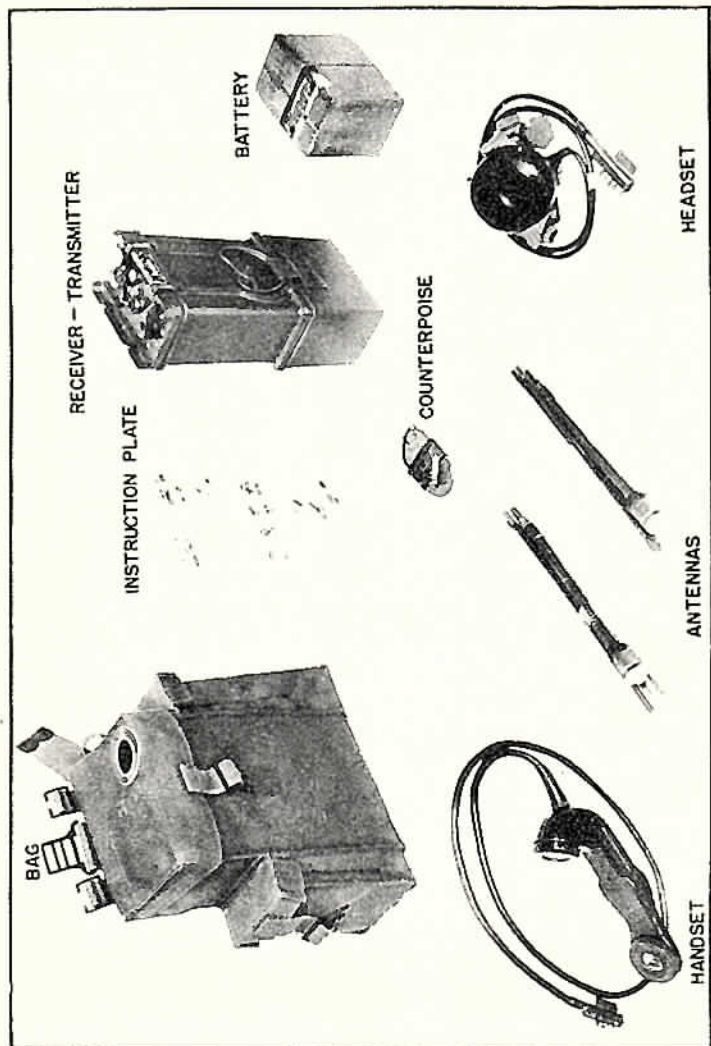
The position of the radio set with relation to surrounding objects greatly effects the operating range. If the other station or stations can be seen, satisfactory operation is probable. Intervening hills or tall buildings can hamper or prevent contact. Valleys, depressions, densely wooded areas and low places are poor sites. Keep away from power lines, bridges and underpasses. Flat terrain is good. Generally transmission over water is better than on land.

304. Maintenance

- a. Operator maintenance is simple and essential. Ensure it is done. The battery is all important. The one used is the dry battery BA 289 U. The normal life of the fresh battery under normal working conditions is 24 hours.

- b. The longer a battery has been in storage the shorter its life is likely to be. They should be stored in a dry cool place. All dry battery packs have a manufacturer's date printed on them and they should be used in "date order" so that the older batteries are used first.

PLATE I



RADIO SET CPRC 26

SECTION 4—RADIO SET AN/PRC 510

401. Purpose and Facilities

- a. The Radio Set AN/PRC 510 is a battery operated, portable, FM, VHF, continuously tunable radio set intended to provide manpack voice communication from battalion headquarters to company, or equivalent roles. It has a working range, under normal conditions, of approximately five miles. It operates in the frequency range 38.0 to 54.9 Mcs. The equipment is immersion-proof and shock resistant.
- b. The set can be operated in a vehicle, as a ground station, or while being carried by an operator. A vehicular installation kit is available. Provision is also made for remote antenna operation and unattended relay operation using two sets.

