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an ALLIED publication

understanding and using

CITIZENS BAND RADIO

A complete guide for users and potential users of the Citizens Band Radio Service. Covers licensing, equipment, installation, and use.

UNDERSTANDING AND USING CITIZENS BAND RADIO

Written Under the Direction of
the Publication Division
Allied Radio Corporation

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PREFACE

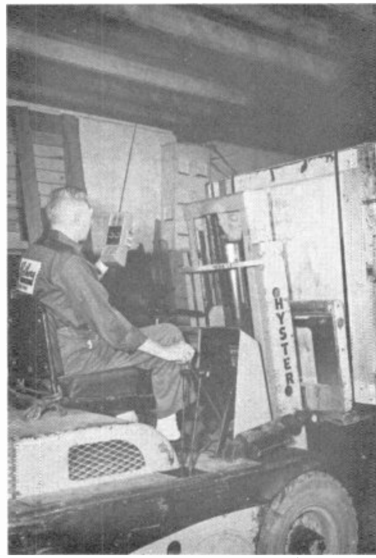
The introduction of the Citizens Radio Services has made two-way radio a practical tool which can be used by any U. S. citizen, 18 years of age or over. Furthermore, Citizens Band radio equipment is being produced in a variety of forms for every conceivable type of operation, and at prices that will fit almost any budget. Some units are designed strictly for use as base stations, while others can be operated as either fixed or mobile stations. There is also a wide variety of the transistorized walkie-talkie type transceivers that operate directly from batteries and may be carried in the hand; many of these units do not even require an FCC license for operation.

The purpose of this book is to provide users and potential users of this service with a better understanding of Citizens Band radio and to promote interest in this exciting new field. Included here are discussions of the Citizens Radio Service and how it began, its uses, how to obtain the license, CB equipment, antennas, how to use CB equipment, operating procedures, servicing hints, and many other practical topics designed to guide you in selecting the radio equipment best suited for your needs and in setting up your station with the least amount of time and effort. Also included is an appendix which lists the FCC field offices and the 10 signals language code.

ALLIED RADIO CORP.

SOME PRACTICAL USES OF CB RADIO

Construction



Warehouse Operations

Railroad Freight Yards

TABLE OF CONTENTS

CHAPTER 8

APPENDIX A

APPENDIX B

CHAPTER 1

GETTING ACQUAINTED WITH CITIZENS BAND RADIO

When radio was first developed, it was hailed as the "miracle of the age," yet there were many people who thought it would never become practical as a means of communication. Today, however, radio has become a part of our everyday lives and is used to provide entertainment as well as communication. Furthermore, since the advent of Citizens Band radio, this medium has become a versatile tool which can provide an invaluable service to everyone. The uses of radio are limited only by the imagination.

WHAT IS CITIZENS BAND RADIO?

This question can best be answered by saying that CB radio is many things to many people, depending primarily on how it is used. In 1947 the FCC (Federal Communications Commission) established the Citizens Radio Service to permit personal short-distance radiocommunications, signaling, and remote control by radio signals. This service made available to the general public for the first time, the long-awaited convenience of a two-way radio system which could be used by practically anyone for either business or personal activities.

Prior to this time, the frequency spectrum was reserved for those radio services which operated in the interest of public safety, necessity, and convenience. This made radiotelephone communications available for military purposes, commercial and industrial interests, ships, aircrafts, public utilities, and local governmental agencies such as fire and police departments, to name just a few. There were also certain portions of the frequency spectrum which were allocated for amateur radio, and although this service does not fall directly into any of the aforementioned categories, it has earned its place in the spectrum by virtue of the services rendered by amateur operators during times of disaster, national emergency, and because of its continuing value as a scientific training ground for our nation's youth. Also, amateur radio has contributed many technical advances to the field of radio.

Before the days of CB radio, there were thousands of people who were interested in radiotelephone and could actually make good use of it. Yet, they were deprived of operating space in the frequency spectrum because they were unable to qualify for one of the FCC licenses. Realizing the need for a radio service which could be used by the average citizen with little or no knowledge of radio, the FCC presented to the public the Citizens Radio Service.

An FCC license is required before you can transmit with CB equipment. This license is easy to obtain; no knowledge of radio is required and any U. S. citizen who meets the age requirements can get it. You only need to fill out the proper application and mail it to the FCC with a remittance for $8.00. There are even certain conditions in which no CB license is required (discussed later).

Classes Of Operation

Citizens Band radio is divided into four classes, A, B, C, and D. At the time CB radio was initiated, there were only two classes of license (A and B) available. The radio frequencies allocated for both classes of operation are in a band 10 megacycles (mc) wide between 460 and 470 mc. As you can see from Fig. 1-1, this band falls within the ultra-high frequency (UHF) range of the spectrum. The Class-A and -B service was intended to provide two-way radiotelephone wherever the need arose. A business, for example, could use CB radio for dispatching its delivery trucks, or it could be installed in the family car to provide radiocommunications with the home. The primary difference between the Class-A and -B services was in the two-way radio equipment. All CB operation, of course, is governed by the rules and regulations adopted by the FCC. These regulations not only stipulate how CB radio is to be used, but they also give the technical requirements which the radio equipment must meet.

The radio equipment for Class-A operation had to meet much more stringent technical standards than the Class-B units, but Class-A operators were also allowed more versatility in operation. For example, Class-A equipment was permitted to operate with a miximum input power of 60 watts to the final

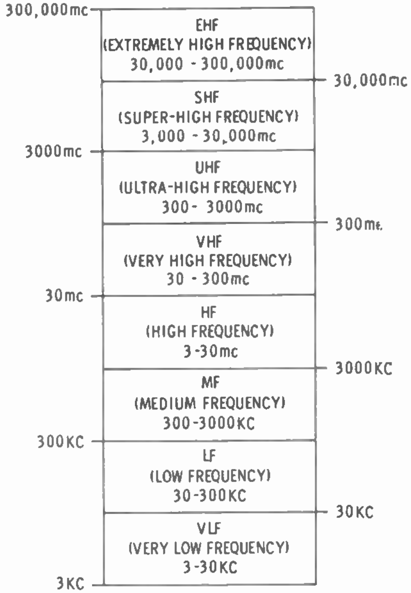


Fig. 1-1. The radio-frequency spectrum.

stage of the transmitter, as opposed to only a 5-watt input power for Class-B units. This meant that, all things being equal, Class-A stations could provide more reliable communications over a greater area than Class-B stations.

Although its uses were practically unlimited, Citizens Band radio was rather slow in gaining acceptance. The two principle reasons for this were the high cost of equipment and the limited range of communications. Cost was especially limiting with the Class-A units. Initially, the production of CB equipment was more or less on an experimental basis, and it was hampered by the many problems associated with equipment operating at ultra-high frequencies.

Despite these obstacles, many Class-A units were sold—mostly to businesses, industries, and others who had specific need for them. Their cost at this time was rather high and the range of communications with this equipment was somewhat limited. Eventually, some reasonably priced Class-B units appeared on the market, but there was still the problem of limited range. One of the factors that determines the range of a transmitter is its operating frequency. At UHF, radio waves tend to travel in a straight line between transmitting and receiving antennas; they do not reflect and bend as much as the lower-frequency waves do. This is illustrated in Fig. 1-2; the UHF signal travels more or less in a line-of-sight path between the two antennas. Intervening terrain or objects such as trees or buildings greatly attenuate, and sometimes completely block, UHF radio signals. When striking these same objects, however, the lower-frequency signals bend much more readily and thereby reach the receiving antenna with lower loss.

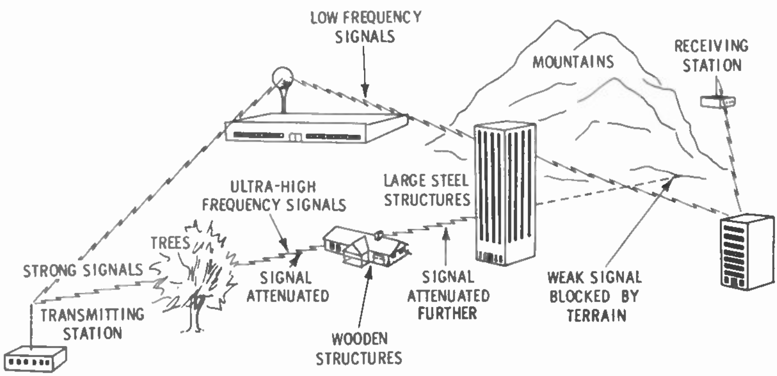


Fig. 1-2. Characteristics of radio waves at low and high frequencies.

Shortly after the Class-A and -B services were introduced, a third class was announced. Known as Class C, this service was reserved for the remote control by radio signals of such devices as garage doors, model airplanes, boats, etc. The FCC regulations prohibit the use of radiotelephone in this class CB operation.

Realizing the shortcomings of UHF communications and the need for a Citizens Band radio that was more practical, the FCC in September of 1958 allocated a number of channels for use by a new CB service labeled Class-D. Although Citizens Band radio had been in existence for 11 years, it was not until the Class-D service was introduced that it really got off to a good start. In fact, most people had never even heard of CB radio until this time. The older Class-A and -B services are still being used but it is the Class-D service that accounts for the widespread popularity of CB. Now, frequencies formerly assigned in the 11-meter amateur band have been reallocated for Class-D stations, and at these lower frequencies more reliable communications can be obtained. Furthermore, Class-D equipment is readily available in a variety of styles and at reasonable prices.

Channel Allocations And Operating Limitations

Each class of CB radio is designed to fill a specific need and each must operate in compliance with the FCC regulations. Channel assignments for the various classes are different, and there are limitations as to the type of operation that can be employed. Some technical knowledge is necessary to understand the *why's* and *why not's* of CB operation.

To begin with, the Class-A license permits the user a much higher transmitter power input than Class B and also provides a variety of operating frequencies from which to choose. Moreover, the antenna height is not nearly as restricted as it is for Class B. A variety of channels are available for Class-A assignments on a shared basis with other stations in the Citizens Radio Service. To be more specific, there are 48 channels in the 460- to 470-mc band which can be used by Class-A stations. These channel frequencies are listed in Table 1-1. Each channel is separated by 50 kilocycles (kc)—enough separation to prevent properly operating equipment from causing interference on adjacent frequencies. A Class-A station is assigned one-frequency only, and prior FCC approval must be obtained before the equipment can be operated on any other channel.

Table 1-1. Frequency Allocations for Class-A Stations

ALL FREQUENCIES IN MEGACYCLES			
462.55	463.15	465.30	465.90
462.60	463.20	465.35	465.95
462.65	464.75	465.40	466.00
462.70	464.80	465.45	466.05
462.75	464.85	465.50	466.10
462.80	464.90	465.55	466.15
462.85	464.95	465.60	466.20
462.90	465.05	465.65	466.25
462.95	465.10	465.70	466.30
463.00	465.15	465.75	466.35
463.05	465.20	465.80	466.40
463.10	465.25	465.85	466.45

Power limitations for Class-A stations are quite lenient; the maximum plate input power is 60 watts. This is the highest transmitter power permitted any class in the Citizens Radio Service. Normally, Class-A units are authorized to transmit radiotelephone only, although other types of emission may be permitted if there is sufficient reason. Application for such authorization must be submitted to the FCC, stating not only the type of emission desired, but also why it is needed and what bandwidth will be required to provide satisfactory communications. Each Class-A license lists the type of emission authorized, and the maximum bandwidth it can occupy. Practically all Class-A stations transmit either AM (amplitude modulation) or FM (frequency modulation) radiotelephone. The differences between the two are illustrated in Fig. 1-3. In an AM transmitter, the *frequency* of the carrier remains constant while the *amplitude* is varied by the audio signal (Fig. 1-3A). The amount of change is termed the percentage of modulation. In an FM transmitter, the *amplitude* of the RF carrier remains constant, and the frequency is varied above and below its normal value by the voice signal (Fig. 1-3B).

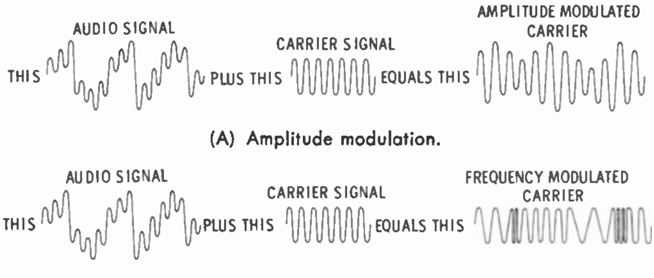


Fig. 1-3. Two types of modulation used in CB radio.

As you can see, the names amplitude and frequency modulation are quite descriptive of the effect that the modulation has on the carrier.

Although Class-B Citizens Band equipment is much less complex than that used for Class-A, the maximum permissable transmitter power input is only 5 watts, or less than one-tenth the power permitted Class-A stations. Also, all Class-B stations are restricted to operation on a single shared UHF frequency of 465 mc, unless the radio equipment has been type-accepted for Class-A operation. In this event, the station may also be operated on any of the Class-A frequencies. Equipment that is not crystal-controlled must have a type-acceptance number which signifies that it meets all FCC technical requirements. Manufacturers often request type-acceptance for crystal-controlled equipment as well. Class-B stations are permitted to use either AM or FM radiotelephone and can also use a modulated or interrupted unmodulated signal for operating radio-controlled devices.

Shortly after the opening of Classes A and B in the UHF band, the Class-C service was introduced. As mentioned previously this class was to be used *solely* for remote-control purposes. Initially, only one frequency (27.255 mc) was allocated for Class-C Citizens Band operation. However, in September of 1958 the FCC allocated five additional operating frequencies. The Class-C channels currently in use are 26.995 mc, 27.045 mc, 27.095 mc, 27.145 mc, 27.195 mc, and 27.255 mc. The initial 27.255-mc channel is shared with other CB stations, and stations operating on any of these frequencies are not guaranteed any protection from interference caused by medical,

Table 1-2. The Class-D Channel Frequencies

Channel	Freq. in MC	Channel	Freq. in MC
1	26.965	12	27.105
2	26.975	13	27.115
3	26.985	14	27.125
4	27.005	15	27.135
5	27.015	16	27.155
6	27.025	17	27.165
7	27.035	18	27.175
8	27.055	19	27.185
9*	27.065	20	27.205
10	27.075	21	27.215
11	27.085	22	27.225
	†Channel 23	27.255 mc	

*National CB Calling and Emergency Channel
†Shared with Class-C Stations

scientific, and industrial equipment operating on 27.120 mc. Only two types of emission are permitted for Class-C operation —amplitude tone modulation, and on-off unmodulated carrier signal. Class-C stations are limited to a transmitter power input of 5 watts, except when operating on the original 27.255 mc channel. Here 30 watts is permitted.

When the FCC established the Class-D service, it allocated a group of frequencies formerly assigned to the 11-meter amateur band. This assignment gave Class-D stations 22 channels on which to operate exclusively. Since then a 23rd channel (27.255 mc) has been made available on a shared basis with Class-C stations. All 23 Class-D channels are listed in Table 1-2. Note that they are 10 kc apart, except where separated by Class-C channels. The FCC regulations also stipulate that all Class-D equipment that is not crystal-controlled must have an FCC type-acceptance number. (Some transceivers are type-accepted even though they are crystal-controlled.) Again, there is no guarantee against interference caused by industrial, medical, and scientific devices operating at 27.120 mc.

The only types of emission permitted for Class-D operation are amplitude-modulated (AM) radiotelephone and single sideband (SSB).* Frequency modulation is not permitted because it requires too much bandwidth. Obviously, the excessive channel space occupied by FM signals would cut down the number of channels which could be included in a given bandwidth. Class-D equipment is also limited to a transmitter power input of 5 watts; and while this may seem rather small, it can provide communications over surprising distances. Power, however, is not the only factor which determines the communicating range.

HOW CB RADIO IS BEING USED

The uses of Citizens Band radio are practically unlimited and each passing day finds new applications. CB equipment can be permanently installed at a fixed location, in vehicles (Fig 1-4), or it can be carried in your hand as a portable unit. In a car, it can be used to provide communication with your office, home, or with other vehicles. It can be used in boats and airplanes, on hunting, fishing, or camping trips, or even on a golf cart. Businesses, both large and small, are finding that CB radio is helpful. Much time and money can be saved with radio-dispatched service and delivery trucks—to say

*Although CW is permitted with CB equipment using a power input of less than 100 milliwatts, no license is required for such units.

Fig. 1-4. A Knight-Kit® Citizens Band multichannel transceiver. A Class-D input with 5 watts input, it can be used as a mobile unit in a car, boat or truck, or with available accessories as a base station or portable unit.

nothing of more efficient, customer-pleasing service. Countless others in varied occupations are finding Citizens radio equally as helpful—radio and TV technicians, plumbers, police and fire departments, surveyors and highway maintenance crews, to name just a few.

Many garages, service stations, hotels, motels, and even restaurants, have CB equipment. A directory with call letters and monitoring channels of these establishments, arranged by areas, would enable motorists to get emergency road aid or make reservations while driving.

Actually, a new program called Highway Emergency Locating Plan (H.E.L.P.) is now being promoted by automobile clubs and car manufacturers to help motorists equipped with CB equipment. The plan is to have Channel 9 of the CB band continuously monitored by volunteer citizen teams, police agencies, road service stations, and hospital emergency rooms. Motorists stranded with car trouble or in distress can summon aid by calling for it on Channel 9.

CHAPTER 2

OBTAINING THE LICENSE

Although an FCC license is required for operation of CB radio equipment, it is as simple to obtain as a drivers license. In fact, it is usually simpler. On the other hand, the FCC has set up specific rules and regulations concerning the operation of CB equipment, and failure to comply with these is sufficient reason for a station license to be revoked.

ELIGIBILITY

Any citizen of the United States, male or female and 18 or more years of age, is eligible for a Citizens Band license. Persons under 18 may operate CB radio equipment—but only under the direct supervision of a licensee who must assume full responsibility for proper station operation. Applicants for a Class-C Citizens Band license (used for remote-control operation of garage doors, model airplanes, boats, etc.) need only be 12 years of age to obtain a license.

Applicants are not required to learn the Morse code, nor to take any oral or written examination. No operator's license is required—only a station license authorizing the installation and operation of the equipment. A CB license is not granted to aliens, nor to any person representing an alien. The same is true for a representative of a foreign government or to any corporation in which a director or officer is an alien.

THE LICENSE APPLICATION

If you have purchased any new CB radio equipment lately, you probably found an FCC license application (Form 505-modified) enclosed. If not, you can obtain one very easily by writing the FCC field office nearest you. These are listed in the appendix for your convenience. The license application is a simple questionnaire with several carbons attached and a full sheet of instructions for filling it out. The questions presented on this form, however, are self explanatory and should require little explanation.

All applicable questions on the application must be answered. Failure to do so may result in it being marked "incomplete" and returned. Any number of CB transmitters can be covered by a single license as long as they are all under the control of the licensee and in the same geographical area; however, only one applicant (which can be a corporate group or company) can be licensed for the same equipment.

One entry on the license application requires you to signify that you possess a current copy of Part 95 of the FCC Rules and Regulations governing the Citizens Radio Service. Part 95 is included in Volume VI, which can be purchased for $1.25 by writing the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Subsequent transmittal sheets will be supplied you at no additional cost. These transmittal sheets cover the changes in regulations which come about from time to time.

After answering all questions on the license application, be sure to sign it. Until just recently this had to be done in the presence of a notary public. Now, however, the application requires no notarization.

If the completed application is for Class-B, -C, or -D station authorizations, it must be mailed to the Federal Communications Commission office at 334 York Street, Gettysburg, Pennsylvania 17325. If, however, the application is for a Class-A station authorization, request for special temporary authorization or other special requests, or correspondence relating to an application for any class of CB license, it must be mailed to the FCC office at Washington, D.C. 20554. In the latter case, be sure to direct it to the attention of the secretary.

At the time of this writing, the FCC was processing as many as 20,000 CB license applications each month; with such a heavy demand, it is not unusual for processing to require several weeks. The license must be in the applicant's possession before he can operate CB equipment. The mere fact that an application has been made does not constitute authorization to begin operation.

The license in this service is now issued for $8.00 and is good for five years from the date of original issuance, renewal, or modification. Application for renewals, should be filed at least 30 days before the license expires. Fom time to time there may be changes in your permanent mailing address, the number of units under your control, etc. Should any such changes conflict with the terms on the current license, a new license application must be filled out and submitted to the FCC. Upon receipt of the revised license, the applicant must forward the old one to the FCC.

Fig. 2-1. Knight-Kit Model C-555 Class-D transceiver.

It will be interesting to note that there are now about 800,-000 licensed CB'ers in the United States as compared with 260,000 amateur radio operators. This will give you some idea of the popularity of CB radio. Even more significant is the fact that amateur radio has been in existence for over fifty years, while CB radio is still in its infancy. Much of the operation on the CB bands is also by unlicensed stations. CB transmitters which operate with a power input of 100 milli-watts (one-tenth of a watt) or less do not require an FCC license so long as they communicate with similar unlicensed units. Most of the units in this power range are of the hand-held type similar to the Class-D transceivers in Figs. 1-4 and 2-1. They operate under Part 15 of the FCC rules, and are permitted "ham" type hobby operation, so long as they do not interfere with Class C or D CB stations.

