

150-MEGAHERTZ BELLBOY®
PERSONAL RADIO SERVICES
EQUIPMENT DESIGN REQUIREMENTS
RADIO SYSTEM

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each carrying a pocket receiver. A maximum of 20 radio transmitters can be provided in the system and all transmitters are controlled simultaneously by the J1 control terminal equipment.

Ranges of Equipment

1.03 The dc range from the control terminal to a transmitter is 10,000 ohms of loop resistance using a ± 130 volt signal battery. The ac range or maximum transmission loss is 13 dB. Delay equalization is used in all trunks of multitransmitter systems. The purpose of the equalization is to maintain the difference in delay among any of the trunks to less than 110 microseconds.

1.04 Path losses encountered in the transmission of 150-MHz signals to pocket-carried receivers located in buildings are greater than those encountered in mobile radio transmissions. Signal attenuation within buildings, together with an inefficient pocket receiver antenna, dictates the need for simultaneous transmission of BELLBOY calls over multiple transmitters. This arrangement ensures reliable coverage over the BELLBOY service area.

1. GENERAL

Scope

1.01 This specification, together with the supplementary information listed herein, covers the equipment design requirements for the manufacture and installation of radio transmitters and receivers of the 150-MHz BELLBOY® Personal Signaling System. Section 806-140-153 contains the equipment design requirements for the J1 control terminal equipment and is used together with this section by the equipment engineer so that the equipment can be provided for a complete BELLBOY system.

Capacity

1.02 The BELLBOY personal signaling system will serve a maximum of 3200 subscribers,

1.05 The coverage, inside buildings, from a single transmitter with a given power output depends primarily upon radio-propagation conditions in the surrounding area, the types of buildings or other obstacles in the radio transmission path, and the elevation of the transmitting antenna. The range of this coverage varies from about one mile for a low antenna in a congested business urban area to about five miles for a high antenna in a suburban residential area. The range from a single transmitter to a BELLBOY receiver located outdoors is two to four times greater than for a receiver located indoors. However, since BELLBOY service is intended to cover both indoor and outdoor areas, transmitter locations are laid out on the basis of indoor coverage.

Description

1.06 The 150-MHz BELLBOY personal signaling system provides subscriber dialed one-way signaling service to persons on the move. These, in general, are persons who want continuous communication contacts such as doctors, businessmen, salesmen, etc. The system consists principally of a central office J1 control terminal, from 1 to 20 radio transmitters as required for adequate coverage in a service area, and a number of pocket-carried FM receivers.

1.07 The radio equipment of the system consists of from 1 to 20 KS-20429 FM radio transmitters, which operate in the 150- to 160-MHz range, and pocket-sized KS-20432 FM radio receivers carried by each subscriber. Each receiver is tuned to respond to a distinctive code assigned to the subscriber. Telephone wire-line facilities are used to connect the J1 control terminal to the transmitters.

1.08 The J1 control terminal contains the switching equipment for the personal signaling system. The terminal can be connected to any central office or switchboard that output pulses. This switching equipment functions to receive, register, check, store, and translate dial pulses and to control the operation of the radio transmitters in the system. The J1 control terminal equipment is contained in four, five, or six bays depending upon the number of subscribers to be served. A minimum of four bays of equipment is always required for the initial installation of a system. The four bays will serve up to a maximum of 1200 subscribers. The addition of one supplemental bay increases the capacity of the system to 2400 subscribers and the addition of a second supplemental bay increases the number of subscribers which can be served to a maximum of 3200.

1.09 A person wishing to contact a BELLBOY subscriber located somewhere within the coverage area of the system dials a seven-digit number, for example, BB5-2348. The call is routed through the local office or the local and tandem office resulting in the last four digits being dial pulsed into the J1 control terminal (refer to Fig. 1). The control terminal receives, stores, and translates the four digits into coded signals in the form of three tones ranging from approximately 500 to 1000 Hz. These tone codes are then transmitted over wire-line facilities to modulate one or more radio transmitters which operate on 152.840 or

158.100 MHz. The tone codes are sent three times, at 30 second intervals, for increased system reliability. The frequency-modulated signals, radiated from the transmitters, are received by the BELLBOY radio pager (FM receiver) and are then demodulated. Each receiver contains three tuned-reed coding elements capable of responding to only one distinctive 3-tone code. When the proper 3-tone code is received, an audio oscillator is triggered in the receiver and an alerting tone informs the subscriber that he is being called. The BELLBOY subscriber then calls some prearranged telephone number to obtain his message.