402. General Description

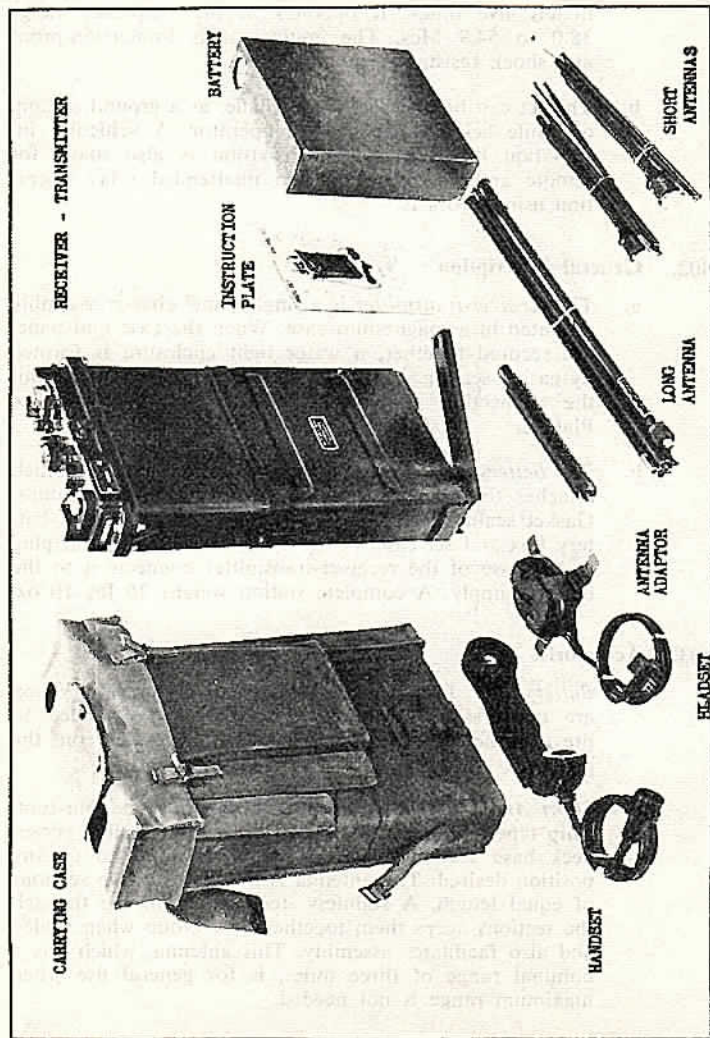
- a. *The receiver-transmitter* is a single panel chassis assembly mounted in a magnesium case. When the case and panel are secured together, a water tight enclosure is formed by gasket sealing. Plugs and jacks are provided to permit the connection of handset, headset and antenna. See Plate 2.
- b. *The battery* is housed in an aluminum battery box which attaches to the set by means of spring loaded clamps. Gasket sealing ensures a water tight union between battery box and set case. A short eight-wire cable and plug in the base of the receiver-transmitter connects it to the battery supply. A complete station weighs 26 lbs 10 oz.

403. Accessories

- a. *Battery Box.* Fastened to the bottom of the battery box are two V-shaped runners which can be extended to prevent the set from tipping when operated on the ground.
- b. *Short Antenna.* The short vertical antenna is a four-foot, whip type, sectional rod fitted with a semi-flexible gooseneck base section which allows it to be tilted to any position desired. The antenna is made up of five sections of equal length. A stainless steel cable running through the sections keeps them together as a group when folded and also facilitates assembly. This antenna, which has a nominal range of three miles, is for general use when maximum range is not needed.
- c. *Long Antenna.* The long vertical antenna is a 10-foot, whip type, sectional rod fitted with a rigid base section. The antenna is made up of seven sections. A nylon cable,

under spring tension, running through the sections keeps them together when extended or folded. This antenna, which has a nominal range of five miles, is used when maximum range is required. It screws into a flexible coupler which, in turn, screws into the LONG ANT jack on the control panel.

PLATE 2



RADIO SET AN/PRC 510

- d. *Remote Antenna.* Facilities are provided for remote antenna. This enables the operator and set to take cover and still provide good siting for the antenna.
- e. *Handset and Headset.* In an emergency, the handset of the CPRC 26 can be used with the AN/PRC 510 but the reverse does not hold true. The headset is the same as that supplied with the CPRC 26.
- f. *Battery.* Power is supplied by a dry battery pack BA 349/U. Life of a fresh battery under normal operating conditions is about 24 hours. The longer a battery has been in storage the shorter its life is likely to be. They should be stored in a dry cool place. All dry battery packs have a manufacturer's date printed on them and they should be used in "date order" so that the older batteries are used first.