CHAPTER 3

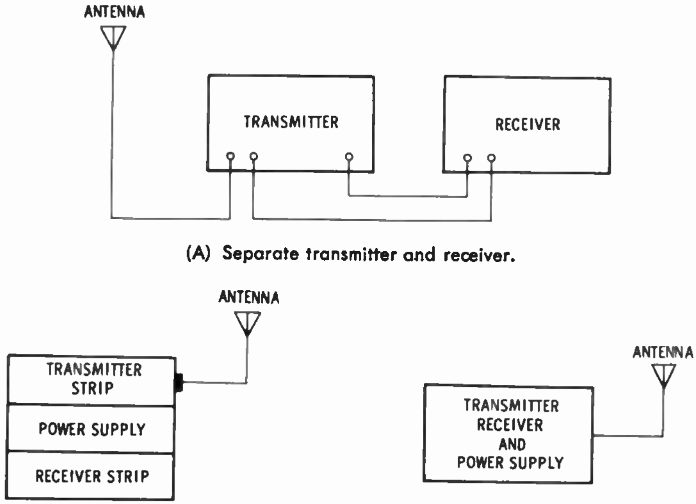
ABOUT THE EQUIPMENT

There is practically an unlimited variety of Class-D Citizens Band equipment currently available with models for every conceivable type of operation. Furthermore, many of these units can be purchased either in kit form or factory built.Some are designed for indoor operation from the standard 115-volt AC household power; others operate strictly from a DC voltage source. There is still a third class which will operate from either AC or DC, making them readily adaptable for use as fixed or mobile stations.

Even within these classes there are several variations. Usually when a piece of CB gear is designed to operate from either AC or DC, there will be a choice when ordering, between a 6- or 12-volt DC power supply. Many of the Class-D units incorporate what is commonly referred to as a three-way power supply which will operate from 115 volts AC as well as 6 or 12 volts DC. Practically all late-model automobiles employ a 12-volt electrical system. Some equipment manufacturers also provide a choice in the AC power requirements; models which can be operated from 220 or 440 volts AC, for example. When it is desired to install AC-operated CB equipment in an automobile, a device known as an inverter must be used to provide the proper voltage.

TRANSCEIVERS

Since Class-D transmitters are limited by law to a comparatively low output, most of the equipment is of the transceiver design. As its name implies, the transceiver is a combination transmitter and receiver. To better understand this, refer to Fig. 3-1. Basically there are three types of construction. The older-type commercial two-way radio equipment consisted of a separate transmitter and a receiver (Fig. 3-1A). Later, manufacturers went to single-piece construction (Fig. 3-1B)



(A) Separate transmitter and receiver.

(B) Transmitter, receiver, and power supply on common chassis.

(C) Transmitter, receiver, and power supply combined.

Fig. 3-1. Three types of two-way radio construction.

whereby the transmitter, receiver, and the power supply were all housed in the same enclosure; but they were essentially still separated circuit-wise. In the third type of construction this proximity idea has been carried a bit further. Here, the transmitter, receiver, and power supply are all contained on the same chassis with some of the circuits (other than the power

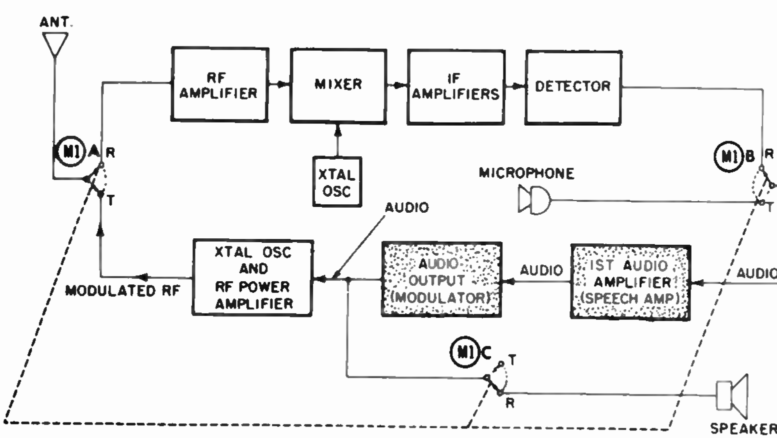


Fig. 3-2. Block diagram of a typical CB Class-D transceiver.

supply) common to both sections. As an example, the audio amplifier and audio-output stage, normally associated with the receiver circuit, may be called on to serve as the audio driver and modulator stages, respectively, when in the transmitting mode. This circuit transition is generally accomplished by means of a relay switch. Fig. 3-2 shows a block diagram of a typical CB Class-D transceiver. The shaded boxes indicate stages used during both transmitting and receiving functions. In addition to the economic aspects of such a design are simplicity of operation and a more compact construction.

There are many variations in the circuitry of these transceivers. Some are designed to operate on one channel while others permit any one of several CB channels to be selected.

Multichannel Fixed-Tuned Units

When the equipment is to be used in an application where several operating channels are needed, but with some means of instantly switching the proper crystals into the transmitter and receiver circuits, the multichannel, fixed-tuned transceiver is the answer. These units permit you to select crystals for the specific channels on which you wish to operate within the limits of the Class-D frequency allocations.

Most of the modern transceivers employ a single control switch to simultaneously select both the transmitting and receiving crystal for the same channel. Transceivers are available with provisions for transmitting and receiving up to 23 channels.

A Class-D transceiver of this type is illustrated in Fig. 3-3. It employs a crystal-controlled transmitter and dual conversion superhet receiver. A selector on the front control panel

Fig. 3-3. The Hallicrafters Model CB-24 shown here is one example of a multichannel fixed-tuned CB transceiver.

enables any one of 23 Class-D channels to be put into operation by simultaneously switching the proper transmitter and receiver crystals into the circuit.

A Class-D multichannel, fixed-tuned transceiver with provisions for operating on any of 10 channels is illustrated in Fig. 3-4. Transceivers of this type are supplied with one set of transmitting and receiving crystals already installed; you add transmitting and receiving crystals for 9 additional channels of your choosing.

The receiver is of the superheterodyne type to assure excellent sensitivity for increased range, and high selectivity to prevent adjacent channel interference. Transistors are employed to permit extremely compact construction. The unit in Fig. 3-4 measures only 2½″ high by 10″ wide by 7″ deep;

Fig. 3-4. A Class-D transceiver with provision for simultaneous selection of transmitter and receiver channels.

yet, it provides the maximum legal RF input of 5 watts permitted by the FCC.

Equipment that provides separate selection of receiving and transmitting channels can be used for cross-channel operation (i.e., where you transmit on one channel and receive on another within the same band). In addition to the transceiver types discussed so far, there are still others which employ receivers that are strictly tunable.

23-Channel Transceivers

Today, the most popular equipment seems to be transceivers using a synthesizer (Fig. 3-5). This method of crystal control allows the operator to use any one of the 23 Class-D channels by simply turning a selector. A synthesizer is an unique way of using 12 crystals to perform as 46 would with other types of circuits. Prices range from $129.95 to over $300.00 and these models are available from almost all equipment manufacturers.

Of course, it is seldom that anyone would want to operate on all 23 channels. However, in applications where you might want to change operating channels to avoid crowded conditions, it is not necessary to install different crystals with a 23-channel unit. Also, in different parts of the country, different channels are active. With a 23-channel unit, no matter what part of the country you are located in or move to, you can communicate with anyone else.

Fig. 3-5. Citi-Fone 23-channel transceiver for base or mobile use.

RECEIVER TYPES

The receivers employed in CB equipment must be especially sensitive as well as selective. One of two types of receiver circuits will be found in CB transceivers, the regenerative or superregenerative, and the superheterodyne. There are, of course, many variations within these designs.

Regenerative Receivers

The regenerative receiver is by far the simpler of the two. It may consist of only two or three stages, as opposed to perhaps nine or ten in the superheterodyne circuit. Of those transceivers with regenerative circuits, most use a more stabilized version that is known as the superregenerative receiver. This type of receiver has somewhat more sensitivity than one using a straight regenerative circuit. One of the inherent characteristics of the superregenerative circuit is its ability to "hang on" to radio signals. In short, regenerative receivers provide fair sensitivity and selectivity with a minimum of components.

Superheterodyne Receivers

Superheterodyne receivers are much more complex than regenerative receivers, but they also provide greater sensitivity and selectivity. A block diagram of a typical superheterodyne receiver is shown in Fig. 3-6. In addition to the basic stages shown here, two or three more are generally included for squelch, noise limiting, etc. The Knight® Model KN2565B in Fig. 3-7 is a typical example of a Class-D transceiver using a superheterodyne receiver circuit. A selector switch on the front panel allows you to select any one of 23 crystal-controlled channels. An unique feature of this transceiver is that this unit can also be used as a 2.5-watt public-address amplifier. The receiver section can be continuously tuned thru all 23 Class-D channels. A block diagram is shown in Fig. 3-8. The entire

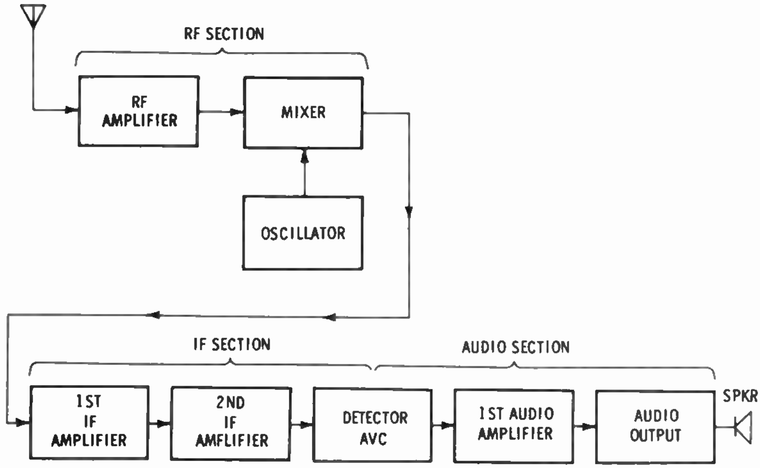


Fig. 3-6. Block diagram of a typical superheterodyne receiver.

transmitting and receiving functions are accomplished with 10 tubes, 12 diodes, and 2 transistors.

The Class-D channels have very little space between them, and for this reason it is necessary that frequency drift be kept to a minimum. Otherwise, considerable interference with stations operating on adjacent-channels could result. Practically all superheterodyne receivers in Class-D operation, and for

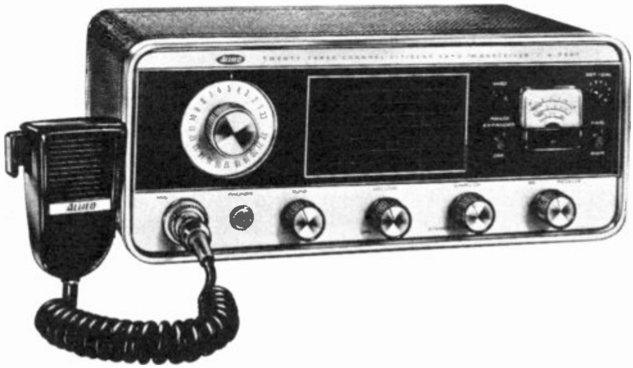


Fig. 3-7. The Allied Model A2567 transceiver has frequency synthesized circuit for 23-channel operation. It provides crystal-controlled transmit and receive functions on all Class-D band channels.

that matter in Class-A as well, are crystal controlled for greater frequency stabilization. Generally, the transmitter and receiver crystals are paired for the same channel so that both can be switched into operation at the same frequency simultaneously.

The majority of CB transceivers using superheterodyne receivers employ an AVC (automatic volume control) circuit. This circuit is used as a means for controlling the sensitivity of the receiver so that it will vary in inverse proportion to the

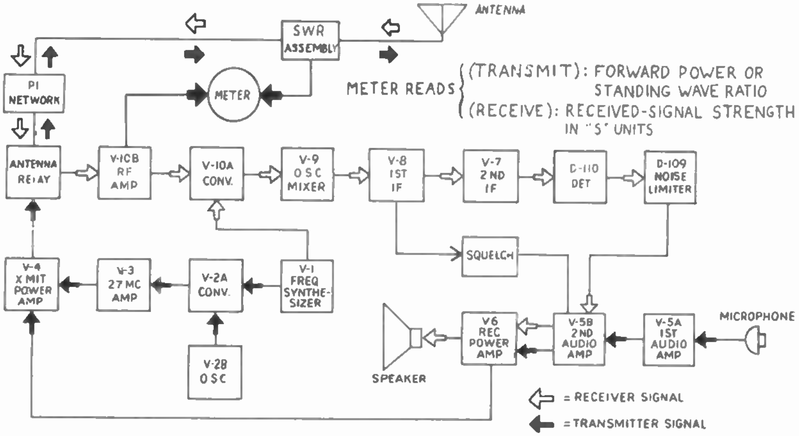


Fig. 3-8. Block diagram of the Allied Model A2567 transceiver.

strength of the incoming radio signals. In other words, with AVC the output of the receiver tends to remain the same for both strong and weak signals. Quite often another type of AVC circuit known as *delayed* AVC is used. This circuit is somewhat more desirable because it permits maximum gain to be achieved on the weaker signals.

Noise-limiter circuits are also used in most CB receivers. Ignition noise and other pulse-type interference is especially troublesome around the Class-D frequencies. The purpose of the noise-limiter circuit is to eliminate or at least minimize noise peaks which accompany the signal through the receiver. A number of different circuits have been developed for this purpose.

The noise-limiter circuit may employ a separate tube or it may utilize a section of the detector/AVC tube (Fig. 3-9).

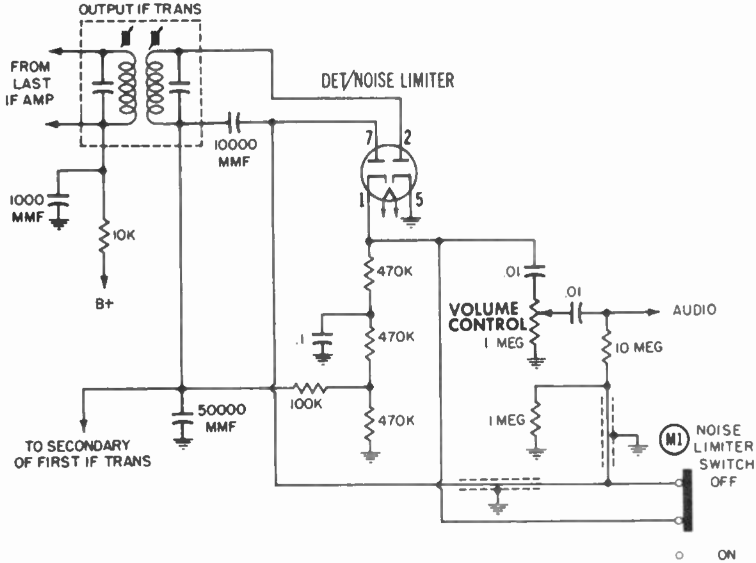


Fig. 3-9. A typical detector/AVC/noice-limiter stage.

Notice that this noise-limiter circuit can be switched into or out of the circuit. This arrangement is used in quite a few transceivers.

Most of the larger CB transceivers employ a squelch circuit to disable the audio, or sound, section while no signal is being received. (This eliminates the background noise normally heard during a no-signal condition.) Before this stage can be unblocked, the strength of the incoming signal must be above a level determined by the setting of the squelch control. The two basic systems are known as signal-operated and noise-operated squelch. In the former, the incoming signal must be of sufficient strength before the control action is terminated. In the latter system (noise-operated squelch), however, it is the reduction or disappearance of background noise while a signal is present that unblocks the audio section. The signal-operated squelch system is generally used in Class-D Citizens Band receivers.

Fig. 3-10. The housewife—farm, suburban, or urban—can make good use of walkie-talkie or base station CB unit to keep in touch with husband and children.

TRANSISTORIZED CB EQUIPMENT

The advent of transistors has brought about many changes in equipment design—two of the most prominent being reduced size and lower power consumption. Transistors are now being used in almost every type of equipment operated electronically. The term *solid-state* describes an electronic circuit that uses no vacuum tubes, only semiconductors—transistors and diodes.

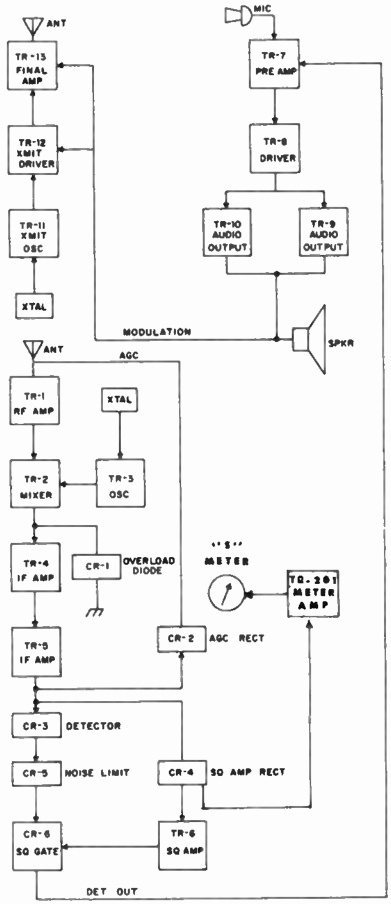


Fig. 3-11. Block diagram of the Knight-Kit Safari III CB transceiver.

The solid-state circuit is now predominant in two-way radio equipment, both in hand-held walkie-talkies that usually operate with less than 2 watts of transmitter input power and in the larger 5-watt transceivers.

An example of a solid-state 5-watt transceiver that incorporates features of advanced technology is the Knight-Kit Safari III. Because transistorized units are cool-running and many miniaturized components are now available, all parts can be mounted close together and the overall size of the product can be greatly reduced.

The compactness of the Safari III (2-1/8″ high, 6-7/8″ wide and 8-1/2″ deep) makes it an extremely versatile communications unit. It operates from a 12-volt DC battery for mobile use; an AC power supply converts it to a base station; or hunters, fishermen, construction workers, and others can convert it to a lightweight portable with an accessory battery pack using rechargeable or inexpensive nonrechargeable *D* cells.

The stage arrangement of this transceiver is shown in the block diagram of Fig. 3-11, and complete circuit details are given in the schematic diagram of Fig. 3-12. As you can see from the block diagram, the circuit uses 14 silicon transistors and 9 diodes.

The receiver is a 6-transistor crystal-controlled superhet. Antenna signals are applied to TR-1 which amplifies the output and sends it to mixer TR-2. TR-3 is a crystal-controlled oscillator. Output from TR-3 is also fed to TR-2. Output from TR-2 is amplified by TR-4 and TR-5, IF amplifiers. TR-5's output is applied to CR-3 detector and CR-4 squelch rectifier. CR-4 drives squelch amplifier TR-6 and TR-201 S-meter amplifier. CR-5 is a series-gate noise limiter.

The audio section is for the receiver and transmitter. Audio is fed to TR-7 preamp and TR-8 driver. Output from TR-8 is fed to TR-9 and TR-10, push-pull power amplifier, which drives the speaker or modulates the transmitter.

The transmitter section is crystal-controlled by oscillator TR-11. TR-12 amplifies TR-11's output and drives the final amplifier TR-13, which uses a double pi-type output. High-level collector modulation is fed to driver and final, assuring a high percentage of modulation. Zener diode CR-7 provides regulated 10 volts DC to critical circuits.

Two more examples of transistorized CB units are shown in Fig. 3-13 and 3-14. Both of these are hand-held walkie-talkies designed for Class-D operation.

ACCESSORY EQUIPMENT

Also found throughout the CB service are certain accessories for use with existing equipment, as well as several other interesting devices worthy of discussion. These devices will be discussed on the following pages.