1.10 To prevent BELLBOY customers from being signaled by any but their own home system, a nationwide numbering plan is used. This plan changes the relationship between the subscribers' numbers and the signaling tones. Initially, provisions will be made for eight such numbering plans (A through H), which will be administered by the AT&T Company.

Radio Equipment**50- to 150-Watt Transmitter**

1.11 The KS-20429, L1 through L3 base station transmitters are enclosed in a cabinet measuring 60 inches high, 23-3/4 inches wide and 25-1/2 inches deep and are intended for indoor use. The KS-20429, L4 through L6 base station transmitters are enclosed in a cabinet measuring 65 inches high, 23-3/4 inches wide and 26 inches deep and are intended for outdoor use. All transmitters (L1 through L6) weigh approximately 390 lbs.

1.12 The transmitters operate on 152.84 or 158.10 MHz with the output power adjustable from 50 to 150 watts. The operating frequency is determined by a precision crystal-controlled oscillator with a frequency accuracy of one part per million or ± 150 Hz over a one year period. The transmitter mounted in the cabinet (Fig. 2) is composed of a meter panel, a power amplifier, a local operations panel (LOP), an exciter-driver, a high stability oscillator, trunk terminating unit (TTU), main power supply, and an audio and power line junction box. In addition, two optional add-to-isolator kits (L7 and L8) which mount at the rear of the cabinet (Fig. 3) are available. The isolators may be required to reduce interfering effects of other

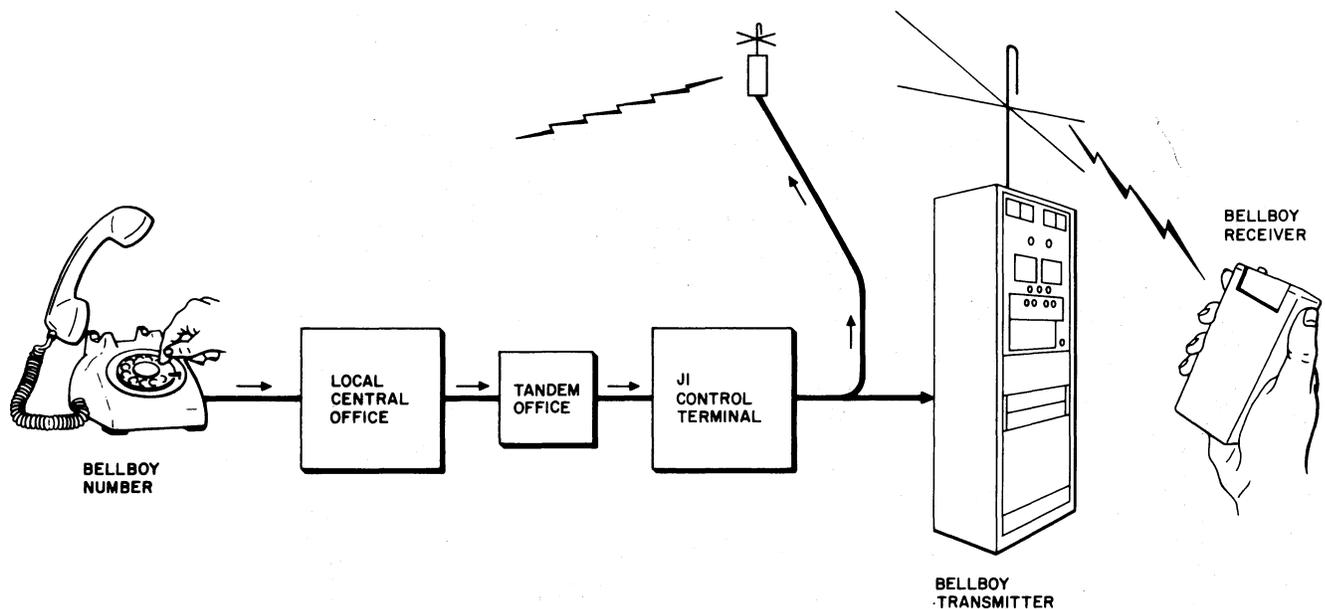


Fig. 1—BELLBOY Call Routing

transmitters which may be operating close to the BELLBOY frequency.