404. Siting

The position of the set relative to surrounding objects greatly affects the operating range. Normally, line of sight range can be expected. An intervening hill or tall building may hamper or prevent contact with the distant station especially when the obstacle is close to either station. Valleys, depressions, densely wooded areas and low places are poor sites. Objects such as cliffs and buildings, which are not directly in the transmission path will sometimes produce helpful reflections which may increase the range or make transmission possible around obstructions under poor conditions.

405. Frequency Separation

- a. Radio sets using the AN/PRC 510 will work in close proximity providing the operating frequencies are spaced 200 Kcs or more apart. If the frequency separation is only 100Kcs stations of the different nets must be 600 yards apart.
- b. Both receiver and transmitter frequencies are calibrated against internal calibration oscillators to insure accuracy of the dial reading. Calibrating points are shown in the operators manual, which also contains calibrating instructions.

406. Interoperability

The AN/PRC 510 can work with all types of radio set CPRC 26 on all channels. It can also work on the radio net AN/PRC 509 on 38 Mcs. The radio set C42 covers the entire band of the AN/PRC 510.

407. Radio Set AN/PRC 509

The radio set AN/PRC 509 is similar to the AN/PRC 510 in every respect but frequency band. The frequency band of the 509 is 26.3-38 Mcs. The radio set AN/PRC 509 is primarily for Artillery units.

408. Operation

Details of the operation of the radio set AN/PRC 510 are contained in the Operators Handbook issued with each set.

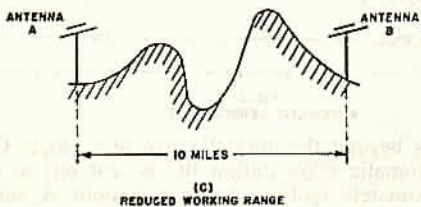
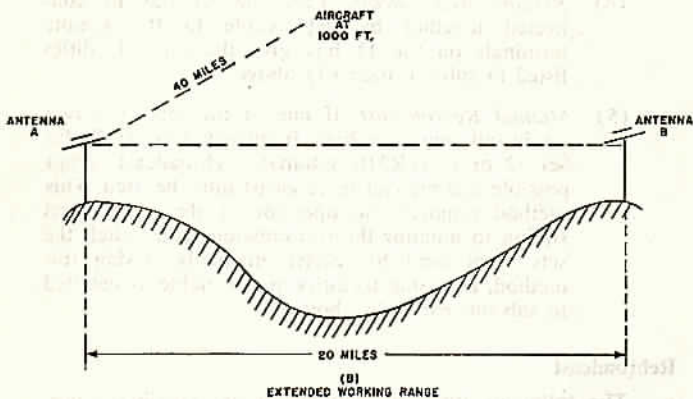
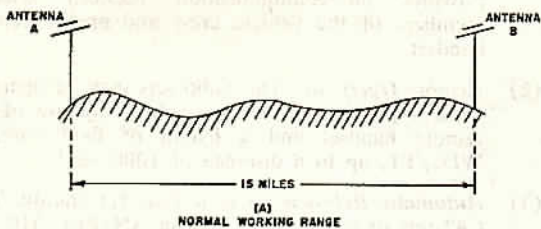
SECTION 5—RADIO SET C42

501. Description

- a. The Radio Set C42 is a VHF, FM set which is continuously tunable over the frequency range 36 to 60 Mcs. Each channel occupies 100 Kcs resulting in 241 channels being available. Calibration points are provided at 100 Kcs steps throughout the tuning range and therefore netting is not required. The set operates on a nominal 24 volt DC supply.
- b. The radio set is normally mounted in a vehicle but it may be dismounted and used as a ground station. Normal ranges over average rolling ground using an eight-foot rod antenna are:
 - (1) High Power—up to 15 miles
 - (2) Low Power—up to 4 miles.
- c. The range may be extended by using a special antenna system, by elevating the antenna, and by carefully selecting the antenna site. In built-up areas and mountainous country, shorter ranges may result depending on the path profile. This is illustrated in Plate 3.
- d. Consideration must be given when selecting antenna locations to both the immediate and anticipated deployment of stations on the net. In Plate 3 (a) for example, if the antenna at sites A and B were removed to the top of the hills better range could be expected. If the co-axial cables are not long enough to provide a favourable antenna location, the station could be moved and operated remotely by using the remote control handset. Extended range operation can be expected when operating to aircraft equipped with the Radio Set AN/ARC 44 or similar set. By using these aids, and taking into account possible future locations of outstations, satisfactory communications should result.
- e. The radio set should only be operated on high power when communication on low power is not possible. This will reduce the chance of enemy interception, possible interference to friendly stations and conserve station batteries.