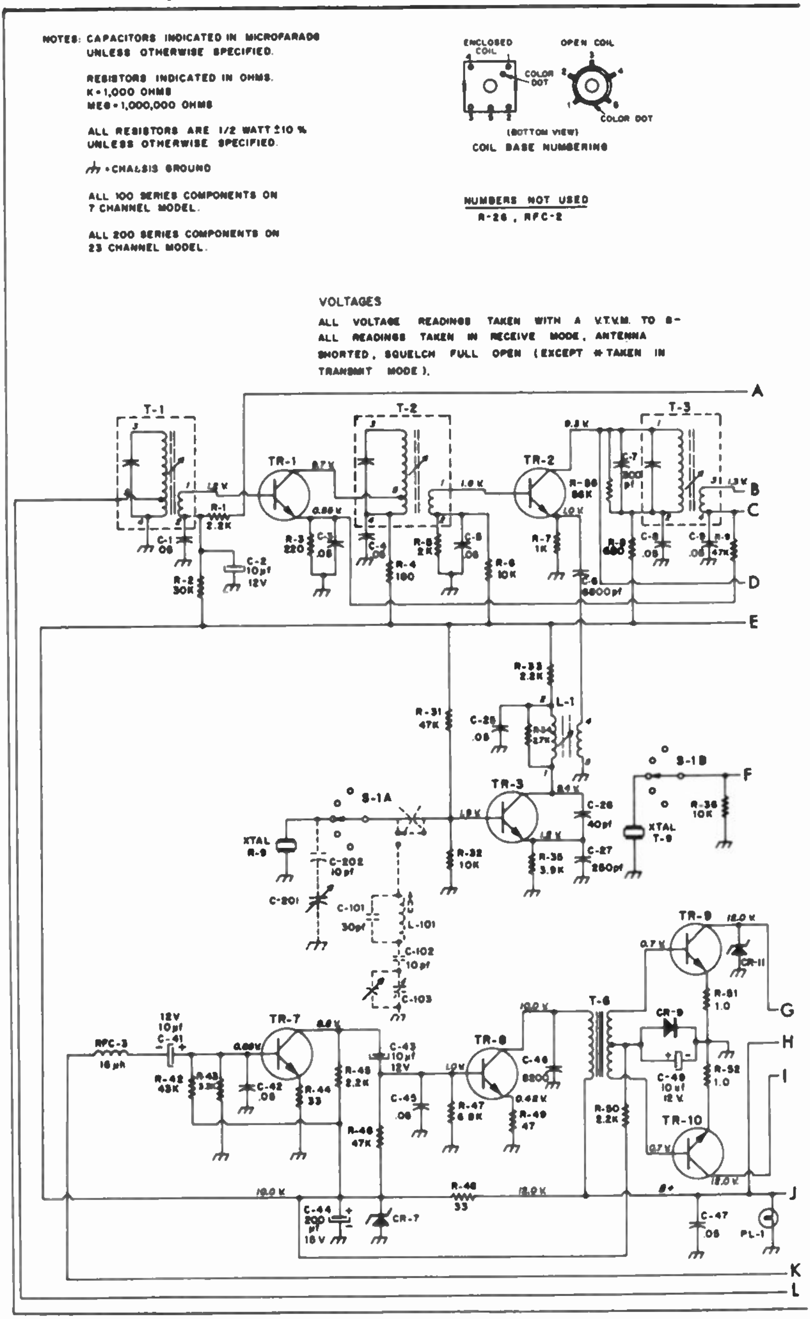
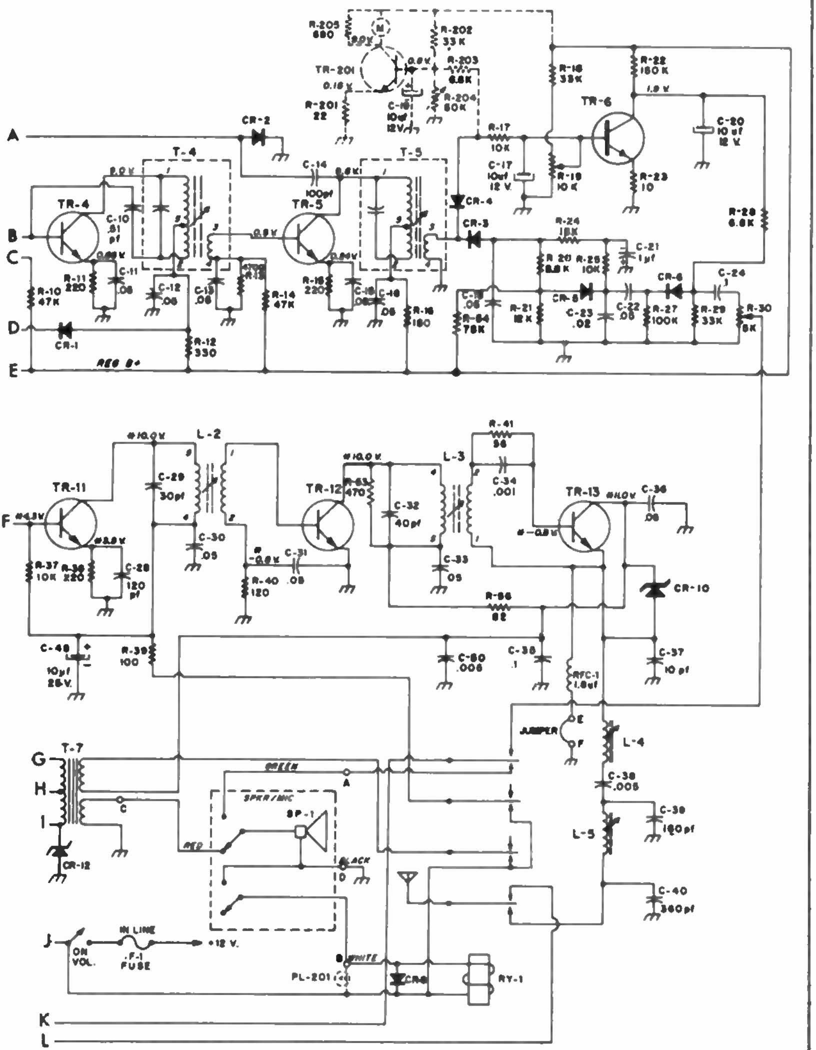


Fig. 3-12. Schematic diagram of Knight-Kit



Safari III CB solid-state transceiver.

Fig. 3-13. Midland 5-watt 6-channel walkie-talkie is available with rechargeable batteries.

Fig. 3-14. The Johnson *Personal Messenger* shown here, is still another example of an all-transistor CB walkie-talkie.

Coded Calling Systems

In some areas, the CB channels are so congested that it is often difficult to carry on business activities. To overcome this problem, a type of coding system called tone squelch is provided on some CB equipment to reject all transmissions other than those within a controlled network. Each station within the network transmits a coding tone in addition to the voice signal. Some systems transmit a tone (made inaudible by filters) during the entire message; others transmit only a brief tone when the mic button is first depressed. Each receiver is equipped with a decoder that responds only to the tone transmitted from stations within the network. All receivers remain silent to transmissions originating outside the controlled system. The moment any station within the chain begins transmitting, the tone signal will activate the decoder at all receiv-

Fig. 3-15. One example of a selective calling system is this *Tone-Alert* unit produced by the E. F. Johnson Co. For use with any transceiver.

ers and permit the message to be heard. If other networks using tone squelch are operated on the same channel and in the same area, it may be necessary for one of the stations to switch to a different coding tone in order to avoid interference.

Means are also provided for calling one or more stations within a system without disturbing the others. This is known as selective calling. Depressing a push button or dialing a combination causes one or more coded tones to be transmitted, activating a signaling device at the station being called. Se-

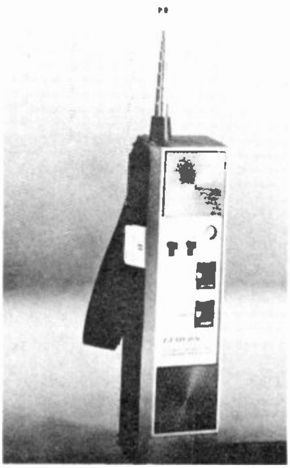


Fig. 3-16. This Lloyds Walkie Talkie includes a call signal capability as an integral part of its circuitry.

lective calling systems are available as an accessory for existing CB equipment (Fig. 3-15) and also are included in the design of some transceivers. The walkie-talkie in Fig. 3-16 is designed with call signal capability. A tone can be transmitted to other units of the same type to signal an incoming message.

Converters

Basically a converter is a device which selects the desired signal and converts its frequency into one which can be tuned in on a standard AM broadcast receiver. Some CB equipment is available with a separate transmitter and receiver. Hence, should you have a transmitter but no receiver or if you simply desire an additional receiver (to monitor CB transmissions in your car, for example), the converter offers the ideal solution. Being relatively small devices, they can easily be mounted under the dash in automobile installations and present no problem where space is at a premium.

Transverters

The transverter, as its name implies, is a combination transmitter and converter. The transmitter section must be crystal-controlled if it is to be used for Class-D operation, and it must conform in all other ways to the FCC regulations governing equipment design. The converter section operates in conjunction with a standard broadcast receiver in the same manner as described previously.

Audio Compressors

The maximum percentage of modulation permitted with CB transmissions is limited to 100%. Exceeding this value can produce audio distortion and interference on adjacent frequencies. Modulation percentage is at its highest or voice peaks, for example when you emphasize a word or letter. At this same time, however, the average audio level may be well below the 100% limit. Basically then, the purpose of the audio compressor is to compress or hold down these voice peaks and at the same time permit a higher average level of audio to be used without exceeding the FCC modulation limitations. Increased audio, as long as it is below 100%, will definitely improve communications. Fig. 3-17 shows a new audio compressor for use with CB transceivers. This unit is a Knight-Kit with a fully transistorized circuit.

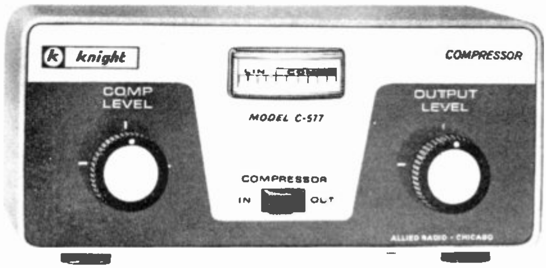


Fig. 3-17. The Knight-Kit Audio Compressor/Preamplifier (C-577) connects between the microphone and transceiver. It increases talk-power and at the same time "rides gain" to prevent over- and undermodulation.

KIT CONSTRUCTION

Most transceiver kits can be easily assembled by persons with little or no previous experience. One type of kit comprises individual components which must be properly connected together to form the completed circuit. In another type of kit, all stages are in the form of prewired subassemblies. All the builder has to do is mount and interconnect the various subchassis. The critical circuits (such as the oscillator) of practically all CB transceiver kits are wired and tuned at the factory. This is done to comply with the FCC regulations which prohibits anyone other than the holder of a second-class or higher commercial radio license from making any repairs or adjustments which could cause illegal operation.

The simplified diagrams supplied with most kits make it difficult to go wrong, although this can happen from time to time. One of the biggest pitfalls—especially among inexperienced builders—seems to be poor soldering. A joint that has too much solder is just as bad, if not worse, than one not having enough. It would be far worse for a blob of solder to run down a terminal and short high voltage to ground, than to have a high-resistance (loose) connection caused by insufficient solder or heat ("cold" soldered joint). Loose connections generally cause intermittent operation, and while often difficult to track down, the loose connection rarely damages other components. A short, on the other hand, can do considerable damage. Many makes of kits (all Knight-Kits) now include detailed soldering instructions that anyone can follow.

The main things to remember in building up a kit is to follow instructions and work carefully. Have sufficient room in which to work, and place the construction diagram in view

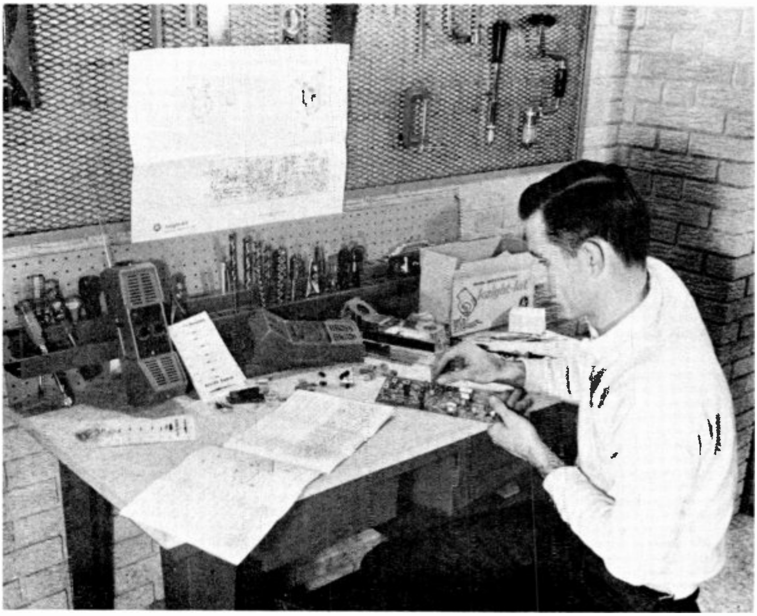


Fig. 3-18. Building a CB transceiver kit.

for constant reference. Fig. 3-18 shows a transceiver being assembled from a kit. Wiring is simplified by having most components mounted on a single printed-circuit board.

EQUIPMENT SELECTION

The proper selection of equipment depends on your individual needs. Moreover, it is important to consider every angle before making a selection, since personal satisfaction hinges on the proper choice.

If you plan to use CB radio between fixed points, you probably should consider a unit designed to operate from a 115-volt AC supply. However, if you intend to use it for mobile operation also, it would be wise to select a unit which is designed to operate on both 115 volts AC and either 6 or 12 volts DC. If your car uses a 6-volt electrical system, keep in mind that you may later trade for a car which uses a 12-volt system. Thus, you might consider a model that is designed to operate on either 6 or 12 volts.

Another factor to be considered when choosing equipment is the terrain surrounding the area in which it is to be used.

A transceiver having less than the maximum allowable plate-input power would hardly be satisfactory where maximum distance is desired; yet the same unit might be entirely adequate for shorter distances—particularly over level terrain or water. Anyone requiring short-distance communications away from normal power facilities will probably find the smaller transistor portables with self-contained batteries more desirable than the larger transceiver with its cumbersome battery supply. Also, in areas where channel traffic is very light, the receiver need not be too selective—but you should consider the possibility that the channel may some day become quite crowded. Even though a transceiver with less selectivity may cost less, a compromise may have to be reached. A receiver with good selectivity as well as squelch and noise-limiter circuits is a prerequisite for good reception in the larger metropolitan areas where channel traffic is heavy. If the equipment is to be installed in a car you will also want a push-to-talk button on the mic, allowing one-hand operation.

As you can see, there are many questions to be answered before you can make a satisfactory selection. These are only a few of the general points to be considered, each person's needs will be different.

CHAPTER 4

SETTING UP A STATION

Every two-way radio installation, regardless of how simple, involves a certain amount of planning. Furthermore, each installation presents a unique set of requirements and may therefore be considered a custom installation.

MOBILE INSTALLATIONS

Unlike the average base station, mobile installations present individual problems because of the variety of vehicles in which the equipment may be installed. It is virtually impossible to give the exact procedure for each type of installation; however, an understanding of some of the major considerations will be helpful. Installing CB equipment in an automobile or other vehicle is usually not difficult—even a layman will have little trouble when guided by a few simple hints.

Mounting The Equipment

For temporary short-range operation the transceiver can be placed in the front seat of the car with the cigarette-lighter outlet serving as the power source. A small clamp-on type antenna fastened to the drain trough above the car door will generally permit reliable communications up to several miles or more, depending on terrain etc. The antenna cable can be routed through the window. For more permanent installations, however, the transceiver is usually mounted under the dash within easy reach of the driver, as shown in Fig. 4-1. Mounting a transceiver in this manner is not always as easy as it appears because of some factor in the automobile design. For example, the unit must not be mounted directly in the path of the heater air stream, because temperature extremes can affect frequency stability, and excessive heat often damages components. Crystal microphones are especially susceptible to damage by high temperatures. Generally, CB equipment designed for mobile

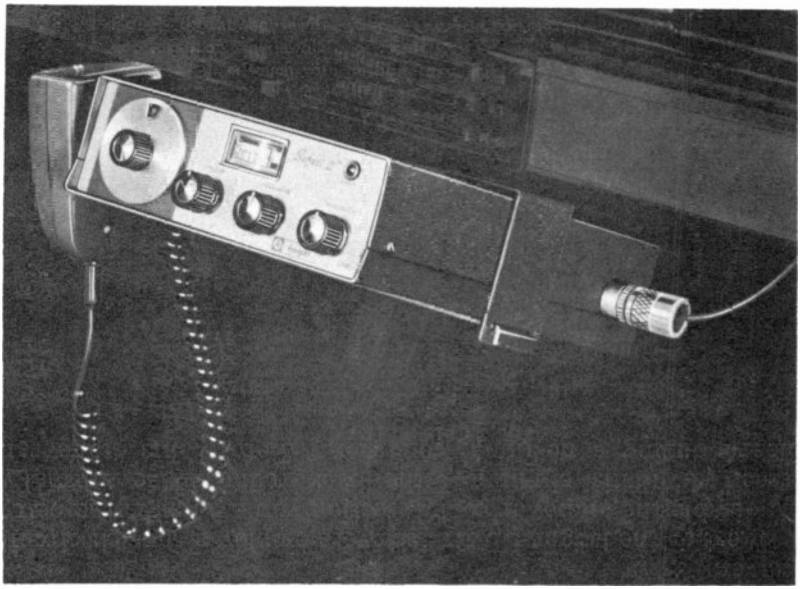


Fig. 4-1. CB transceiver mounted under the dash.

operation will use some type of microphone other than crystal for this reason.

Another factor to consider in mounting the equipment is safety of operation. The transceiver should be mounted in such a way that it does not interfere with proper operation of the vehicle. If it were located beneath the dash but too near the steering column, it could interfere with brake-pedal travel or cause the driver discomfort when applying the brakes. Equally dangerous is a mounting location too far to the right, requiring the driver to lean over to reach the set. Also, for safety's sake it is advisable to employ a microphone with a push-to-talk button, permitting one-hand operation while driving. These are only a few of the possibilities that should be considered before choosing the mounting location. To complicate matters, you'll often find that the underside of the dash is either not level, or it is cluttered with heater controls, cigarette lighters, ash trays, etc. In such cases, there are several alternatives for mounting the CB equipment: (1) choose another location; (2) relocate the interfering object(s) ; or (3 use mounting brackets that will extend below the interfering object. There are a number of universal mounting brackets available to take care of just about any installation problem.

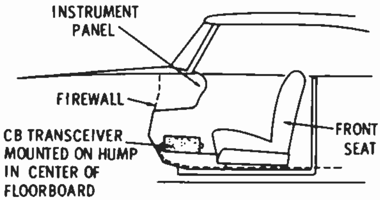


Fig. 4-2. A CB transceiver mounted on the ridge of the front floorboard.

Another mounting location that might be considered is on the hump in the center of the front floorboard. The microphone hanger can be fastened to the dash within easy reach of the operator. Large self-tapping screws are generally used to fasten the transceiver to the floorboard, since the transmission located directly beneath makes use of bolts and nuts impractical. Fig. 4-2 shows a transceiver mounted in this location. Specific instructions for installing any given piece of CB equipment is generally included in the operating manual supplied by the manufacturer.

Power Source

After the mounting location has been selected and the equipment is properly installed, the power cable must be connected to the voltage source. The power cable should be kept as short as possible because its wire has a certain amount of resistance which causes some of the source voltage to be dropped across it. If long runs of cable are necessary, make sure they are heavy enough to handle the current; otherwise, it can cause the voltage to be pulled down considerably.

CB equipment can be connected to the automobile power source at several points, as shown in Fig. 4-3. When the *A* lead is connected directly to the battery terminal, as shown in Fig. 4-3A, the DC path is completed from the battery through the metal framework of the car to the transceiver chassis. If the starter solenoid is located closer to the radio equipment than the battery, the *A* lead can be connected to its "hot" side (Fig. 4-3B.) If you are not sure where the starter solenoid is positioned, it can be located by tracing the battery cables; one (usually braided) will be connected to ground, and the other will lead to the starter solenoid.

If neither of these methods are suitable, the radio equipment can be connected to the ignition switch, provided the unit does not require too much power. The *A* lead can be connected to either of two terminals in this instance. If you wish the trans-

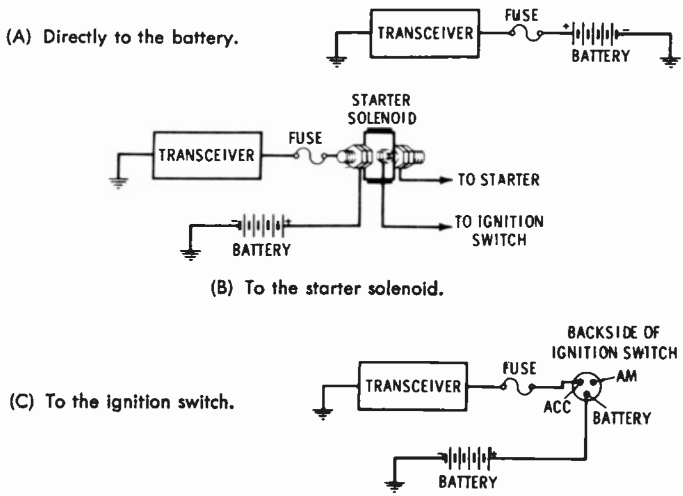


Fig. 4-3. Three methods of connecting a transceiver to the DC power source in a mobile installation.

ceiver to operate only when the ignition switch is on, connect it to the accessory terminal (Fig. 4-3C). The equipment can be used anytime (with the ignition switch on or off) if connected to the ammeter terminal. The former method, however, prevents drainage of the car battery should the unit unknowingly be left on for any length of time.

Practically all CB transceivers include a protective fuse of some type, either in series with the *A* lead (Fig. 4-4A), or in a holder on the radio equipment itself (Fig. 4-4B). Locate the fuse (or fuses) before installing the unit so that you will know where it is, should trouble occur.

In cases where it is desired to install a 6-volt transceiver in a vehicle with a 12-volt DC electrical system, a voltage-dropping resistor must be used. Connecting a 6-volt unit to 12 volts can damage or ruin any number of circuit components within a matter of seconds. To reduce the source of voltage from 12 to 6 volts requires the use of a resistance placed in series with the *A* lead, as shown in Fig. 4-5. The value of this resistor is chosen so that approximately 6 volts will be dropped across it. The value is not given here since it will vary with the amount of current the equipment requires; however, it can easily be computed by Ohm's law. Also, the amount of power to be dissipated will determine the wattage requirements of the resistor.

(A) In-line fuse holder.

(B) Built-in fuse holder.

Fig. 4-4. Two types of fuse holders used with CB equipment.

This method cannot be used with all equipment, because the amount of voltage dropped across the resistor depends entirely on the amount of current which is drawn through it. Some CB units draw essentially the same amount of current when transmitting or receiving, but the majority require more current when transmitting. This, of course, means that a resistor chosen to drop 6 volts when receiving will drop even more when transmitting, reducing the RF output considerably. Consult the service literature for the power consumption of the equipment. If the difference between transmitter and receiver is significant, this method should not be used.