1.13 The transmitter employs a high-stability oscillator, exciter-driver, and power amplifier to process a carrier signal. The RF signal path begins at the high-stability oscillator (Fig. 4) where the output is 12.5 to 13.5 MHz. This signal is connected to the exciter-driver where it is multiplied 12 times in frequency, modulated by the audio from the local operations panel, and then amplified to produce an rf output of approximately 10 watts at output frequencies in the range of 150.0 to 160.0 MHz. The exciter-driver output is connected to the power amplifier which increases the rf output of the exciter-driver to the rated power output of the transmitter. The power amplifier produces up to 150 watts of rf output power. The output of the power amplifier is connected to harmonic filter No. 1. When no isolators are used, the output of harmonic filter No. 1 is connected to harmonic filter No. 2 via the directional coupler. These two filters are low pass filters that pass the fundamental carrier frequency and reject harmonics. Each filter is capable of rejecting the second harmonic frequency by 70 dB. The directional coupler provides dc outputs for operating the rf on-the-air indicator and the forward and reverse wattmeter. Harmonic filter No. 1 contains a power sampler. The output of this power sampler is connected to an RF TEST

jack on the meter panel and provides convenient access for various pieces of external test equipment.

1.14 The transmitter is completely transistorized except for the tripler, the output of the exciter-driver, and the power amplifier output stages. All operating voltages for the transmitter are supplied by three separate power supply chassis. These are the high-stability oscillator power supply, the exciter-driver power supply, and the main power supply.

1.15 A meter panel is provided for checking and aligning the transmitter. It contains four meters, three indicating lamps, and a receptacle for sampling the rf output signal. Switches on the power amplifier, local operations panel, and exciter-driver select the specific voltage or current to be measured. The rf output, plate voltage and current, and control grid voltage of the power amplifier are measured continuously when the transmitter is keyed in the local mode. When the transmitter is in the remote mode, the meters are deactivated.

1.16 The POWER OUTPUT meter indicates the rf output of the transmitter. A directional coupler and the FWD/REV switch on the meter panel provide for measurement of either forward or reverse power output.