502. Facilities

- a. The following facilities are generally available from a C42 set installation, however users should check the pertinent operators handbook to insure what facilities are applicable:



- (1) *Intercommunication.* An amplifier within the C42 provides intercommunication between selected members of the vehicle crew and/or the remote handset.
- (2) *Remote Operation.* The radio sets may be operated from a position out of the vehicle by use of the remote handset and a length of field wire, ie WD1/TT, up to a distance of 1000 yards.
- (3) *Automatic Rebroadcast in a Two Set Station.* Two C42 sets or one C42 set and an AN/PRC 510/509 connected together in a vehicle harness can be used to automatically rebroadcast the incoming signal from one set over the other. This and other rebroadcast facilities are described in paragraph 503 below.
- (4) *Remote Rebroadcast.* Two one set stations connected together by field cable to the remote terminals on the J1 box give the same facilities listed in sub-sub para (3) above.
- (5) *Manual Rebroadcast.* If one of the sets in a two set installation is a high frequency type ie Radio Set 52 or C11/R210 automatic rebroadcast is not possible and manual rebroadcast must be used. This method requires the operator at the rebroadcast station to monitor the transmissions and switch the sets from send to receive manually. Using this method, the same facilities are available as detailed in sub-sub para (3) above.

503. Rebroadcast

- a. The following types of rebroadcast are possible, Automatic, Remote and Manual. An example of automatic rebroadcast is illustrated in Figure 3. Two stations A and D located 26 miles apart require communications.

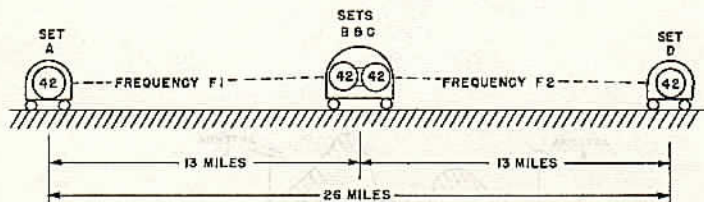


FIG. 3
AUTOMATIC REBROADCAST

- b. This is beyond the normal range of a single C42 set so an automatic relay station BC is sent out to a location approximately halfway between stations A and D. This relay station consists of two C42 sets in one vehicle. Set A works to set B on frequency F1. Messages received by Set B are automatically retransmitted by set C on

frequency F2 and received by set D. When set D replies the reverse occurs. A and D thus have a direct link with each other without the delays of sequential relay. This method can be extended to net operation.

504. Radio Set C45

The Radio Set C45 is similar to the Radio Set C42. However the frequency band is 23-38 Mcs and has 151 channels.

SECTION 6—MISCELLANEOUS

601. Radio Set B47

The Radio Set B47 is a VHF, FM set installed in A and B vehicles in Europe where a five-mile working range is required. It is interoperable with other VHF, FM sets in the 38-56 Mcs frequency range.

602. Radio Set B48

The Radio Set B48 is a VHF, FM set installed in artillery B vehicles in Europe where a five-mile working range is required. It is interoperable with other VHF, FM sets in the 26-38 Mcs frequency range.

603. Radio Set AN/ARC 44

The Radio Set AN/ARC 44 is a VHF, FM set at present being used in the CH 112 helicopter to provide communication on the ground tactical net. It is intended that the set will also be installed in light aircraft. The frequency band is 24.0-51.9 Mcs.

frequency 17 and received by 17. When set E requires
the reverse occurs. A and B then have a narrow band with
each other without the delay of sequential relay. This
method can be extended to any operation.

200. Radio set 135

The Radio set 135 is similar to the Radio set C-1. How-
ever the frequency band is 1.35 Mc and has 131 channels.

Section 2 - DIRECTLY RELATED

201. Radio set 147

The Radio set 147 is a VHF FM set similar to A and
B. It is in Europe where a frequency band is assigned.
It is interchangeable with other VHF sets in the 10-30 Mc band
frequency range.

202. Radio set 148

The Radio set 148 is a VHF FM set similar to A and
B. It is in Europe where a frequency band is assigned.
It is interchangeable with other VHF sets in the 10-30 Mc band
frequency range.

203. Radio set 149

The Radio set 149 is a VHF FM set similar to A and
B. It is in Europe where a frequency band is assigned.
It is interchangeable with other VHF sets in the 10-30 Mc band
frequency range.

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