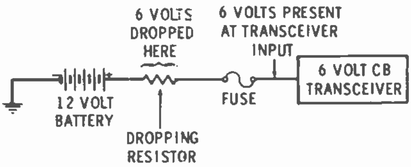


Fig. 4-5. Method of connecting resistor in series with "A" lead to drop voltage from 12 to 6 volts.

Incidentally, when installing a CB unit designed to operate from more than one power source, be sure to use the proper terminals or the correct power cord, whichever the case may be. Also, battery polarity must be taken into consideration, especially with transistorized equipment. Here, it's important to know which terminal of the car battery is connected to ground. Since the adoption of the 12-volt electrical system, almost all American cars use the negative-ground electrical system; however, prior to 1956, the majority used the positive-ground system.

A lot of CB transceivers are designed for operation from a 115-volt AC power source only. Surprisingly enough, however, this does not necessarily limit these units to base-station operation. By means of a DC to AC inverter, such transceivers can also be used in mobile work. An inverter is a device that converts the 6- or 12-volt DC battery voltage to 115-volts AC at 60 cycles, thereby duplicating the standard household power. A typical DC-to-AC inverter is shown in Fig. 4-6. These devices are available in models which will operate from a variety of DC input voltages, including 6 and 12 volts. There are several possible locations for an inverter when used in automobile installations. Here again, a lot depends on the type of car, size of unit, available space, etc. Smaller inverters can be set in the front seat or on the floorboard or, if adequate space is available, perhaps mounted under the dash beside the transceiver. If not, there is usually sufficient room in the trunk. Suitable mounting brackets to securely fasten the inverter under the dash or in the trunk are available as accessories for permanent installations. Also available is a small remote-control unit that fits under the dash for the trunk-mounted inverter, providing complete control from within the vehicle.

The average transceiver should cause no undue strain on the present electrical system of the car, provided the latter is in good working condition and the radio equipment is used

Fig. 4-6. Knight-Kit® DC to AC solid-state inverter/charger.

with discretion. Like any other electrical device, it would not be advisable to operate the equipment for prolonged periods when the engine is not running. Even running at a slow idle is equally as bad, since at this speed the engine is usually not turning the generator fast enough to restore the same amount of power being drawn from the battery. The batteries employed in most of today's cars are designed to supply a great deal of power. Although late-model broadcast receivers generally draw less current than their older counterparts, additional current is required for such things as power windows, power seat, etc. If you have trouble keeping the battery charged, even under normal operation, it would be advisable to have the electrical system of the car checked, paying particular attention to the voltage-regulator setting. If most of your driving is confined to short runs in the city, for example, the voltage regulator can usually be adjusted to provide a higher charging rate. However, to prevent possible damage to the electrical system, there is a maximum setting which should not be exceeded. If adjustments are in order, let someone who is qualified do the job, otherwise it could end up costing you money.

If the present generator is not capable of safely providing enough current to keep the battery charged, an oversized generator may be the answer. There is also another type of charging device, known as an alternator, which can provide the higher charging currents needed. Actually, an alternator is an AC generator which operates in conjunction with a rectifier to supply DC current to the battery. A nice feature of the alternator is that it is capable of providing charging current even at idling speed. This is one of the reasons why it is commonly used on police cars and in other mobile applications where more than average battery power is required. Alternators are also included on some of the late-model automobiles as standard equipment.

Routing The Transmission Cable

After the transceiver is mounted and connected to the power source, the next step is to figure out how the antenna cable is to be routed and what length will be needed. The transmission line should be kept as short as possible and at the same time should be routed away from the engine, gauges, switches, relays, etc—all tend to induce noise. Fig. 4-7 shows

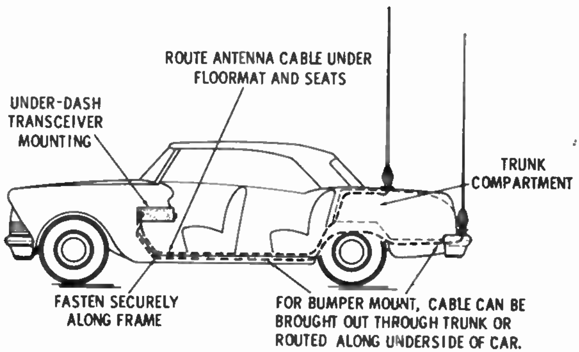


Fig. 4-7. Two methods of routing the antenna cable.

two methods of routing the antenna cable. If a rear-bumper antenna mount is used, the cable can be run either through the inside of the car or along the underside. On an inside route, lay the cable along the edge of the floor, beneath the floor mat or carpeting. The rear-seat cushion will have to be removed, and perhaps a small hole will have to be drilled, in order to feed the line into the trunk area. Another hole may have to be drilled so that the line can pass from the trunk area to the antenna. Always check for existing openings before drilling a hole. If it does become necessary, fit the hole with a rubber grommet to prevent the cable from being damaged. If the antenna cable is run along the underside of the car, make sure it is securely clamped along the frame and routed away from movable parts and the muffler or exhaust pipe.

Mobile Noise Problems

One of the biggest problems in mobile operation is noise. Most electrical noises disrupt the amplitude of radio signals; thus they have the greatest effect on AM equipment. The majority of CB equipment employs some type of noise limiter; however, these circuits are not always capable of handling the job. Usually, some additional steps must be taken to suppress this type of interference. Fig. 4-8 shows a basic automobile ignition system and the potential sources of noise.

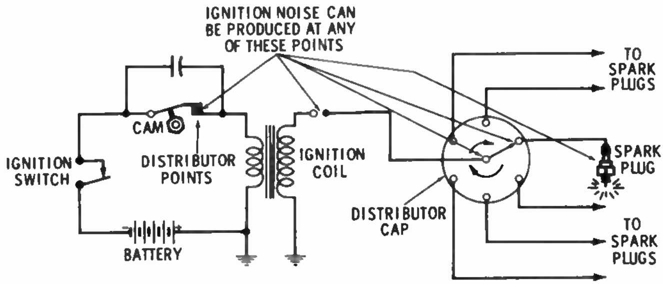


Fig. 4-8. Basic automobile ignition system with potential noise sources noted.

Although ignition noise cannot always be completely eliminated, it can be reduced considerably with suppression devices. One way is by using resistor-type spark plugs. In some of the later model cars radio resistance cable is used to interconnect the distributor, coil, and plugs. This provides the same amount of suppression as the resistor plugs. You should *never* use both resistor plugs and resistance wiring because it can cut down on the efficiency of your ignition system. A number of

Fig. 4-9. The Sprague SK-1 *Suppressikit* is one example of a commercial noise suppression kit for mobile installations.

commercial noise-suppression kits, such as the one shown in Fig. 4-9, are currently available to supply your needs.

Generator noise is also quite common and is especially troublesome at high frequencies. It can be recognized by a whine that varies in pitch with the speed of the engine. It is the result of the arcing that occurs between the generator brushes and commutator. A 0.5-mfd bypass capacitor will usually minimize or completely eliminate this trouble. This capacitor should be a noninductive, coaxial feedthrough type connected in series with the armature wire of the generator (Fig. 4-10). A tubular capacitor of this value may already be

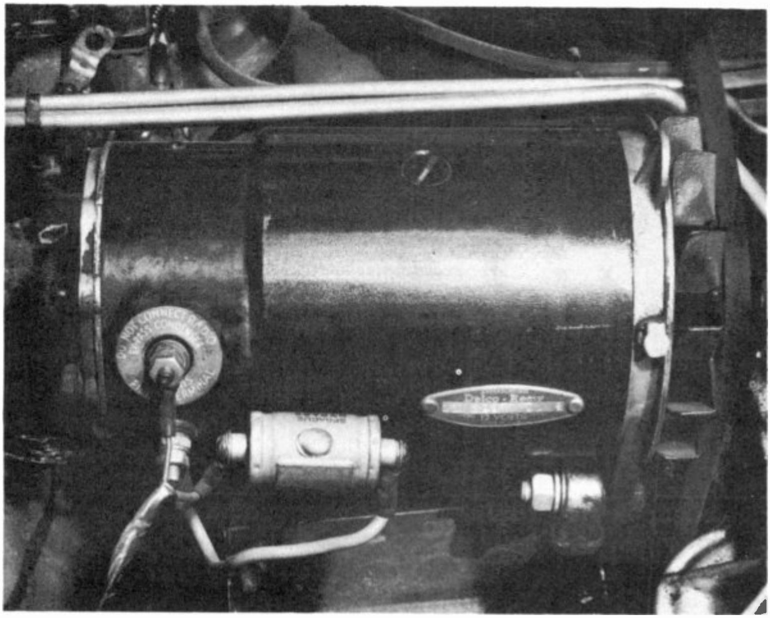


Fig. 4-10. A coaxial bypass capacitor connected to eliminate generator whine.

connected to the armature terminal of the generator if a standard broadcast receiver is installed in the car. However, a tubular capacitor, because of its construction, has a certain amount of inductance which reduces its efficiency at higher frequencies.

When installing a coaxial capacitor, the case must be grounded to the generator; it may be necessary to scrape or sand the surface under the mounting screw to provide a good ground contact. Do not place the capacitor in the field lead, since the generator could be damaged if the capacitor were to short. Even when the capacitor is used, noise may become quite severe due to worn brushes or a dirty or worn commutator. In this case the generator will have to be overhauled before the noise can be completely eliminated.

A tunable device designed especially to suppress generator noise in the 3- to 30-mc range is shown in Fig. 4-11. This unit is connected in series with the armature lead of the generator; then it is tuned for minimum noise at the operating frequency.

Alternator filters are also available for those cars that do not use generators. They function in the same manner as the Cesco filter, but they are tuned to the higher frequency of the alternator "hash."

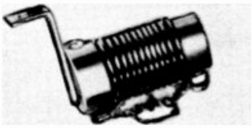


Fig. 4-11. The Knight 3-30 mc tunable filter.

Another type of noise, although not nearly as common as generator whine or ignition interference, is produced by the voltage regulator. This "hash type" interference occurs as the relay points open and close. It can usually be eliminated by installing noninductive, bypass capacitors in series with the battery and armature leads of the voltage regulator (Fig. 4-12). Other sources of noise include the electric gas gauge, the turn-signal flasher, and the brake-light switch. Noise produced by these sources can be eliminated in most cases by connecting a noninductive bypass capacitor in series with the "hot" lead to each unit, in the same manner as described previously.

Static electricity creates still another type of noise. This too is recognized by a popping sound, but unlike ignition interference, this noise will generally continue as long as the vehicle is in motion and even when the engine is turned off. In fact, this is one way to identifying static noise.

Static electricity is generally more troublesome in older automobiles where the body components are loose. A static electrical charge can build up between any two pieces of metal which are not bound together securely. When this electrical charge reaches a certain level, it will discharge to adjacent

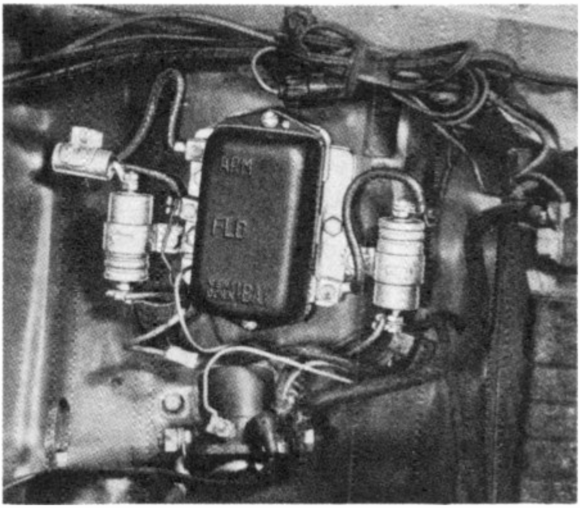


Fig. 4-12. Noninductive coaxial capacitors connected to eliminate voltage regulator interference.

metal components. It is this corona discharge, or spark, that causes the popping noise heard from the radio receiver. To eliminate static interference it is necessary to bond the two pieces of metal together. A bonding strap, such as that shown in Fig. 4-13, is generally used for the purpose. It may be necessary to bond the hood and trunk lid to the body, the instrument panel and possibly even the fenders to the frame, etc. until the trouble is corrected.

Wheel static is also troublesome with some cars. This can usually be corrected by installing a wheel-static eliminator (Fig. 4-14) inside of the wheel cap. Another related source of noise, although not quite as conmmon as wheel static, is tire

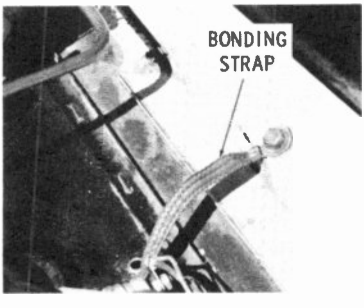


Fig. 4-13. A bonding strap.

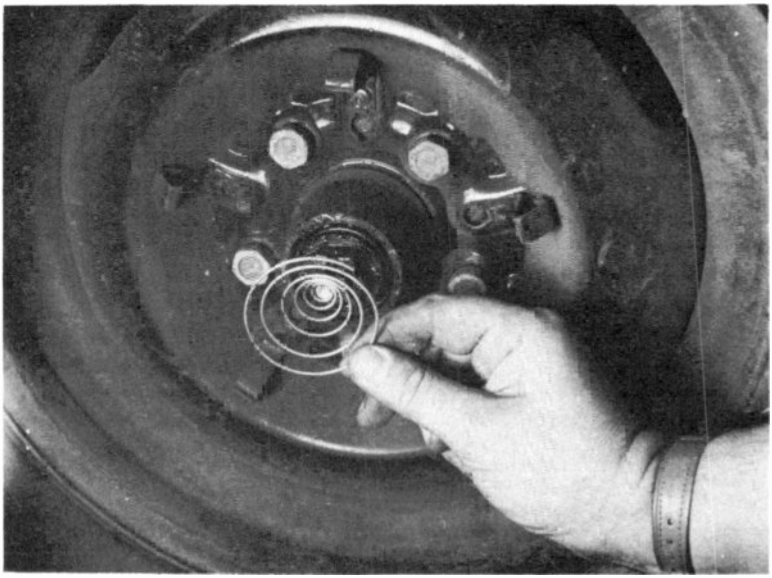


Fig. 4-14. A wheel static eliminator.

static. Special powders are available to eliminate this offender. The powder is usually blown into the tire with a tire pump.

BASE-STATION INSTALLATIONS

Actually there is not too much involved in setting up a base station once the antenna has been installed. One of the most important aspects of the installation, however, is the location of the antenna. It is obviously desirable to mount the antenna as high as legally possible, but at the same time it is not advisable to use excessively long runs of transmission line. As mentioned previously, the RF signal losses normally incurred within this line increase with the length of the cable. Therefore, the base station antenna should be mounted at a point that will afford maximum elevation, yet be within a reasonable distance from the radio equipment itself. The antenna cable and the power cord should be neatly routed behind the radio equipment. The equipment itself can be placed in almost any convenient location, as long as there is adequate ventilation to prevent overheating. Most transceivers also require a ground connection, which can be provided by driving a standard copper ground rod into the earth and running a wire (not less than 14 gauge) between it and the radio equipment. In some cases, an existing water pipe or faucet can serve as the ground with the wire firmly clamped to it. The antenna mast should also be grounded as protection against lightning. The same ground rod used for the transceiver may also be used for this purpose, with a 4- to 6-gauge wire connected between it and the antenna mast. After the radio equipment is properly connected, several transmitter adjustments may be necessary before the station is put into operation. If final tuning and antenna loading adjustments are required, be sure they are performed by a person who is properly qualified. The operating manual supplied with the equipment should always be consulted for specific pre-operation instructions.

COMMUNICATING RANGE

No one can say how far Citizens-Band transmissions will carry. Even for a given input power, the communicating range will vary greatly. Range is determined by a number of factors, one of which is the operating frequency. A Class-B transceiver operating as a fixed station and with the proper antenna is generally capable of line-of-sight communications of up to 10 miles or more with similarly equipped stations. This same equipment might only be able to provide reliable communications up to a half mile or so when operating under adverse conditions as a mobile station.

Class-A equipment also operates in the UHF range, although at a higher input power. Strangely enough, however, the communicating range does not increase proportionately with power, especially at UHF frequencies. Many Class-A units are designed to operate at less than the maximum input power allowed, because full-power operation will not produce a substantial increase in range. The majority of Class-A equipment is capable of providing reliable communications ranging up to 10 or 20 miles or more.

With Class-D equipment, communications between fixed stations separated by 15 miles or more is not uncommon. Occasionally, atmospheric conditions are such that radio waves traveling upward into the sky are bent back to earth and received hundreds of miles away. These unusual conditions generally occur during the late spring, summer, and early fall.

The range of mobile-to-mobile communications using Class-D equipment varies greatly—generally about 1 to 5 miles on land, and around 10 to 12 miles across water. These figures vary, of course, depending on conditions. Base-to-mobile communications at the Class-D frequencies is normally 10 to 15 miles. It may be less than one mile where there are obstructions to block the ground waves, or more than 10 miles when the mobile unit operates from an elevated area.

Basically, there are seven factors which determine the communicating range—type of equipment employed, transmitting power, operating frequency, surrounding terrain, interference present, type of antenna used, and antenna elevation. The latter does not necessarily mean the elevation of the antenna above ground, but rather its relative height with respect to the receiving antenna.

CHAPTER 5

CITIZENS BAND ANTENNAS

The performance of any two-way radio system is largely dependent on the design and efficiency of its antenna. With Citizens-Band equipment, the antenna becomes even more important because of the low power limitations imposed by the FCC. In actual practice a CB transmitter with 5 watts input power will generally deliver no more than 2½ watts of radio energy to the antenna; the output may even be less, depending on the efficiency of the transmitter, its adjustment, etc. Quite often the input is much less than 5 watts (mostly in small transistorized units), in which case the transmitter output may only be a fraction of 1 watt. This, of course, means that we will be dealing with relatively weak signals, compared with those originating from stations in other radio services. The Citizens Radio Service is designed to permit short-distance communications, and for this reason the transmitter power is limited.

By careful selection and installation of an antenna, it is possible to utilize to the fullest what little power is permitted, and thereby obtain optimum performance from your two-way system. In order to do this, the antenna must be capable of radiating and receiving as much radio energy as possible; this can be done only when minimum losses are incurred within the system. The antenna is analogous to a chain, which is only as strong as its weakest link. Regardless of how powerful the transmitter or how sensitive the receiver, the two-way radio is only as good as its antenna. Quite often CB equipment is condemned because of unsatisfactory performance, when actually it is only the antenna system that is at fault.

With a good antenna it is possible to overcome, at least partially, some of the apparent shortcomings of CB radio. One of the biggest problems is limited range, which is due in part to the low transmitter power used in CB operation. The communicating range can be extended either by increasing the input power of the transmitter or, in many cases, by merely improving the antenna system. Assuming that the transmitter is already operating at the maximum legal power input and is properly adjusted, then only the antenna remains as a means of extending the range. This can be accomplished by either reducing the amount of signal loss in the existing antenna sys-

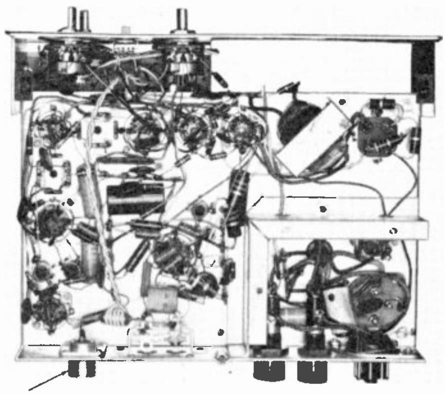


Fig. 5-1. Under-chassis view of CB transceiver showing coaxial antenna connector.

tem, or by using a more efficient antenna. In considering the efficiency of an antenna, the entire antenna system must be taken into account. This includes not only the antenna itself, but also the transmission line and any loading, matching, or coupling devices ahead of or following it. The inability of any one of these components to do their job efficiently can reflect on the performance of the entire system. The larger Class-D transceivers generally incorporate a coaxial receptacle on the top or rear of the chassis for connecting an external antenna (Fig. 5-1). These units are coupled to the antenna through a coaxial transmission line. Smaller CB equipment, such as the all-transistor Class-D transceiver in Fig. 5-2, generally employs a built-in telescopic antenna which is part of the unit itself. These antennas can be extended when the equipment is in operation, and conveniently collapsed when not in use. In

Fig. 5-2. An example of an all-transistor portable transceiver with built-in telescopic antenna.

two-way radio, the same antenna is generally used for both transmitting and receiving radio signals, with some type of relay employed to switch it from one circuit to the other.

RADIATION CHARACTERISTICS

To help in understanding antennas, a person should also have some knowledge of radio waves and their relationship to the antenna. All radio waves are electromagnetic in nature—that is, they are formed in much the same manner as the magnetic field that exists around a conductor through which current is flowing. However, radio waves actually radiate into free space somewhat like sound waves only much faster—in fact, 186,000 miles a second (the speed of light). Depending on the frequency and intensity of the antenna currents that produce them, radio waves can travel distances ranging up to

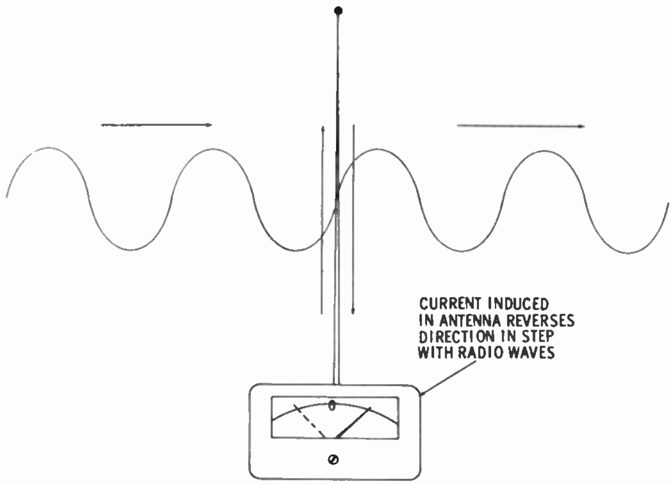


Fig. 5-3. Current flow induced in a conductor by radio waves.

several thousand and even millions of miles before their energy is dissipated.