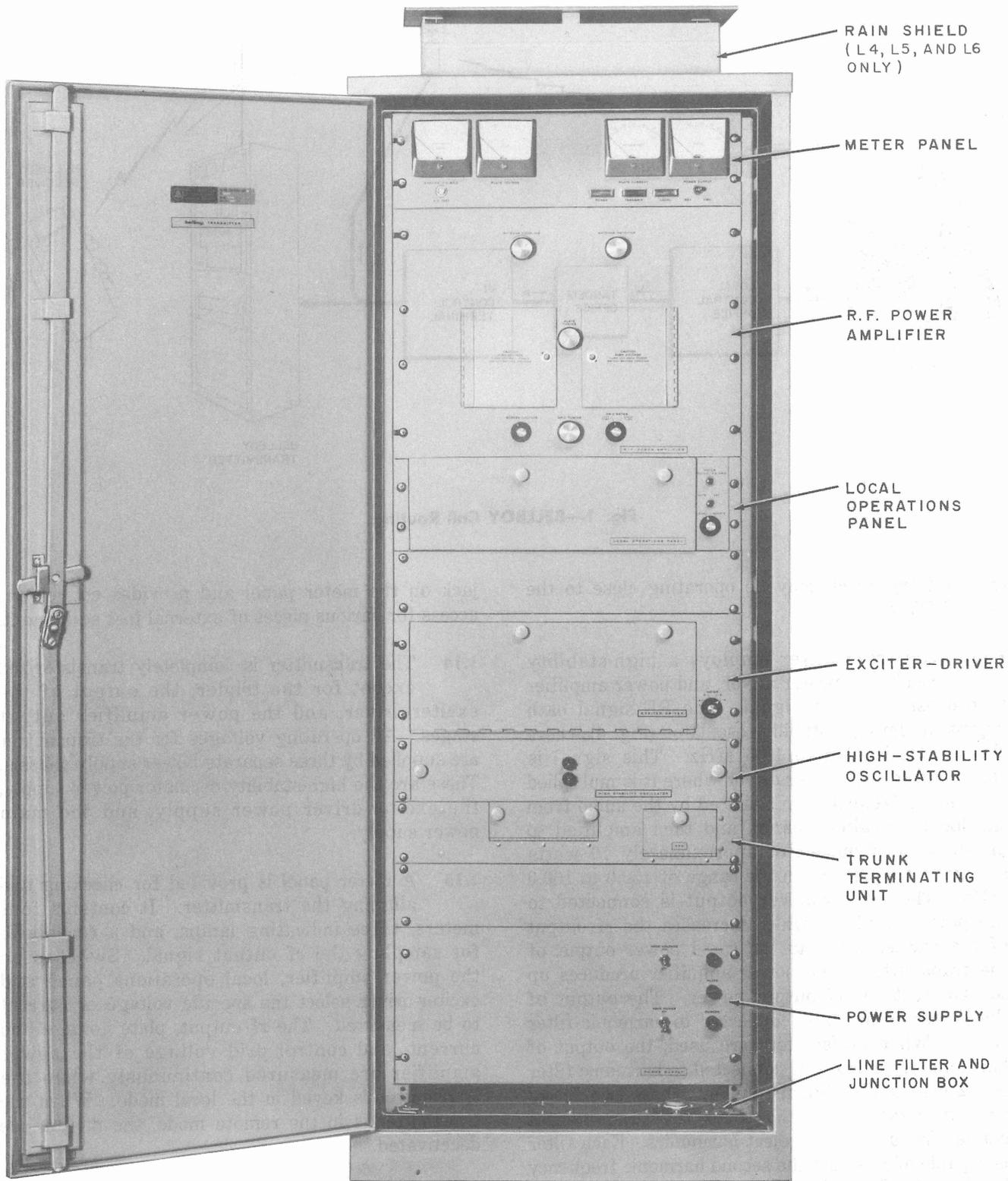
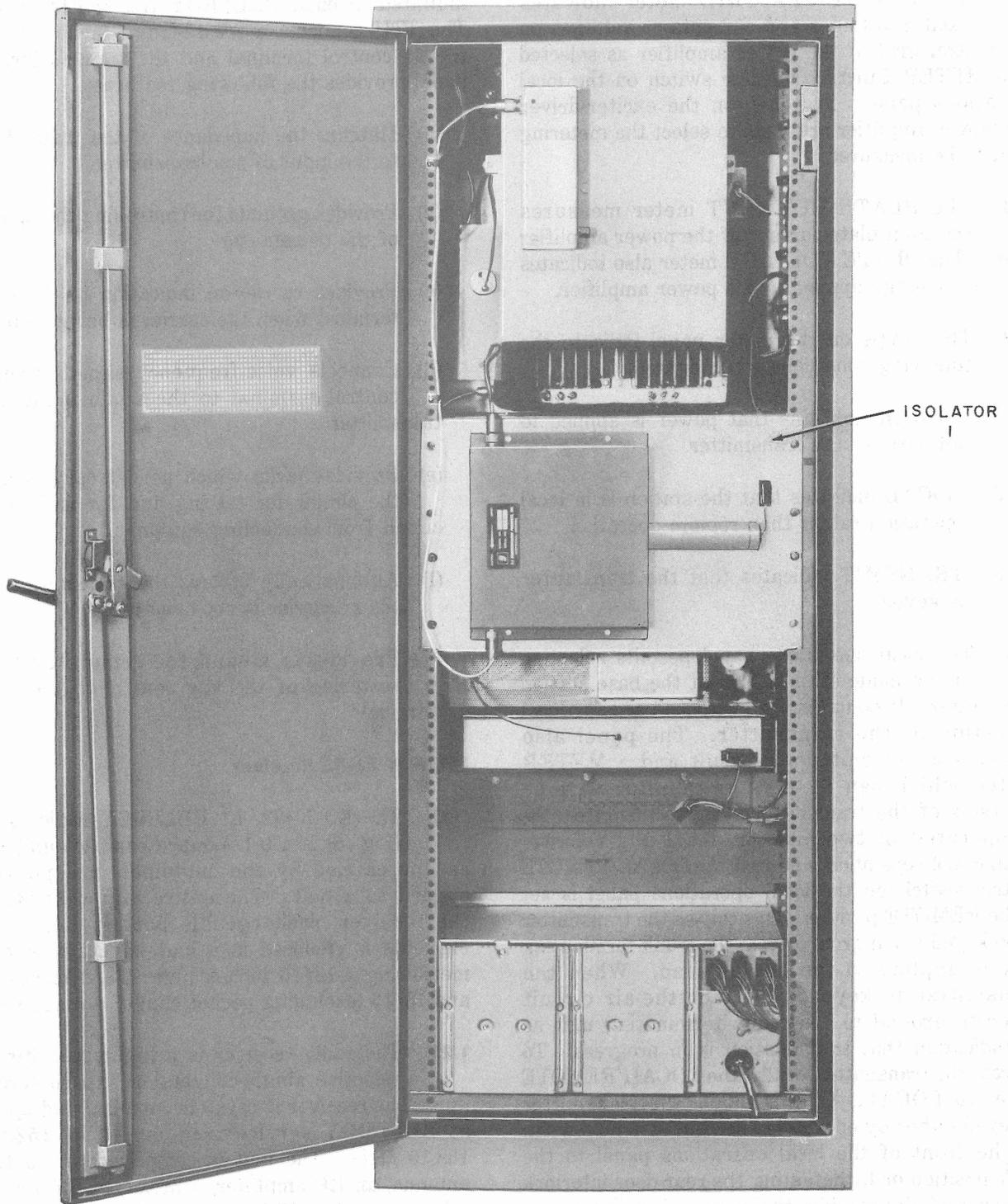