Because of their electromagnetic properties, the waves leaving the antenna will induce currents in any conductor they contact (Fig. 5-3). Furthermore, these induced currents will exhibit the same characteristics as the current originating at the transmitting station. From this you might assume that the transmission and reception of radio waves is fairly simple; however, there are a few other factors that complicate the picture somewhat. For example, an antenna of just any length will not respond efficiently to radio waves of a particular frequency. The frequency of a radio wave is determined by the number of cycles that occur each second, and the wavelength is the distance traveled during one cycle. This is illustrated in

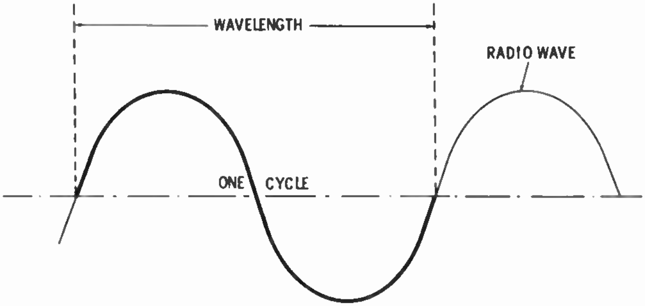


Fig. 5-4. Relationship between wavelength and distance.

Fig. 5-4. Maximum current will be induced in the receiving antenna when its length has a specific mathematical relationship with the wavelength of the signal being received. The same relationship holds true with regard to the antenna used to radiate these signals.

Polarization

Wave polarization can be considered as the angle at which radio waves leave the antenna. Basically, a radio wave consists of two moving fields of energy. One field is electric and the other is magnetic. The polarization of a radio wave is determined by the position of the lines of force in the electric field, and the latter, in turn, is determined by the position of the radiating element of the transmitting antenna. Hence, if the electric lines of force run parallel to the ground, the radio wave is horizontally polarized; and if they are perpendicular to the ground, the wave is vertically polarized. In either instance the lines of force in the magnetic field will be at right angles to the electric lines. It follows, then, that a transmitting antenna with a horizontal radiating element will emit horizontally polarized waves, and that one with a vertical element will emit vertically polarized waves.

Polarization is important in two-way radio because it affects both the transmission and reception of radio signals. For example, it has a considerable influence on the behavior of radio waves as they travel away from the transmitting antenna; it also dictates the type of receiving antenna needed for maximum signal pickup.

Until now all reference to polarization has been concerned with radio waves; however, you will also hear the term *antenna polarization* mentioned quite frequently. When an antenna is positioned in such a way that it radiates vertically polarized radio waves, the antenna is likewise termed "vertically polarized." By the same token, a horizontally polarized antenna is one that is positioned parallel to the ground and radiates horizontally polarized waves. Although this is the accepted terminology, it is often confusing to those unfamiliar with antennas. The fact that an antenna is vertically or horizontally polarized does not necessarily mean that it has poles like those of a battery or a permanent magnet, but merely indicates the polarization of the radio waves that the antenna is intended to radiate or receive. A whip antenna, for example,, is classified as a vertically polarized antenna when mounted in the usual perpendicular manner. This same antenna, however, could just as easily be made horizontally polarized by positioning it parallel to the ground. From this we see that polarization is not an inherent property of the antenna itself, but rather a matter of its position with respect to the ground.

Gain

Although no antenna is capable of amplifying radio signals, through proper design it can be made to concentrate its radiated energy in such a way that it will appear to have been produced by a much stronger source. For example, an antenna that concentrates most of the radio energy in one direction will provide an increase in coverage in that direction over another antenna which is fed the same amount of power, but radiates energy equally well in all directions. However, you cannot obtain something for nothing, so increasing the field strength at one point is made possible only at the expense of field strength elsewhere. Simple vertical antennas—those consisting strictly of a radiating element—generally have unity gain and can therefore utilize only that amount of energy being fed to them. Thus, if a transmitter having an output of 2.5 watts is connected to such an antenna, the most power that can be expected from it, even assuming no loss, is 2.5 watts. A "gain" antenna, however, is capable of concentrating radio energy in such a way that it will appear much stronger than the signal producing it. By using gain antennas it is possible to make 3 watts from the transmitter "look" like 30 watts when leaving the antenna. This means that the transmitter power will in effect be increased 10 times, making it equivalent in performance to a 30-watt transmitter. Hence, the extended range and improvement in overall performance that could be realized with a 30-watt transmitter can be achieved with only 5 watts by using a suitable antenna.

Basically there are two types of gain—omnidirectional where a gain is realized in all direction, and unidirectional where the signal gain is primarily in one direction. A CB antenna that is designed with unidirectional characteristics will usually provide a higher signal gain than one that is omnidirectional. The amount of gain is determined by comparing the performance of a given antenna with that of a standard antenna; it is expressed as a ratio of the power levels required to produce equivalent field strengths. The gain in decibels (db) equals ten times the log of this power ratio. Gain will be discussed further as a comparison is made between the various CB antenna types.

ANTENNA DESIGN

All antennas perform the same basic function of radiating and receiving radio energy, but not necessarily in the same manner. The design of the antenna will determine its performance characteristics and, in turn, its usefulness for a specific application. Moreover, the physical as well as the electrical characteristics are important because both are interrelated. Some antennas are designed for a more or less general class of operation, while others are made to exhibit certain characteristics which make them more suitable for particular type of operation.

Antennas can be made to radiate and receive radio signals equally well in all directions or to respond more in a given direction. Either type has its advantages and disadvantages. Omnidirectional antennas are generally used in mobile and base station installations where communications are desired in all directions at the same time. For point-to-point communications between fixed stations, however, a unidirectional-type antenna is better suited. These can also be used for communicating with CB stations in all directions; however, to do this efficiently the antenna must first be turned toward the desired station.

An antenna may consist of nothing more than a single element, or it may be more complex, having a number of elements. In either instance, only a single element (sometimes in two pieces) is used to radiate or receive the radio signals. This one is commonly referred to as the driven element. It is the number of elements and their length, spacing, and relationship to each other that determine the operating characteristics. Each element has a specific function and contributes in some way to the over-all performance of the antenna. Furthermore, the driven element must have a specific mathematical relationship to the wavelength of the radio signals it radiates or receives. If its length is incorrect a signal loss will occur.

To understand what is meant by wavelength, refer to Fig. 5-5. Here you can see the relationship between wavelength and antenna length. A wavelength at the 27-mc Class-D frequencies is 11 meters. (A meter is a unit of measurement equal to 39.37 inches). Therefore, by multiplying this figure by 11 you will see that a wavelength at 27 mc is 433.07 inches.

You will find the term *meter* used quite frequently in connection with two-way radio. It is common practice to refer to the wavelength of radio waves rather than their frequency. In fact, the Class-C and -D Citizens-Band frequencies are commonly referred to as "11 meters." As the frequency of a radio wave is increased, its wavelength is decreased. For example, a wavelength at 54 mc will be half that at 27 mc. The smaller the number of meters, the higher the frequency is.

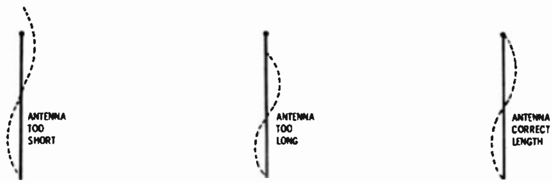


Fig. 5-5. Relationship between wavelength and antenna length.

As you can see, a wavelength at 27 mc (11 meters) is approximately 36 feet long. Although a full-wave antenna is very efficient, it is obviously impractical for most CB installations because of its length. Therefore it is a common practice to use an antenna that is cut to some multiple, such as a half or quarter wavelength. A half-wave antenna for 27 mc will be approximately 18 feet long. While a great many base stations employ half-wave antennas, they are still impractical for mobile operation. Here, a quarter-wave antenna which is only 9 feet (108 inches) long and is much better suited.

There is actually some difference between the physical and electrical length of an antenna. An antenna that is cut to a half wavelength at a given frequency may not be exactly equal to a half wave in space, but somewhat less. One of the factors to which this can be attributed is the circumference of the antenna. For all practical purposes, the smaller the circumference, the less difference there will be between the electrical and physical length. This means, then, that an antenna with a small cross-sectional area will be longer *electrically* than one of the same length having a larger area.

Loading Coils

As mentioned previously, it is often impractical to use a full-wave, or for that matter even a half-wave, antenna because of its length. At the ultra-high frequencies in which Class-A CB equipment operates, the wavelength and, hence antenna length, are quite short. In fact a quarter-wave antenna is generally no longer than 5 or 6 inches. At the Class-D frequencies, however, even a quarter-wave antenna is 108 inches long. Quarter-wave antennas are used almost exclusively in mobile installations, but because of their length, even these are subjected to considerable physical abuse as a result of stricking tree limbs, overhead garage doors, etc. while the vehicle is in motion.

Fig. 5-6. Typical loading coil.

It would appear that the ultimate solution to this problem would be to use an antenna of less than a quarter wavelength. This can be done but it will cause an upset in the electrical characteristics. To make a long story short, a perfect antenna is one that is purely resistive in nature. As an antenna is cut to less than a quarter wavelength, it begins to exhibit certain capacitive characteristics. This capacitance is undesirable in that it reduces the efficiency of the antenna. Therefore, a shortened antenna (one less than a quarter wavelength at the operating frequency) generally uses a device known as a load-

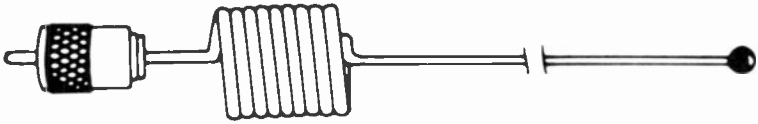


Fig. 5-7. A Class-D whip antenna with the loading coil as an integral part of its construction.

ing coil to offset this undesirable condition. Actually, what happens is that the inductive characteristics of the loading coil are equal and opposite in effect to the capacitive reactance of the antenna and thus the two cancel. You might say that a loading coil makes an antenna "appear" longer electrically than it actually is physically. With such a device it is possible to use a shorter antenna without affecting its efficiency as much. The typical loading coil shown in Fig. 5-6 is completely separate from the antenna, but some are physically a part of the antenna itself as you can see in Fig. 5-7.

(A) At the base. (B) At the center. (C) At the top.

Fig. 5-8. Placement of the loading coil in the antenna.

The loading coil can be used at any one of several points on the antenna (Fig. 5-8). Common locations are at the base, center, and top (Figs. 5-8A, B, and C, respectively).

TYPES OF ANTENNAS

Although there are a wide variety of CB antennas, practically all of them can be classified in one of five basic categories—whip, dipole, coaxial, ground plane, and beam.

The Vertical Whip

A whip antenna is one of the simplest there is. In fact, it is nothing more than a single vertical element (usually rather thin) composed of a suitable conducting material and cut to a specific length. This radiator is classified as a vertical polarized antenna, and the RF signal is fed to the bottom end. Whip antennas have an omnidirectional radiation pattern similar to that shown in Fig. 5-9. As you can see it will provide an equal response in all directions. It should also be mentioned here that a communications antenna exhibits the same field pattern whether radiating or receiving radio energy.

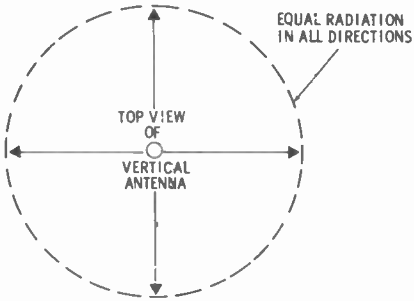


Fig. 5-9. The omnidirectional radiation pattern of a whip antenna.

Whip antennas are generally constructed of stainless steel or some other strong yet flexible material. A typical stainless steel mobile whip is shown in Fig. 5-10. In recent years a number of whips have been constructed of a somewhat less

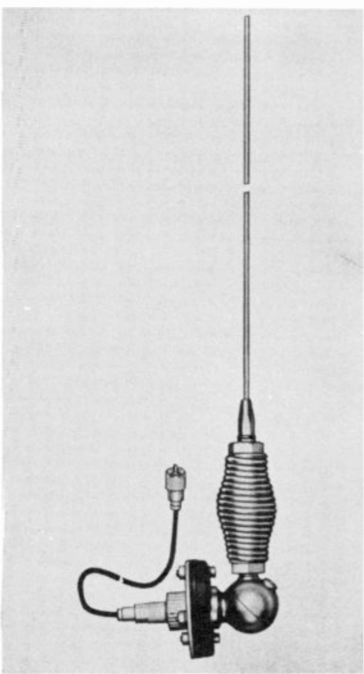


Fig. 5-10. A typical stainless-steel mobile whip antenna for 27-mc operation.

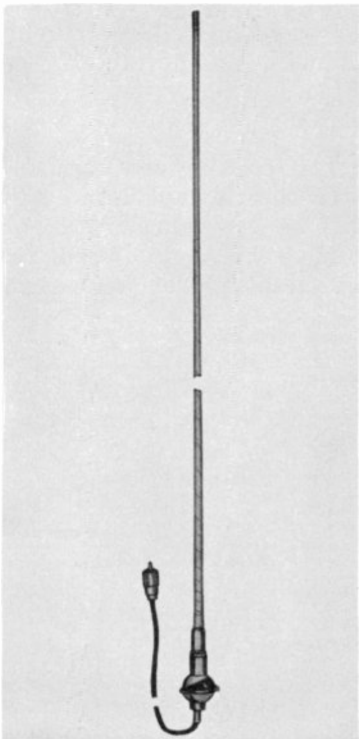


Fig. 5-11. A whip antenna constructed of *Fiberglas.*

flexible material, known as *Fiberglas*. Such antennas usually have a larger diameter than stainless-steel whips, and since *Fiberglas* is not a conductor of electricity, will either have a conductor running through the center or wound in a spiral around the outer surface (Fig. 5-11).

The vertical whip may be almost any length, depending on the frequency at which it is designed to operate. Half-wave whips are sometimes used in Class-D operation; however, the majority are cut to a quarter wavelength and some even shorter. The latter generally use loading coils.

Quarter-wave whip antennas are used quite extensively in all classes of Citizens Band operation. They are well suited for installations where space is a problem, and their relatively low angle of radiation and omnidirectional response means that little RF energy will be lost in space. Moreover, through proper design, the angle of radiation can be lowered to the point where a certain amount of omnidirectional power gain can be realized. Vertical whip antennas are used in practically all mobile and portable CB operations.

Coaxial

The coaxial antenna also has omnidirectional characteristics and is capable of providing gain. At high frequencies, such as those encountered in Class-D operation, it is desirable to keep the angle of radiation as low as possible (Fig. 5-12). At these frequencies the radio energy traveling outward as

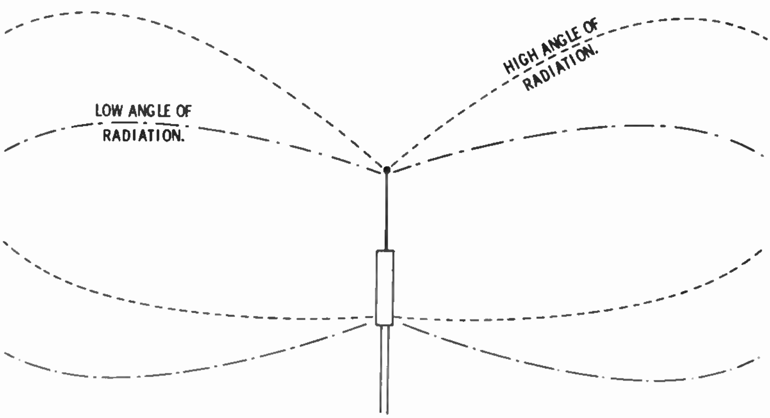


Fig. 5-12. Relationship between antenna and angle of radiation.

sky waves is normally dissipated and, therefore, serves no useful purpose. The most practical solution is to divert this otherwise wasted skywave energy along paths where it can be put to good use. The coaxial antenna (often referred to as a "thunderstick") has a good low-angle radiation pattern and is therefore quite suitable for CB communications. Coaxial antennas are quite popular in base, or fixed-station, installations.

The basic construction of a coaxial antenna is shown in Fig. 5-13. Like practically all others in CB radio, this antenna is fed by a concentric, or coaxial, transmission line comprising a center conductor surrounded by a dielectric material, and this in turn by a shielding braid and a vinyl jacket. Essentially,

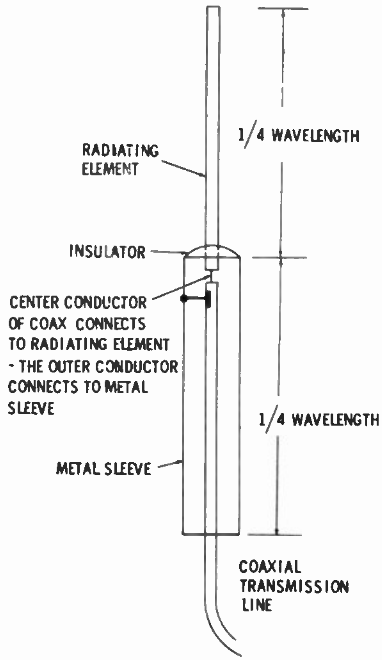


Fig. 5-13. Basic construction of a coaxial antenna.

the transmission line is passed upward, through the metal sleeve to an element at the top. The center conductor of the coaxial line is connected to this element, effectively extending this conductor one-quarter wavelength beyond the end of the transmission line. The outer shielding braid of the transmission line is connected to upper end of the metal sleeve as shown. The center conductor and metal sleeve are separated by some type of insulating material. The sleeve around the transmission line acts as a shield; as a result, very little current is induced on the outside of this line by the antenna field. Coaxial antennas require very little space, and they are quite easy to mount.

Dipole

The dipole, as its name implies, is a two element antenna. Actually, it is nothing more than a single radiating element which has been split into two pieces; the antenna cable is connected at the split, as shown in Fig. 5-14. A good example

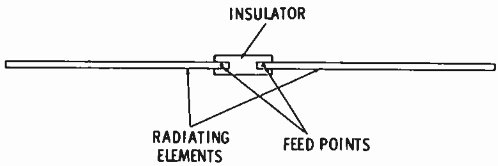


Fig. 5-14. Basic dipole construction.

of a dipole antenna is the so called "rabbit ears" commonly associated with television receivers. The dipole is used to a considerable extent with portable-type CB radio equipment. It is generally telescopic and for this reason is ideal for indoor and portable CB operation. Fig. 5-15 shows a Class-D CB transceiver using such an antenna. This antenna is not omni-

Fig. 5-15. A Class-D transceiver equipped with a telescopic dipole.

directional, but instead it exhibits a figure-eight radiation pattern similar to that shown in Fig. 5-16. Radio waves leaving an antenna of this type are comprised of both vertical and horizontal polarization.

Ground Plane

The ground plane is probably the most popular type of CB base station antenna. Its basic construction is shown in Fig. 5-17, and as you can see, it consists primarily of a vertical-

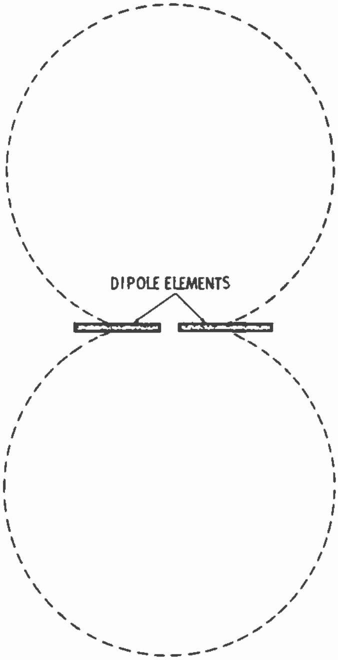


Fig. 5-16. Radiation pattern of a dipole antenna.

radiating element and several radials extending outward at right angles from its base. The ground plane is an omnidirectional antenna and has an angle of radiation that can be lowered to the point where the radiated power can, in effect, be doubled without destroying its omnidirectional characteristics. An artificial ground is provided this antenna by the three or four radials extending outward from its base.

A simple vertical quarter-wave antenna must have a good physical ground before it will provide the desired low angle of radiation. Moreover, its height has considerable effect on the pattern. By the addition of ground-plane radials, however, it can be made to provide low-angle radiation regardless of its actual height above the ground. However, to obtain the true ground-plane effect, the radials should be a quarter wavelength or more above ground. The radials may be at right angles to the driven element or less, depending on the design of the antenna and on the radiation pattern it is desired to obtain.

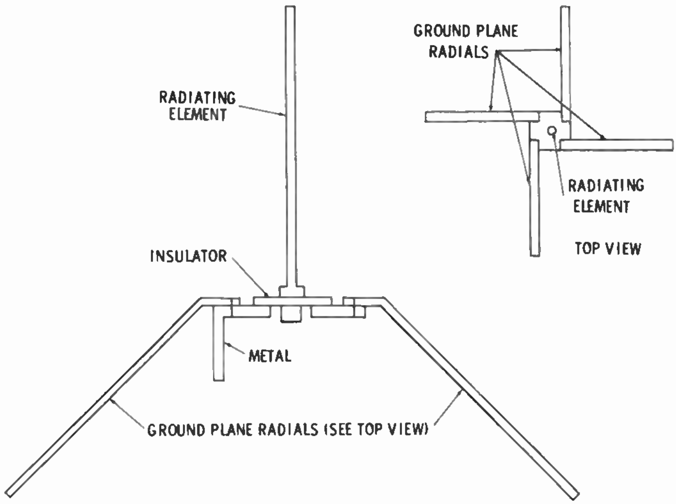


Fig. 5-17. Basic construction of a ground-plane antenna.

Beam

A beam antenna is generally comprised of several elements arranged in such a way as to provide a high signal gain in one direction. The radiating, or driven, element is usually a dipole used in conjunction with several elements known as para-

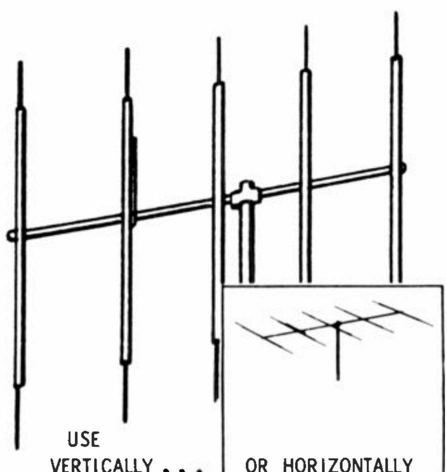


Fig. 5-18. Knight® 5-element CB beam antenna.

sitics. By combining these elements into a suitable array and properly spacing them, it is possible to make their radiation add up along a single direction and form a beam (hence the term "beam" antenna). In this way, a power gain is obtained in one direction, but only at the expense of radiation in other directions. Beam antennas are capable of providing exceptionally high power gains and can also be made very directional. Usually, the more directional the field pattern is, the higher the gain will be. Also, remember that the radiation pattern of an antenna is not only an indication of its transmitting characteristics, but of its receiving qualities as well. Beams that provide a power gain of 9 db are not uncommon. With a forward gain of 9 db, transmitter power will be effectively multiplied eight times. Using this figure as an example, a transmitter with 5 watts input feeding such as antenna would, in effect, perform like one with 40 watts input. Fig. 5-18 shows a typical beam antenna designed for Class-D operation. Beams can be mounted either horizontally or ver-

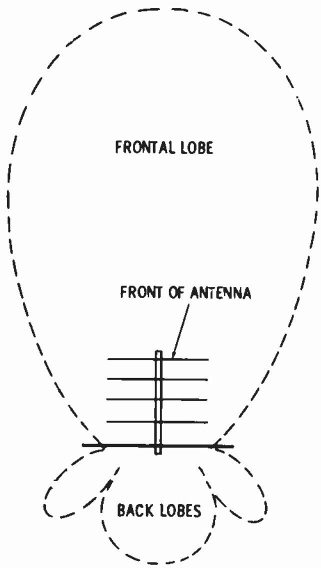


Fig. 5-19. Typical directional radiation pattern of a beam antenna.

tically as desired. They are highly directional and have a radiation pattern similar to that shown in Fig. 5-19. As you can see, this antenna is quite responsive off of the front, but not nearly as much off of the rear and sides.

TRANSMISSION LINES

The electrical path between the antenna and radio equipment is usually provided by a coaxial transmission line constructed as shown in Fig. 5-20. This cable generally consists of either a solid or stranded center conductor and a braided outer conductor. The two are separated by some type of dielectric and the entire construction is covered with a vinyl jacket. The outer conductor serves to keep out man-made electrical noise, which could otherwise produce considerable interference during reception. In addition, the shielding effect of the outer conductor tends to confine the RF energy within the cable, thus preventing it from being radiated before reaching the antenna. Unlike the coaxial cable shown in Fig. 5-20, some have more than one shielding conductor.

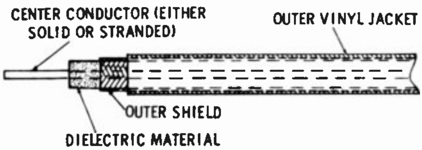


Fig. 5-20. Basic construction of coaxial-type antenna transmission line.

Despite all its desirable features, the coaxial cable must be kept as short as possible to minimize RF losses which are incurred within it. Between any two conductors, separated by a dielectric, there is always a certain amount of capacitance, the exact amount depends on the size of the conductors and the spacing between them, and on the dielectric constant of the material separating them. This capacitance results in an RF signal loss which increases with the frequency of the signal. Recently a number of dielectrics have been developed which result in very low losses.

Practically all CB antennas are designed to accept a coaxial transmission line having a characteristic impedance of 50 to 52 ohms. Table 5-1 lists representative coaxial cables having an impedance within this range and the RF losses they present at various frequencies. These losses are usually expressed as so many db's of attenuation per 100 feet. From the chart you can see that not all cables use the same dielectric material; also, the amount of capacitance per foot varies according to the type of cable. Notice the difference between the losses of the RG-8/U and RG-58A/U cables. At 10 mc, the RG-8/U presents a 0.55-db attenuation per 100 feet of cable, as opposed to 1.6 db for the RG-58A/U. At UHF these

Table 5-1. Coaxial-Cable Characteristics.

Type RG./U	Impd. (ohms)	Capacity (mmf per feet)	Diam. (inches)	Attenuation—db per 100 ft. 1 mc	10 mc	100 mc	400 mc	1,000 mc	Remarks
5A	50	29	.328	.16	.66	2.4	5.25	8.8	Small, low loss.
8	52	29.5	.405	.16	.55	2.0	4.5	8.5	General-purpose.
9	51	30	.420	.12	.47	1.9	4.4	8.5	General-purpose.
9A	51	30	.420	.16	.59	2.3	5.2	8.6	Stable attenuation.
14	52	29.5	.545	.10	.38	1.5	3.5	6.0	RF power.
16	52	29.5	.630	......	......	......	......	......	RF power.
17	52	29.5	.870	.06	.24	.95	2.4	4.4	RF power.
18	52	29.5	.945	.060	.24	.95	2.4	4.4	Polyethylene dielectric.
19	52	29.5	1.120	.04	.17	.68	1.28	3.5	Low-loss RF.
20	52	29.5	1.120	.04	.17	.68	1.82	3.5	Low-loss RF.
58A	50	28.5	1.195	.42	1.6	6.2	14.0	24.0	Polyethylene dielectric.
87A	50	29.5	.425	.13	.52	2.0	4.4	7.6	Teflon dielectric.
117	50	29	.730	.05	.20	.85	2.0	3.6	Teflon and Fiberglas.
119	50	29	.470	......	......	......	......	......	Teflon and Fiberglas.
122	50	29.3	.160	.40	1.70	7.0	16.5	29.0	Miniature coaxial.
126	50	29	.290	3.20	9.0	25.0	47.0	72.0	Teflon and Fiberglas.
141	50	29	.195	.35	1.12	3.8	8.0	13.8	Teflon and Fiberglas.
142	50	29	.206	.35	1.12	3.8	8.0	13.8	Teflon and Fiberglas.
143	50	29	.325	.24	.77	2.5	5.3	9.0	Teflon and Fiberglas.
174	50	30	.10	......	......	......	19.0	......	Miniature coaxial.

losses become even more significant. For example, at 400 mc, the RG-8/U cable has 4.5-db attenuation as compared with 14.0 db for the RG-58A/U. At 1,000 mc the RG-58/U cable presents a 24-db attenuation per 100 feet. These figures are not the same for all cables, even those with the same type number, because different manufacturers may use different dielectrics, slightly different manufacturing techniques, etc, which will alter the specifications.

ANTENNA HEIGHT LIMITATIONS

In mounting a CB antenna, height is of the utmost importance. However, a CB antenna cannot always be mounted as high as desired because of the FCC limitations on antenna structures. Basically, these regulations state that the top of an antenna at a fixed location to be used by Class-B, -C, or -D mobile stations shall not exceed 20 feet in height above any man-made structure or natural formation on which it is mounted, except that when mounted on an existing antenna structure of another station the antenna shall not exceed the height of that antenna structure.

This does not necessarily mean that a CB antenna cannot be over 20 feet above the ground. In fact, it can be hundreds or even thousands of feet above ground and still be only 20 feet above its mounting. Fig. 5-21 illustrates how the 20-foot

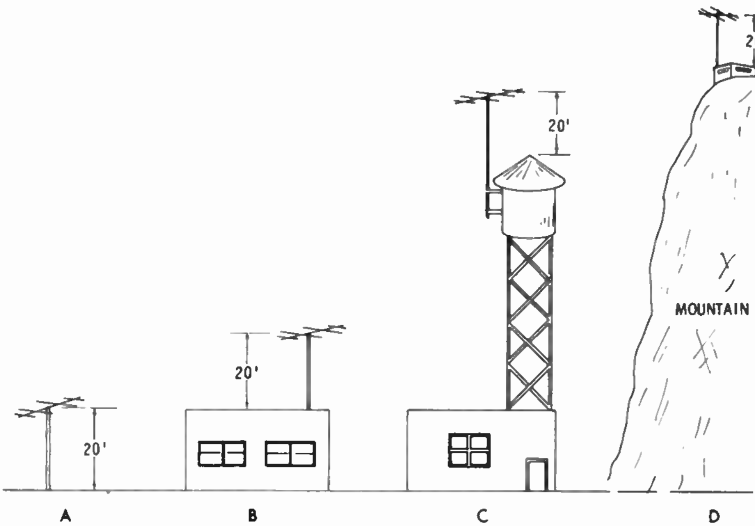


Fig. 5-21. Interpretation of the FCC 20-foot antenna height limitation.

limitation applies. Antenna A is fastened to a mast mounted on the ground. The overall height from ground to the top of the antenna is 20 feet, the legal limit. Antennas B and C, on the other hand, are both mounted atop existing man-made structures. Both provide a higher effective elevation over antenna A, yet neither exceeds the legal 20-foot limit above the mounting. One CB antenna (D) is mounted 20 feet above the roof of a building situated on the top of a mountain, giving a tremendous height above the average terrain. Notice that every antenna in this illustration is only 20 feet above its mounting, yet some provide much more elevation. Therefore, from the standpoint of efficiency, the actual height of the antenna above its mounting is not nearly as important as the effective elevation it affords. In other words, the FCC 20-foot limitation is not necessarily as restrictive as it may seem.

SELECTING THE PROPER ANTENNA

Proper selection of an antenna is very important if maximum efficiency is to be obtained from a two-way radio system. You will also find that the antenna requirements vary considerably from one installation to another.

Base-Station Antennas

A number of factors must be considered in selecting an antenna, although the final selection depends on each individual's needs. One of the major considerations is whether the intended operation is fixed, mobile, or portable. The type of two-way radio equipment with which the antenna is to be used is also a contributing factor to the selection. Moreover, each fixed-station presents a different set of requirements and therefore can be considered a custom antenna installation.

CB antennas are generally available as an accessory, although sometimes they are supplied when new CB radio equipment is purchased. In some instances the supplied antenna is actually a physical part of the equipment itself, as in the case of most pocket-sized transceivers. If short-range portable operation is intended, perhaps with someone a mile or so up the street or even in the same building, such operation would hardly call for a complex rotary beam antenna mounted at the maximum legal height; one of the short-length portable whips that fasten directly to the transceiver will generally suffice. On the other hand, if long-range communications is desired but your CB station is set up in an apartment building where hole drilling for antenna installation is not permitted, one of the longer whips designed for temporary mounting (without drilling) on the outside window sill may be necessary. If you are fortunate enough to live on one of the upper floors, you may still be able to achieve more range than many of the ground stations, because of the increased elevation of your antenna.

If communications are to be from a base station to mobile units, some type of omnidirectional antenna should be employed. What's more, the distance these mobile units will be operating from the fixed station will determine whether an antenna that provides omnidirectional gain is necessary. If finances permit, such an antenna would certainly be desirable. Another important consideration is the amount of space available in which to make a permanent antenna installation. A ground plane, for example, is ideal for base-station installations, and many are capable of providing a high power gain. However, where trees, buildings, and other objects might physically obstruct the ground-plane radials, a good coaxial antenna may be more practical. This type of antenna is capable of providing the same omnidirectional pattern and gain, yet it requires less space than a ground plane. Sometimes you have several choices of a mounting location; in other cases, you must make the best of what you have.

A beam antenna can be used to great advantage if communications over a considerable distance is intended between fixed points. A beam not only provides substantial signal gain, but generally discriminates against unwanted signals from other directions as well. Antenna polarization must also be considered. Practically all mobile units employ vertical antennas, whereas base stations may employ either a vertical or horizontal antenna. Therefore, if operation is intended between base stations only, by all means use a horizontal beam. Conversely, if mobile units are primary concern, the beam should be vertical. Communication, even though not as good, may still be satisfactory with local stations, even when cross polarization is used.

Since beam antennas are directional, a rotor will be required to "swing it around." This, of course, means an additional expense unless a discarded TV rotor can be obtained. If expense is the determining factor, a ground plane may be more practical; it can provide a reasonable amount of gain, but requires no rotor because of its omnidirectional pattern.

Mobile Antennas

Proper selection of a mobile antenna is just as important as selection of the base-station antenna. Vertical whips are used almost exclusively for mobile CB operation. In selecting a mobile antenna, appearance as well as efficiency is often a contributing factor in the choice. The shortened antennas, while somewhat less efficient than the full quarter-wave (108") whip, are often more practical where appearance is the primary concern or where overhead obstructions are particularly troublesome. Also, where too many antennas on a vehicle is objectionable, one of the dual-purpose antennas might be employed. This antenna, together with its coupling unit, provides for both CB operation and standard broadcast reception. In instances where mobile operation is only temporary or where it is not desirable to drill mounting holes in a vehicle, one of the clamp-on CB antennas can be employed. These are currently available as full-length whips which clamp onto the bumper, or as the short loaded whips. The latter type is available in many styles which may be mounted on the drain cutter above the door, the trunk ledge, the roof of the vehicle (this one is held on with suction cups), or an existing AM broadcast antenna.

CHAPTER 6

OPERATING CITIZENS BAND EQUIPMENT

If you have had no previous experience with two-way radio, it is important that you have a basic understanding of how to operate such equipment.

One attractive feature of the Citizens Band transceiver is its simplicity of operation. Despite the wide-band equipment on the market, the number of basic operating controls varies only slightly from unit to unit. Some equipment, because of more elaborate circuits or special features, will have more

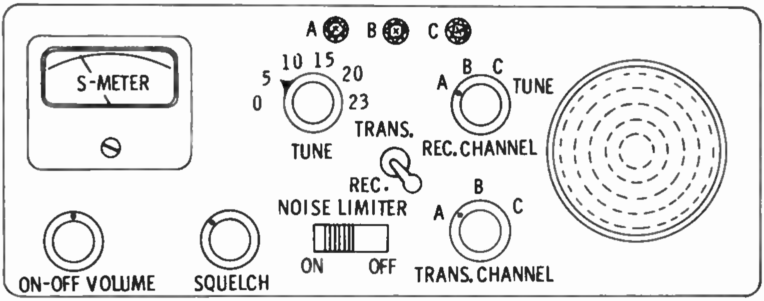


Fig. 6-1. A composite control panel showing the type of controls normally found on CB transceivers.

controls than others. Fig. 6-1 shows a composite transceiver panel with all of the controls normally found on this type of equipment.

ABOUT THE CONTROLS

Practically every CB transceiver has at least five basic controls in common — the channel selector, squelch control, transmit-receive switch, volume control, and on-off switch.

Channel Selector

There are three basic types of CB equipment—fixed-tuned, tunable, and a combination of both. With Class-D equipment the transmitter is always fixed-tuned at one or more predetermined frequencies. The receiver, however, may be either fixed-tuned or tunable. In some equipment the receiver is fixed-tuned for operation on several channels and also continuously tunable across the entire band.

The frequency-selection control on multichannel fixed-tuned transceivers is usually labeled *Channel.* This control is probably a rotary-type switch with letters or numbers designating the various positions. Some fixed-frequency equipment may have provision for only two channels, in which case a toggle, slide-type or two-position rotary switch may be employed for selection. Obviously, single-channel equipment will not have any frequency-switching control. The operating frequency of fixed-tuned multichannel units can be selected by switching the channel selector to the desired position. Furthermore, the frequency at any of the switch positions can be altered by changing the crystals within the equipment. Therefore even a single-channel unit can be made to operate on other channels with little difficulty. For this reason the selector positions are usually marked with arbitrarily selected letters or numbers rather than with the actual channels or frequencies. In addition to the channel-selector markings, some units employ various colored pilot lights to indicate which channel is in operation. The channel frequencies for the various positions depend on which crystals were provided by the manufacturer and are usually given in the information included with the equipment. The Class-D transceiver in Fig. 6-2 has an 8-channel selector switch with easily accessible crystal sockets.

With tunable transceivers, the transmitter frequency is fixed, but the receiver can be continuously tuned, usually over the entire band. This equipment, unlike the fixed-tuned, will have some type of dial indicating the relative setting for various frequencies. The receiving channel positions come into view on the A-2530 transceiver, shown in Fig. 6-2, as the tuning knob is rotated. The matching transmitting channel is also selected in the same manner.

Several factors should be taken into consideration when selecting a channel for operation in either type of equipment. As you know, Citizens Band frequencies are shared with

Fig. 6-2. The Allied A-2530 transceiver design provides up to 16 crystal-controlled transmitting channels. The superhet receiver continuously tunes 23 channels.

other units in this service. Therefore, try to pick a channel that is not too crowded, and at the same time one that will afford the least interference. For example, the FCC does not guarantee Class-D operators any protection from interference due to the operation of industrial, scientific, and medical equipment on the frequency of 27.120 mc. This frequency falls between Channels 13 and 14, so if you intend to use your equipment near hospitals, doctors offices, and factories, it would be best to select a channel other than 13 or 14, and possibly not even 12 and 15 if the interference is too severe. Inasmuch as the twenty-third channel used in Class-D operation is shared with Class-C stations for remote-control purposes it may become quite congested and impractical to use in some localities. The frequency chosen for operation will depend largely on the area where the equipment is to be used. A particular channel may be quite congested in one area and practically unused in another. If in doubt as to which channels are best suited for your particular locality, consult some of the CB operators or equipment distributors in your area. They can usually advise you which channels are crowded and also of any local conditions which may make some channels undesirable in your location.

Squelch Control

The squelch circuit is incorporated in practically all late-model Citizens Band equipment. The primary function of the squelch circuit is to mute the speaker when no signals are being received. Adjustment of the squelch control establishes the level of a control voltage which the incoming signal must overcome before it can be heard from the speaker. With the Squelch control in the Off position, the speaker will reproduce the usual random background noise similar to that heard from a broadcast receiver when tuned between two stations. When an intelligible transmission is received, it will "override" much or all of this background noise. When the transmission ends, the background noise will again emanate from the speaker. By advancing the squelch control to the point where the receiver is silenced, nothing will be heard from the speaker until a signal of sufficient strength is again received.

Any signal that lacks the strength to overcome the squelch voltage will not be heard. This is just as well, since in most cases it would be unintelligible anyway. The further the squelch control is advanced, the stronger the signal must be before it will be heard from the speaker. As a general rule, the squelch control should be adjusted to the point where the receiver is silenced and then just a bit further. In mobile CB operation, it will probably have to be adjusted slightly beyond this point; otherwise, noise pulses from power lines, neon lights, factory equipment, etc. may be of sufficient strength to "break" the squelch. As you become familiar with the equipment, you will be able to determine the proper setting with little difficulty.

Volume Control

A volume control of some type is employed with all CB equipment. As the name implies, its purpose is to control the volume level—but only of the receiver output, not the output level of the transmitter as you might think. The RF power output of the transmitter is fixed; therefore it is useless to turn the volume control up when transmitting. Sometimes the volume control is a step-type switch with several positions. The desired volume level is selected by switching to the position that most nearly meets the demand. This switch, however, cannot be set to obtain a level between these positions. The most popular control used in current CB equipment is the continuously variable potentiometer which adjusts the volume to any level within its range of rotation.

Power Switch

Generally, the on-off power switch is mechanically affixed to the rear of the volume control and works in conjunction with it—just as it does on most radio and TV sets. Turning the volume control clockwise switches the transceiver on and increases the volume. Conversely, turning this control counterclockwise reduces the volume and, at maximum rotation, actuates the switch that turns the unit off. A pilot light may or may not be employed to indicate when the power is on. Ocasionally you may find a unit that has a power switch that is separate from the volume control.

Other Controls and Indicators

In addition to the aforementioned controls, you will also find some CB equipment with a noise-limiter control. This may be either an On-Off switch used to place the noise-limiter circuit in and out of operation or a potentiometer which provides a means of adjusting the degree of noise-limiting action.

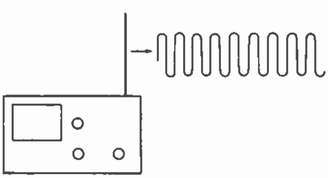
Also, there are transceivers which employ a meter to indicate the relative output of the transmitter or an S-meter which indicates the strength of incoming signals. In fact, some transceivers use a single meter to provide both functions. The necessary circuit changes for this action are made when the push-to-talk button is depressed. In other words, with the button released it acts as an S-meter for the receiver; in the transmit position the meter automatically provides an indication of the RF output. Equipment which does not use a meter may or may not employ some type of pilot light or neon indicator to show when the transmitter is in operation.

In recent months some Class-D transceivers have appeared on the market using a built-in tone-coded selective-calling system. These systems have been available as accessories for some time now, but recent interest in them (due primarily to the crowded channel conditions) has resulted in some manufacturers including tone-coding circuitry in their transceiver designs. With such equipment you will find some type of button or lever on the control panel used to alert the desired station. There will also be a transmit-receive switch on all transceivers.

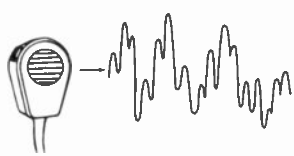
HOW TO USE THE MICROPHONE

There is a wide variety of microphones used with Citizens Band equipment. Some employ a push-to-talk button, and others depend on a push button or switch (usually an automatic-return type) on the equipment itself. The push-to-talk button, or switch, is depressed to activate the transmitter. The receiver output is "killed" while this button is in the transmitting position. Releasing the button disables the transmitter and at the same time restores the receiver to normal operation. When using this button, be sure to depress it an instant before speaking into the microphone. This allows the transmitter circuits to stabilize and also prevents having to repeat the message because of a word missed at the beginning of the transmission. A simple practice such as this will help to alleviate much of the unnecessary traffic in the CB channels.

When the push-to-talk button is actuated, a signal is being transmitted even though no words are spoken into the microphone. An unmodulated carrier (Fig. 6-3A) is being radiated from the antenna. The voice spoken into the microphone produces an electrical equivalent of the sound waves (Fig. 6-3B). When fed into the transmitter, the voice signal is superimposed on the carrier signal, as shown in Fig. 6-3C (this process is known as modulating the carrier).



(A) Unmodulated RF carrier signal.



(B) The audio, or modulating, signal.

(C) Resultant modulated carrier.

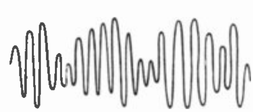


Fig. 6-3. The basic modulation process.

To produce a good, clear signal at the receiver, the microphone must be held the proper distance from the mouth. Holding it too close (Fig. 6-4A) will cause the voice to sound garbled or muffled, and too far away (Fig. 6-4B) will produce a weak audio signal at the receiver. Best results will be ob-

(A) Too close to the mouth.

(B) Too far from the mouth.

(C) The correct distance.

Fig. 6-4. Using the microphone.

tained by holding it one to two inches from the mouth. Occasionally, a whisp may be heard by the receiving station as a result of breathing directly into the microphone from close range. This situation can be relieved somewhat by holding the microphone the correct distance from the mouth and at a 45° angle when speaking (Fig. 6-4C).

Although the unmodulated RF-carrier power of the transmitter is fixed, the level of the reproduced voice signal at the receiver will vary in accordance with the percentage of carrier modulation. The maximum modulation level allowed a CB station is 100%. The percentage of modulation varies with the intensity of the sound entering the microphone. Thus, modulation increases somewhat when a person speaks loudly into the microphone, and decreases when they speak softly. This does not mean, however, that you should yell into the microphone. With some radio equipment this can cause over-modulation. Should the carrier be modulated over 100%, it could not only distort the voice signal, but also introduce harmonics which may extend outside the assigned frequency, and for that matter, even outside the CB band and interfere with other radio services. This is the purpose of the 100% limitation on modulation. Since higher modulation percentages extend the transmitting range to some extent, it is desirable to operate as close as possible to the maximum limit. Most Citizens radio equipment is designed to operate near 100%, but it usually includes some method of self-limiting to prevent exceeding this amount.

CHAPTER 7

THE USES AND ABUSES OF CITIZENS BAND RADIO

If properly used, CB radio can provide a useful service to everyone. Unfortunately, however, this is not always the case. Many are abusing the privilege of operating a two-way radio station, and in doing so, are jeopardizing the very existence of CB radio. Actually, CB radio has become known as the problem band for the FCC. In policing this service, the FCC monitoring stations are uncovering violations by the thousands. This, of course, results in increased regulations of this service and stricter enforcement of the rules and regulations set forth in Part 95. These regulations are altered and amended from time to time as the need arises, and this need is becoming much more frequent each day. This is understandable when you consider the increasing number of CB Stations. Just recently a new set of proposals concerning operating practices was introduced to the commission. Whether or not these proposals are adapted remains to be seen; however, if they should be (and it is very possible they will, at least in a modified form), CB operations will be considerably more limited. The proposed changes are not designed to reduce the usefulness of this service, but instead are directed toward eliminating all operation contrary to that for which CB radio was originally intended. It is important that every operator become thoroughly familiar with proper equipment usage not only with regard to the FCC regulations, but also with courtesy and respect for others with whom you must share the channels. In this way, much of the congestion caused by improper, lengthy, and unnecessary transmissions can be reduced to a minimum. This, of course, would benefit everyone.

The station licensee is solely responsible for the proper operation of his equipment. If he allows another person to operate the station, he must still assume full responsibility for their actions. Obtaining the license is relatively easy; however, you can very easily lose your station authorization by operating contrary to FCC regulations. To protect this privilege you should become familiar with, and operate in accordance with the regulations. It is also necessary to review these regulations from time to time to keep abreast of any changes.

IMPROPER OPERATION

Improper station operation can be classified into one of two categories—accidental and willful. Possibly a third category could be added to include those who have not taken the time to learn the rules, or who have been misinformed somewhere along the line. In any event, there is an increasing number of violations occurring in all categories. These violations fall mainly into two groups—off-frequency operation and the use of CB stations for communications contrary to Part 95 of the FCC rules and regulations. There are also many stations which are operating with a higher transmitter power than is legally permitted, and an even greater number that are erecting antenna structures which do not comply with the regulations. Off-frequency operation is often the result of an inexperienced or unqualified person tampering with the transmitter, or it can be caused by defective circuit components. There is also a good possibility that the unit is badly in need of a frequency adjustment. How often the frequency of a transmitter should be checked will depend on a number of factors. Some equipment requires a frequency check every week or so, whereas other units may not need it for months. The best safeguard against off-frequency operation is periodic checks by a qualified person having the proper equipment and skill. Fig. 7-1 shows how a shift in the operating frequency can cause undue interference to other stations. When this condition exists, you may actually be tying up two channels instead of one and will be doing little, if any, good on either.

As far as actual operating practices are concerned, one common misconception is that Citizens radio can be used in the same manner as amateur radio. This has been especially noticeable in the Class-D service. Perhaps the reason is that Class-D frequencies occupy a space formerly allocated to the 11-meter amateur band. Some who desired to become a ham

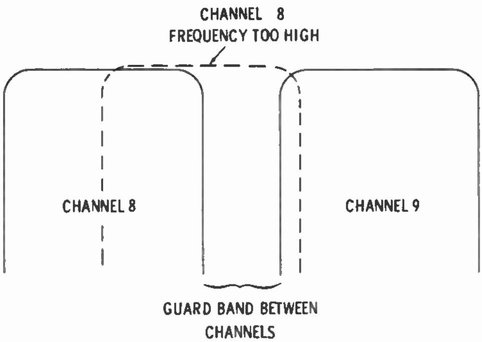


Fig. 7-1. Channel overlapping resulting from off-frequency operation.

operator, but for some reason could not make the grade, have resorted to CB radio, feeling that it can be used in the same manner.

Such practices as calling CQ to establish contacts with unknown stations is also contrary to proper operating practices. This would be permissible only in an emergency where it was imperative that any unit within the area be contacted. In general operation, however, all calls should be directed to the specific station or stations controlled by the licensee. Contacts with those outside this network should be made only by prearrangement or in an emergency. This is done primarily to discourage activities such as DX'ing (attempting to communicate with other stations solely for the purpose of achieving maximum distance), seeing how many contacts can be made with other stations, or to just plain reduce the temptation for casual visiting and "rag chewing" on the air. Another improper operating practice that has become quite a problem is excessive on-the-air testing. This, of course, should be kept to a minimum as it only adds to channel congestion.

Citizens Band radio cannot be used for experimentation or as a hobby, or for any purpose contrary to federal, state, and local laws. Moreover, you cannot use Citizens Band equipment for conveying any type of program material (music, broadcasting, etc.) either directly or indirectly. Also, while it is permissible for the licensee to allow other persons to use the equipment, he cannot charge a fee for this service except under the conditions outlined in the FCC regulations.

The regulations also stipulate who can and cannot make repairs on CB equipment. The licensee, unless possessing a valid first- or second-class radiotelephone operator's license, is not permitted to make any adjustments, repairs, or modifications that could cause improper transmission of RF energy.

Other on-the-air practices that are strictly forbidden include the use of false call letters, and any type of profane or obscene language. The FCC operates a number of monitoring stations 24 hours a day. These stations are manned by engineers who, with the help of the most modern and efficient radio receivers and tracking devices, scan the frequency spectrum for violations committed in all of the radio services. These monitoring stations are very effective in tracking down persons operating equipment contrary to the rules and regulations, and a violation may result in a written citation. A reply to this citation must be made in the manner prescribed in Article 95.113 of the FCC regulations. A continuance of such operation can result in license revocation and loss of all operating privileges. Remember, you have signed a statement that you have a copy of Part 95 and, as in other cases, ignorance of the law is no excuse.

PERMISSIBLE COMMUNICATIONS

Citizens radio is intended to fulfill a definite need. It can be used for a personal convenience, such as establishing a means of communication between your automobile and home, or for practically any legitimate purpose. Applications are practically unlimited; however, transmitters should not be put on the air unless there is something that must be said. CB channels are similar to a telephone party line and must be shared with other stations. Unnecessary transmissions serve only to cause congestion, thereby depriving others of needed channel space. At any rate, transmissions should be made only when necessary, and even then should be limited to the minimum practical time. A radiotelephone code (the "10" signals) used for some time by other radio services has been adopted by many CB operators because it greatly reduces the time required to transmit a message. It is desirable to use these signals to some extent, especially in a business that requires heavy traffic such as dispatching delivery trucks, taxis, etc. The "10" signals are listed in the appendix for your convenience.

STATION REQUIREMENTS

CB stations operating with the equipment as a fixed location must have a current license permanently posted at the key point of control for such operation. Furthermore, a photocopy of this license must be posted at all other fixed locations from which the station is controlled.

The assigned call letters of the CB station must be given at the beginning and end of all transmissions, and at least once every 10 minutes in the case of intercommunication between units of the same station.

The one exception to this rule is during an exchange of sequential transmissions, each less than three minutes in length, in which case the stations need only identify once every ten minutes or at the beginning and end of the exchange instead of at the beginning and end of each transmission. When communications are between Class-D stations of different licensees, the exchange of communications must not exceed five consecutive minutes, and must be followed by a silent period of at least two minutes to provide other stations an opportunity to use the channel.*

Should normal communications be inadequate or be disrupted during an emergency, such as an earthquake, hurricane, flood, or similar disaster, CB equipment in any class can be operated on an emergency basis in compliance with the provisions stated in Article 95.85 governing permissible communications. However, as soon as possible after such emergency operation begins, a notice must be sent to both the FCC in Washington, D.C. and the Engineer-in-Charge of the radio district in which the station is located, stating how the equipment is being used and what type of emergency exists. As soon as normal communicating facilities are restored, such operation must be discontinued and the FCC must be notified of the fact. Discontinuance of special operations may be ordered by the FCC at any time.

These are only a few of the more important station requirements. For a complete rundown, check subpart D of the current CB regulations.

OPERATING PROCEDURE

It is important that every CB'er understand and follow good operating practices. It is very easy to pick up bad operating habits, but it is much harder to break yourself of

*Subject to rule changes now under consideration by the FCC.

them. Therefore, newcomers to the CB ranks must become familiar with the proper operating procedure from the very beginning. Many of the more general do's and don'ts of CB operation have already been covered in previous sections of this chapter; therefore, this discussion will deal with some of the more specific aspects.

Listen First Before Transmitting

One of the first things to remember in operating a CB station is to follow the golden rule; in doing so you will find that courtesy is contagious. Even though CB radio is intended for personal communications, you must share the frequencies with others. Because of the ever-increasing number of stations in this service, there are many areas where the CB channels are quite crowded. For this reason, and because many operators find it necessary (?) to tie up the channels with insignificant small talk, the FCC adopted the 5-minute rule mentioned previously. The 5-minute rule is designed to give everyone a chance to use the channels. FCC regulations also state that you must monitor the frequency to be sure that it is clear before transmitting.

Using The "10" Signals

The "10" signals (listed in the Appendix) provide an easy means of keeping transmissions short. These signals, which have been employed for some time by police departments, fire departments, and many other agencies, can be used to convey a message in approximately half the time it would take otherwise. It is desirable to memorize all of these signals; however, it is not absolutely necessary. About a fourth of them are used in actual practice. A lot depends, of course, on the type of operation involved. If the CB equipment is employed in a fleet of taxi cabs, for example, the "10" signals are used to a much greater extent than in a case where two-way communications are between your car and home.

Let's see now exactly how the "10" signals are used. Without signals the message might go something like this:

Station A: "KHA 1226 unit 1 calling unit 2."
Station B: "This is KHA 1226 unit 2, over."
Station A: "Where are you located now, Bob? over."
Station B: "I'm at the corner of 10th and Elm street, over."
Station A: "Come on back to the shop, I've got some parts for you to deliver, over."

Station B: "I can't right now, I'm busy changing a flat tire on the truck."
Station A: "OK, finish that job as quick as possible and then scoot right on over here, over."
Station B: "All right, I'll be there just as soon as I'm finished. KHA 1226 unit 2, clear."
Station A: "This is KHA 1226 unit 1 clear."

Now using the "10" signals the message would go something like this:

Station A: "KHA 1226 unit 1 to unit 2."
Station B: "This is KHA 1226 unit 2, over."
Station A: "10-20."
Station B: "10th and Elm Streets."
Station A. "10-19."
Station B: "Negative, 10-6."
Station A: "10-4, 10-19 as soon as possible."
Station B: "10-4, KHA 1226 unit 2, clear."
Station A: "KHA 1226 unit 1, clear."

As you can see, the same basic information was conveyed in both instances, but notice how much simpler it was when the "10" signals were used.

Quite often CB operators will defeat the purpose of this system by adding superfluous words to the signals. For example, you will hear someone say, "what is your 10-20." They might as well go ahead and substitute the word location for 10-20 and not even use the signal; 10-20 means "what is your location." This makes as much sense as asking "what is your what is your location." You will also hear such things as, "OK, Bob, I'm 10-4 on that address you gave me, over," when actually the only acknowledgement needed was "10-4." Practices such as these are generally the result of the operator not knowing the exact meaning of the signals, or it might be that he has patterned his operating procedure from others on the band. Just because something finds common usage does not necessarily make it correct.

Distress Communications

It might be appropriate at this time to discuss the usage of the word MAYDAY. As you probably already know, MAYDAY is the international radiotelephone equivalent of the SOS distress signal. Only under the most dire emergency should the MAYDAY signal be used. In fact, the only time you can legally call "MAYDAY" is when you personally are in serious danger. You cannot use it when the danger is to someone other than yourself. Strict penalties can be imposed in cases where MAYDAY is called and no real emergency exists. Fines for this range from $100 to $10,000, depending on the seriousness of the offense, and/or two years imprisonment.

Emergency communications have priority over all other transmissions. On hearing a MAYDAY call or any other communication which indicates that an emergency exists, you must immediately clear the channel. If there is no immediate reply to the station calling for help, it is your duty to answer the call. In doing so you actually become part of the distress traffic and have the same legal privileges as the MAYDAY station.

CB CLUBS, ORGANIZATIONS, AND AWARDS

In order to promote CB radio and encourage good operating practices, thousands of clubs have been organized throughout the country. Officers are elected for each club, and group activities are planned. These activities include a variety of interesting and worthwhile projects.

Some of the activities at CB club meetings include technical lectures for those who desire to know more about their radio equipment, movies on a variety of pertinent subjects, and demonstrations of new CB products. Coffee and doughnuts are as much a part of these gatherings as hot dogs are at a baseball game.

In warm weather most CB clubs take to the out-of-doors by planning picnics, cross-country motorcades, and similar activities. In addition to the thousands of local clubs, there are also many state and national organizations that are devoted to the progress of Citizens Band radio. Awards are given for outstanding accomplishments in civil defense, for contributions to CB radio and the community, and for unusual services rendered to others through the medium of CB radio. There are many kinds of awards and they are presented on local, state, and national levels.

Organizing a CB Club

Practically anyone can organize a club, but to be able to hold it together and make it productive is something else. A club can easily be made successful by following a few simple rules. First of all, elect officers who are respected, capable, and willing to devote a considerable amount of time to club activities. Adopt a program that will appeal to everyone, and above all enroll as many members into the club as possible. If dues are collected, as is usually the case, the more members you have the more money there will be to finance club projects.

Arrange to hold the club meetings at a time that will be convenient for the majority. Since it is impossible to please everyone in this respect, it may be necessary to compromise. Avoid holding the meetings too often since many families object to the bread winner being tied down. By the same token, do not hold the meetings so infrequently that members lose interest. Most clubs hold regular meetings either once or twice a month and have provision in their bylaws for calling special meetings from time to time as the need arises.

Plan the meetings ahead. Give the club members something to look forward to by telling them in advance what is on the agenda for the next meeting—for example, a talk on some interesting technical subject, demonstration of a new piece of gear, or possibly even a tour through some electronics firm, commercial radio station, or other place of interest. You might even consider setting up group construction projects or have certain nights set aside for helping newcomers and other inexperienced persons to construct, repair, or install their CB equipment. If someone in the club is properly qualified to make equipment adjustments and has the test instruments required for the job, you might even set aside an evening now and then which will be devoted entirely to tuning up the club members equipment. Other activities which promote interest in the club include Christmas or New Year parties (at club expense, of course), picnics, equipment swaps, etc. These are just a few of the ideas for building a good CB club. Actually, the type of activities you plan is limited only by your imagination.

CHAPTER 8

SERVICING ASPECTS

Any type of radio equipment, no matter how simple or complex, is subject to breakdown from time to time, and Citizens Band equipment is no exception. Most of the time the repairs are quite simple, involving nothing more than replacing a vacuum tube, fuse, or vibrator. Or, perhaps the cause of the trouble is not in the radio equipment itself but instead some minor fault, such as a broken wire or poor connection. However, in some instances circuit defects, especially those which are intermittent in nature, can be very difficult to track down and require the troubleshooting techniques of a specialist.

WHO CAN SERVICE CB RADIO?

Not just anyone can service two-way radio equipment. According to the FCC regulations, any transmitter tests or adjustments which can cause improper (illegal) operation must be made by or under the *direct* supervision of a person holding either a first- or second-class commercial radio license appropriate for the type of emission being used. In the case of Class-D equipment this would mean a commercial radiotelephone license. Obviously, before an unlicensed person can perform any type of tests, repairs, or adjustments, he must first know what changes can affect proper operation. This is one place where the old saying, "a little bit of knowledge is a dangerous thing," holds true.

Notice that the regulations state "by or under the direct supervision of a properly licensed person." This means that such tests and adjustments can be made by anyone, as long as he is supervised by a person with the proper license. The licensed person is then held responsible for the proper functioning of the station equipment after such tests, repairs, or adjustments have been completed.

At first it would appear that this regulation would limit the construction of CB kits and it does to a certain extent. However, certain exceptions to this rule make it possible for an unlicensed person to construct, install, and service certain commercially manufactured Class-C and -D equipment. For example, no commercial radiotelephone license is required to construct a kit or to install and maintain other commercial equipment in which the frequency-determining elements of the transmitter (including the crystal) and all other component in the crystal-oscillator circuit have been preassembled, pretuned, and sealed at the factory. Replacement or adjustment of any components which might cause off-frequency operation cannot be made without first breaking the seal.

If just anyone were permitted to service and adjust this type of two-way radio, imagine the chaos that would result on the CB bands (and for that matter on many of the commercial bands as well) due to off-frequency operation, spurious radiations on unrelated frequencies, overmodulation, and so on. Even though a person has the ability to repair and adjust CB equipment *properly*, he must have an appropriate commercial license before he can perform this service *legally*.

Repairs An Unlicensed Person Can Make

A person who does not hold a commercial radiotelephone license is still not completely restricted from working on CB equipment. There are quite a few repairs that can be made without affecting the legal operation of the two-way radio equipment, but you must be able to recognize them. If you are not sure what can and cannot cause improper operation, it is best to adapt a "hands off" policy altogether and leave the servicing to a qualified technician.

Generally, you can make minor repairs, such as replacing tubes, vibrators, fuses, and even the majority of components such as resistors, capacitors, and coils, in the receiver circuit; however, in transceivers be extra sure about any repairs made in those circuits of the receiver which are common to the transmitter. In some instances an unlicensed person should not even attempt to replace certain tubes in a transceiver. One example of this would be in some of the Class-B UHF equipment which is not crystal controlled. Here, replacing an oscillator tube without retuning the circuit will often cause off-frequency operation. Even in the crystal-controlled Class-D transceivers replacing an oscillator or final RF-amplifier tube often necessitates touch-up tuning adjustments which cannot legally be performed except by a person holding the proper commercial license.

TEST EQUIPMENT FOR CB SERVICING

The amount and type of test instruments required to service CB equipment will depend largely on the volume of service work and the class of CB units to be serviced. Assuming you are properly licensed to work on two-way radio, you will need, among other things, a wattmeter for checking the RF power output of transmitters, some type of field-strength meter, a dummy load to replace the antenna while tests and repairs are being made, and an accurate signal generator

Fig. 8-1. A typical 6/12-volt filtered DC power supply.

(preferably crystal-controlled and with a calibrated attenuator) for checking receiver sensitivity and troubleshooting. Other instruments which are helpful in maintaining CB equipment include a frequency meter, a grid-dip oscillator, and some type of instrument for checking the percentage of modulation of the transmitter.

The average VTVM (vacuum-tube voltmeter) or a VOM (volt-ohm-milliameter) with a sensitivity of at least 20,000 ohms per volt will also be helpful for general troubleshooting purposes. Although it is best to check tubes by the substitution method, a tube tester is often helpful in confirming your suspicions. A mutual conductance tube tester is preferable but a dynamic- or emission-type checker will suffice for general purposes. You will need some kind of CB antenna (an omnidirectional ground plane will do) for making a final check of equipment operation on the bench, and it will be necessary to provide a primary source of DC power for operating DC and AC/DC transceivers. (The majority of Class-D Citizens Band units have a two-way power supply which will operate from either AC or DC.) An automobile storage battery can be used to supply DC; however, with this arrangement it will also be necessary to provide a battery charger. Better still is one of the commercial 6/12 volt filtered DC supplies such as the one shown in Fig. 8-1. This supply is capable of delivering 10 amperes continuous current and 20 amperes intermittent current. In addition, this unit has provisions for varying the 6- and 12-volt output above and below these values.

The wattmeter can be any one of several types. Some meters indicate the exact output of the transmitter in watts, while others provide a relative indication of the output power. The Knight-Kit Model P-2 shown in Fig. 8-2 is an example of the relative indication type. However, in addition to reading the relative output power of the transmitter, it also indicates the SWR (standing wave ratio) of the signal being delivered to the antenna.

There are two basic kinds of wattmeter. One is an in-line type and the second is known as a terminating wattmeter. Before describing these meters it should be pointed out that when checking transmitter operation, the RF output should be fed to a dummy load rather than the antenna whenever possible. This, of course, prevents undue interference to other stations operating on the same channel. There will be

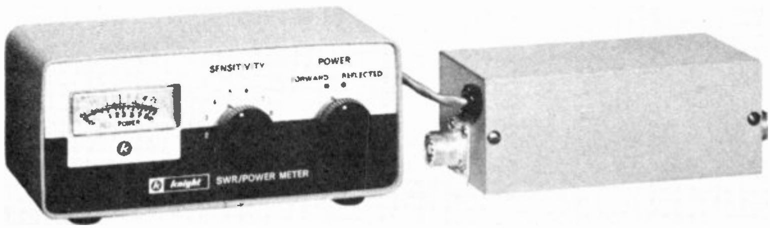
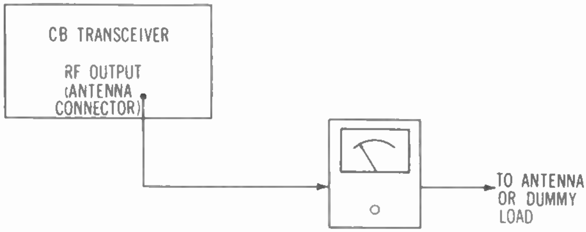


Fig. 8-2. This instrument, the Knight-Kit P-2, reads relative RF power output and SWR.

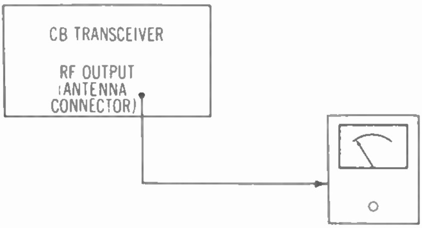
cases, however, where the signal must be fed to the antenna for testing purposes but "on-the-air" testing should be kept at a minimum. The in-line wattmeter as its name implies, is connected in series with the transmission line between the transmitter output connector and the antenna (Fig. 8-3A). The Knight-Kit unit shown in the photo of Fig. 8-2 is one of the in-line types. If the antenna is not going to be connected into the circuit, the wattmeter must be terminated with some type of dummy load or the final amplifier tube may be damaged by excessive current. Futhermore, the dummy load, or dummy antenna as it is sometimes called, must also have the correct impedance (usually 50 to 52 ohms) before the transmitter will load into it properly. You can use a commercial dummy load, such as the one shown in Fig. 8-4, or you can build one yourself by using a construction similar to that shown in Fig. 8-5. A coaxial connector, cable adaptor, and a No. 47 pilot lamp were employed to construct this unit.

The terminating-type wattmeter connects directly to the RF- output connector of the transmitter (Fig. 8-3B), and as its name implies, the meter itself serves as the terminating load for the transmitter. Either type of wattmeter can be used; however, the series (in-line) unit does provide greater versatility.

A RF field-strength meter can also be a useful tool in servicing CB radio equipment. It does not have to be too elaborate, but it should be fairly sensitive. This type of meter provides a quick way of checking to determine whether or not a transmitter is radiating RF energy and approximately



(A) Series type.



(B) Terminating type.

Fig. 8-3. Method of connecting wattmeter to read RF output.

how much. The meter does not have to be connected to the transmitter; instead, the signal from the transmitter is induced in a small antenna on the unit. The signal is then rectified and fed to the meter itself to provide a relative indication of the strength of the incoming signal. One example of an inexpensive field-strength meter is shown in Fig. 8-6.

Fig. 8-4. A typical 50-ohm commercial dummy load.

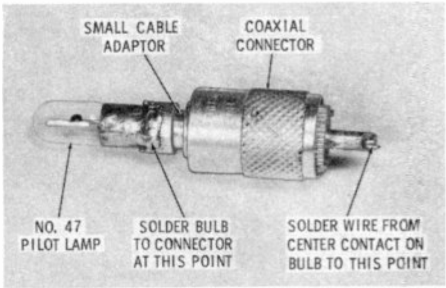


Fig. 8-5. A homemade dummy load using a coaxial connector and a No. 47 pilot lamp.

When circuit alignment becomes necessary, as it will in any radio equipment of this type, a stable signal generator (preferably crystal calibrated) is required. It should be able to cover all RF and IF ranges from 150 kc to 30 mc, be capable of delivering a signal of less than 1 microvolt, and have provision for signal modulation. The signal generator can also be used to locate defective stages.

A UHF signal generator will be required if Class-A or -B equipment is to be aligned.

Another instrument used quite extensively in CB servicing and alignment is the frequency meter. Several instruments are available for this purpose; the accuracy of the type chosen will depend primarily on the class of CB gear to be checked. Class-D transmitters are permitted a frequency tolerance of .005%. This means that a Class-D station operating on the

Fig. 8-6. The Monarch Model FSL-1 field-strength meter.

Fig. 8-7. The Seco Model 500 test set can be used for checking crystals; it also provides an RF test signal for other types of troubleshooting.

Fig. 8-8. The Eico Model 715 CB transmitter tester for checking modulation and RF power output of a transmitter.

frequency of 27.005 mc cannot deviate more than ±1,350 cycles per second. In other words, if the frequency checks between 27.00365 and 27.00635, it's still within the legal limit, although this is cutting the line pretty close. A frequency meter used to check Class-D equipment should be accurate within at least .0025%. One instrument commonly

Fig. 8-9. The Seco Model 520A antenna tester.

used for this purpose is the heterodyne frequency meter. With this device a signal from a built-in tunable oscillator is heterodyned with the transmitter signal to obtain the measurement. Another commonly used meter indicates the difference between the frequency of the transmitter and a crystal-controlled reference frequency within the instrument itself.

In addition to the afore-mentioned test equipment are several other instruments which are invaluable for servicing CB equipment. In Fig. 8-7 you see illustrated, the Seco Model 500 test unit. This instrument is used to check crystals and also provides an RF signal which can be used for troubleshooting purposes. For checking modulation and transmitter RF output, an instrument such as that shown in Fig. 8-8 can be employed. This self-powered unit is also used to check antennas and transmission lines, and it has provision for monitoring audio. A third instrument in this series is the Seco Model 520A antenna tester shown in Fig. 8-9. This unit reads forward and reflected power in watts and is also calibrated to read SWR. It has another scale which indicates the efficiency of the antenna system as a percentage. An instrument such as this will also indicate antenna defects such as broken elements, shorted or broken transmission cable, etc.

The Knight-Kit Model Ten-2 CB Checker (Fig. 8-10) is a new and versatile piece of test equipment. Allied lists these ten functions: measures antenna efficiency by relative standing wave ratio (SWR) ; measures output power, percentage of positive modulation, percentage of negative modulation, field

Fig. 8-10. Knight-Kit Ten-2 CB Checker.

strength and relative crystal activity; may be used as signal monitor, crystal controlled RF generator, audio generator, and code-practice oscillator.

HINTS ON SERVICING

Before a defective transceiver is removed from a permanent installation, a check of all logical trouble possibilities may save some time. A disconnected power cord, a blown fuse, or possibly even a defective power cord or power receptacle could be the reason. Some units are equipped with a pilot light that indicates when power is applied. This can be helpful in determining whether supply voltage is present. Visual inspection of fuses is often deceptive, since a hairline break in the element may not be detected with the naked eye. Fuses should either be checked with an ohmmeter, or a new one substituted. A hairline break is not always a sign of trouble in the radio equipment; it often is caused by execssive voltage surges. Repeated fuse failures of this type, not traceable to the CB equipment itself, may be due to trouble in the car electrical system—possibly a misadjusted voltage regulator.

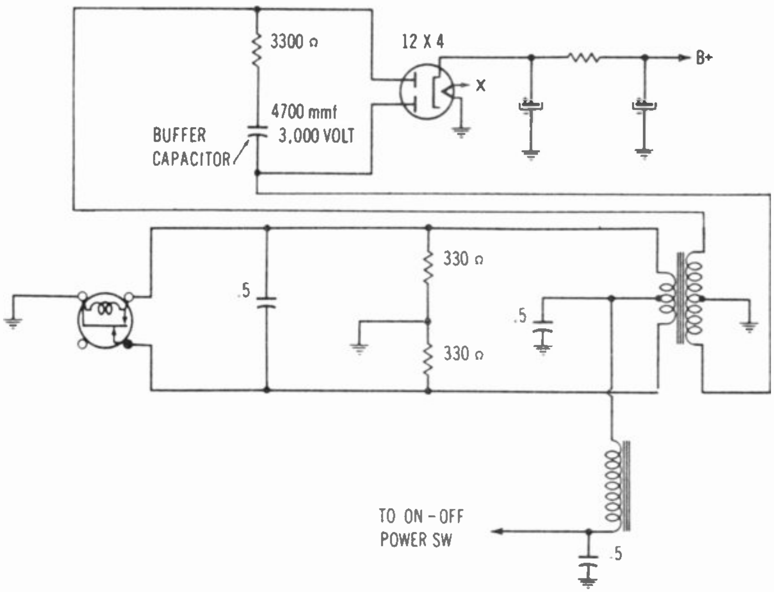


Fig. 8-11. Typical vibrator power supply showing location of buffer capacitor.

This is further evidenced by frequent burnout of tube filaments and various lights throughout the car.

If the fuse is found to be good, but the equipment still does not receive power, check the *A* lead and the connection to the source voltage. Also, make certain that the equipment is grounded properly. Only after all possibilities of this type have been checked should the transceiver be removed from its mounting. Even then, it is best to try to repair it on the spot, where its antenna and source voltage are available. In this way, repairs and adjustments can be checked under actual working conditions. Some repairs, of course, are impractical to handle in the field, in which case the unit should be removed and taken to the shop.

After removing the equipment, determine which section is defective—the transmitter, receiver, or power supply. It's unlikely that all three will become defective at one time, although a common receiver-transmitter stage may develop trouble and impair the operation of these two sections. Furthermore, since the power supply is common to all stages, a defect in it can affect the operation of all three sections. When a fuse blows, it is usually an indication that excessive current is being drawn by the equipment. If a universal supply is employed and the unit operates normally on AC or DC, but not both, a power-supply defect is indicated. However, should the fuse blow on both types of operation, the trouble is probably within the transmitter or receiver circuits.

Assuming that the trouble occurs during the DC operation, check such components as the rectifier tube, vibrator, and buffer capacitor(s). Other than tubes, a defective buffer capacitor is one of the most common vibrator power-supply troubles—second only to the vibrator itself. If the buffer(s) check out alright, remove the vibrator and replace it with one known to be good. It is best to check the buffer capacitor first because a defective buffer can cause the vibrator to be damaged very easily. Fig. 8-11 shows the location of the buffer in the power-supply circuit.

Sometimes both the vibrator and the buffer are bad. It is a good habit to always replace the buffer when a new vibrator is installed. In fact, many manufacturers will not guarantee their vibrators unless the buffer is checked first.

The majority of equipment malfunctions are due to tube defects. Open filaments can often be spotted by a quick visual inspection. Other tube defects can be readily located by direct substitution (the preferred method) and can usually be confirmed by a tube tester. Some CB equipment will not work efficiently if one or more tubes fall even slightly on the weak side. Therefore it is necessary to replace tubes that would ordinarily give much longer services in other types of equipment.

If the trouble is something other than tubes, a close visual examination of the circuit components can be quite helpful. Often a charred or cracked resistor, or a blackened wire or burned spot on the chassis, will immediately indicate the faulty part. Don't just replace a burned component; check further to determine why it was burned. Your sense of smell can also be of help, since most parts give off a rather unpleasant odor when they become overheated. Moreover, placing the tip of your finger on the body of a large wirewound resistor, which ordinarily should get very warm, will sometimes reveal an open resistor.

Special Considerations

A number of CB transceivers use printed circuitry. Fig. 8-12 shows an example of a printed board. The wiring pattern, which is a flat metal foil conductor, is imprinted or etched on the board and is sometimes covered with an epoxy

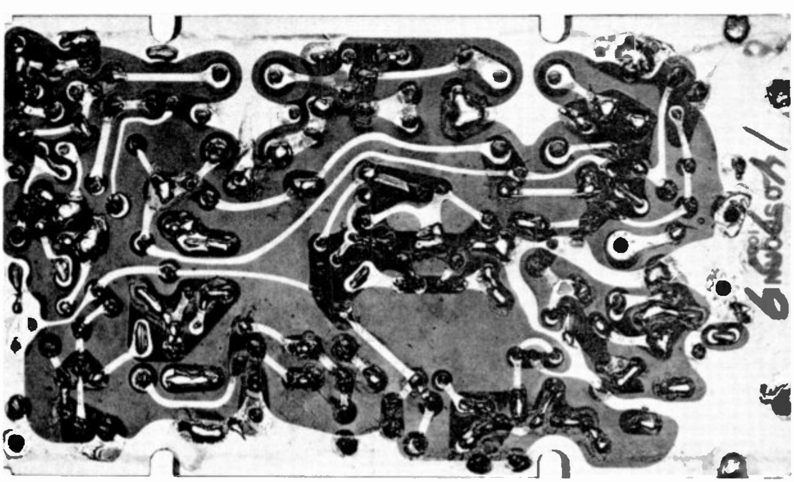


Fig. 8-12. A typical printed-circuit board.

resin coating to prevent dust and moisture from affecting operation. The circuit components, which may be located on either side of the board, are connected to the printed wiring through holes in the board. Special care must be exercised when servicing equipment using this type of construction. Occasionally one of the conductors will break due to physical strain, warpage, etc. Often this will be nothing more than a hairline break, although it can be sufficient to disable the entire transceiver. The break can usually be spotted by placing a light on the underside (opposite the wiring side) of the board.

When checking a printed-circuit board, it is best to use a test prod with a sharp point to pierce the epoxy resin coating over the printed wiring. Tests should be made at soldered junctions rather than by punching holes at just any point along the delicate conductors. Also, when replacing components in a printed circuit, special soldering techniques must be used to prevent damaging the board. Use a low-wattage iron or gun, since the bond between the printed wiring and the board can be broken by excessive heat. Also, avoid using too much solder on a connection; it could result in a short between conductors.

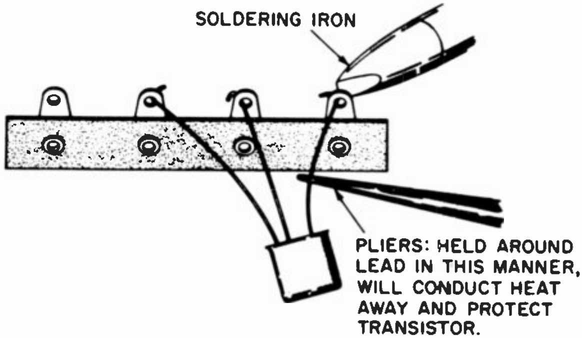


Fig. 8-13. Method of using long-nose pliers as heat sink to prevent damaging transistor when soldering the leads.

Transistors, like printed circuits, require special considerations when being tested and replaced. Excessive heat at the leads when soldering one into a circuit, can easily cause damage. Therefore always grasp the lead being soldered with a pair of long-nose pliers, between the transistor and the soldering iron, as shown in Fig. 8-13. The pliers will act as a heat sink and prevent possible damage. Plug-in transistors should be removed from their sockets before heat is applied to the socket terminals. Also, always remember to use a low-wattage soldering iron in transistor circuits.

Another reminder concerning repairs in transistorized equipment—if a VOM or VTVM is used to check transistors, make sure the internal ohmmeter voltage supplied to the test leads does not exceed the rated value of the transistors and other components. Also, avoid indiscriminately grounding various terminals throughout the circuit—be certain of your test points.

APPENDIX A

FCC FIELD OFFICES

Mailing addresses for Commission Field Offices are listed below. Street addresses can be found in local directories under "United States Government."

Field Engineering Offices

Address all communications to Engineer in Charge, FCC

Alabama, Mobile 36602
Alaska, Anchorage (P.O. Box 644) 99501
California, Los Angeles 90014
California, San Diego 92101
California, San Francisco 94126
California, San Pedro 90731
Colorado, Denver 80202
District of Columbia, Washington 20555
Florida, Miami (P.O. Box 150) 33101
Florida, Tampa 33606
Georgia, Atlanta 30303
Georgia, Savannah (P.O. Box 77) 31402
Hawaii, Honolulu 96808
Illinois, Chicago 60604
Louisiana, New Orleans 70130
Maryland, Baltimore 21202
Massachusetts, Boston 02109
Michigan, Detroit 48226
Minnesota, St. Paul 44102
Missouri, Kansas City 64106
New York, Buffalo 14203
New York, New York 10014
Oregon, Portland 97205
Pennsylvania, Philadelphia 19106
Puerto Rico, San Juan (P.O. Box 2987) 00903
Texas, Beaumont (P.O. Box 1527) 77704
Texas, Dallas 75202
Texas, Houston 77002
Virginia, Norfolk 23510
Washington, Seattle 98104

Common Carrier Field Offices

Address all communications to Chief, Common Carrier Field Office, FCC

California, San Francisco 94105
Missouri, St. Louis 62101
New York, New York 10007

APPENDIX B

THE "10" SIGNALS

Code No.	Meaning
10-1	Receiving Poorly
10-2	Receiving Well
10-3	Stop Transmitting
10-4	OK, Message Received
10-5	Relay Message
10-6	Busy, Stand By
10-7	Out Of Service, Leaving Air
10-8	In Service, Subject To Call
10-9	Repeat Message
10-10	Transmission Completed, Standing By
10-11	Talking Too Rapidly
10-12	Visitors Present
10-13	Advise Weather/Road Conditions
10-16	Make Pickup At ....
10-17	Urgent Business
10-18	Anything For Us?
10-19	Nothing For You, Return To Base
10-20	My Location Is ....
10-21	Call By Telephone
10-22	Report In Person To ....
10-23	Stand By
10-24	Completed Last Assignment
10-25	Can You Contact ....?
10-26	Disregard Last Information
10-27	I Am Moving To Channel ..
10-28	Identify Your Station
10-29	Time Is Up For Contact
10-30	Does Not Conform To FCC Rules
10-32	I Will Give You A Radio Check
10-33	EMERGENCY TRAFFIC AT THIS STATION
10-34	Trouble At This Station, Help Needed
10-35	Confidential Information
10-36	Correct Time Is ....
10-37	Wrecker Needed At ....
10-38	Ambulance Needed At ....

Code No.	Meaning
10-39	Your Message Delivered
10-41	Please Tune To Channel ....
10-42	Traffic Accident At ....
10-43	Traffic Tieup At ....
10-44	I Have A Message For You (or ....
10-45	All Units Within Range Please Report
10-50	Break Channel ....
10-60	What Is Next Message Number?
10-62	Unable To Copy, Use Phone
10-63	Net Directed To ....
10-64	Net Clear
10-65	Awaiting Your Next Message/Assignment
10-67	All Units Comply
10-70	Fire At ....
10-71	Proceed With Transmission In Sequence
10-73	Speed Trap At ....
10-75	You Are Causing Interference
10-77	Negative Contact
10-81	Reserve Hotel Room For....
10-82	Reserve Room For ....
10-84	My Telephone Number Is ..
10-85	My Address Is ....
10-89	Radio Repairman Needed At ....
10-90	I Have TVI
10-91	Talk Closer To Mike
10-92	Your Transmitter Is Out Of Adjustment
10-93	Check My Frequency On This Channel
10-94	Please Give Me A Long Count
10-95	Transmit Dead Carrier For 5 Seconds
10-99	Mission Completed, All Units Secure
10-200	Police Needed At ....

Note: Any 10-code signal may be reversed by stating it as a question. For example, **10-20?** would mean "What Is Your Location?" or **10-36?** "What Is The Correct Time?"

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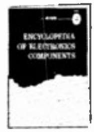

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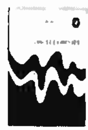

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