Fig. 2—KS-20429 Transmitter



KS20429, L2 REAR VIEW
(PRE PRODUCTION MODEL)

Fig. 3—KS-20429 Transmitter Rear View

1.17 The EXCITER-PA-GRID meter indicates exciter voltages and currents or voltages on the control grid of the power amplifier as selected by a METER function selector switch on the local operations panel. Switches on the exciter-driver and power amplifier are used to select the metering point to be measured.

1.18 The PLATE CURRENT meter measures the total plate current of the power amplifier tubes. The PLATE VOLTAGE meter also indicates the plate voltage applied to the power amplifier.

1.19 The lamps on the meter panel indicate the following conditions when lighted.

1. POWER indicates that power is applied to all parts of the transmitter.
2. LOCAL indicates that the station is in local operation rather than remote operation.
3. TRANSMIT indicates that the transmitter is keyed.

1.20 The local operations panel permits selection of the mode of operation of the base station transmitter. It contains the switches used for local operation of the transmitter. The panel also contains an rf on-the-air circuit and a METER switch which can be used to monitor various functions of the transmitter. The transmitter can be operated in two modes: local and remote. When remote operation is desired, the LOCAL/REMOTE control switch on the local operations panel is set to the REMOTE position. This causes the transmitter to be keyed when ground from the trunk terminating unit is applied to the keying lead. When the transmitter is keyed, the rf on-the-air circuit connects ground to the trunk terminating unit as an indication that transmission is in progress. To operate the transmitter locally, the LOCAL/REMOTE is set to LOCAL. In this mode, the transmitter is keyed either by operating the XMTR/KEY switch on the front of the local operations panel to the KEY position or by defeating the rear door interlock switch and depressing the nonlocking button on the back of the local operations panel. A ground from the operated KEY switch keys the transmitter.

J41643B Transmitter Trunk Terminating Unit

1.21 The transmitter trunk terminating unit (TTU) is a 4-inch high, 19-inch long panel

mounted in each BELLBOY transmitter cabinet. The TTU connects a 2-wire-trunk facility between the J1 control terminal and the transmitter. The panel provides the following features:

- (a) Matches the impedance of the trunk facility to the input of the transmitter
- (b) Provides grounds for controlling the operation of the transmitter
- (c) Provides carrier-on indication to the control terminal when the carrier is being radiated
- (d) Connects voice-frequency signals from the control terminal to the audio input of the transmitter
- (e) Provides jacks which permit easy access to the circuit for testing and for isolating the circuit from connecting equipment
- (f) Automatically unkeys the transmitter when the rf carrier is not modulated
- (g) Provides a means for remote and local restoring of the key control to the control terminal.

BELLBOY Radio Receiver

1.22 The KS-20432, L1 BELLBOY radio receiver (Fig. 5) is a 9-1/4-ounce compact unit which can be carried by the customer in a pocket or clipped to a belt. The entire unit consisting of the receiver, rechargeable battery, and coding elements is enclosed in a high-impact plastic case measuring 4-13/16 inches high, 2-3/8 inches wide and 15/16 (excluding pocket clip) of an inch deep.

1.23 The radio receiver is a highly sensitive and selective single-conversion superheterodyne unit. The receiver is crystal-controlled and operates at BELLBOY service frequencies of 152.84 or 158.10 MHz. The unit is comprised of: a ferrite antenna, an RF amplifier, a mixer, an IF amplifier, a limiter, and an FM detector. The detector output drives three resonant-reed coding elements which, when simultaneously excited, trigger an audio oscillator and sound transducer. The sound transducer provides a 2-kHz alert tone to the subscriber.

1.24 Two controls are located at the top of the radio receiver. One control is an ON-OFF

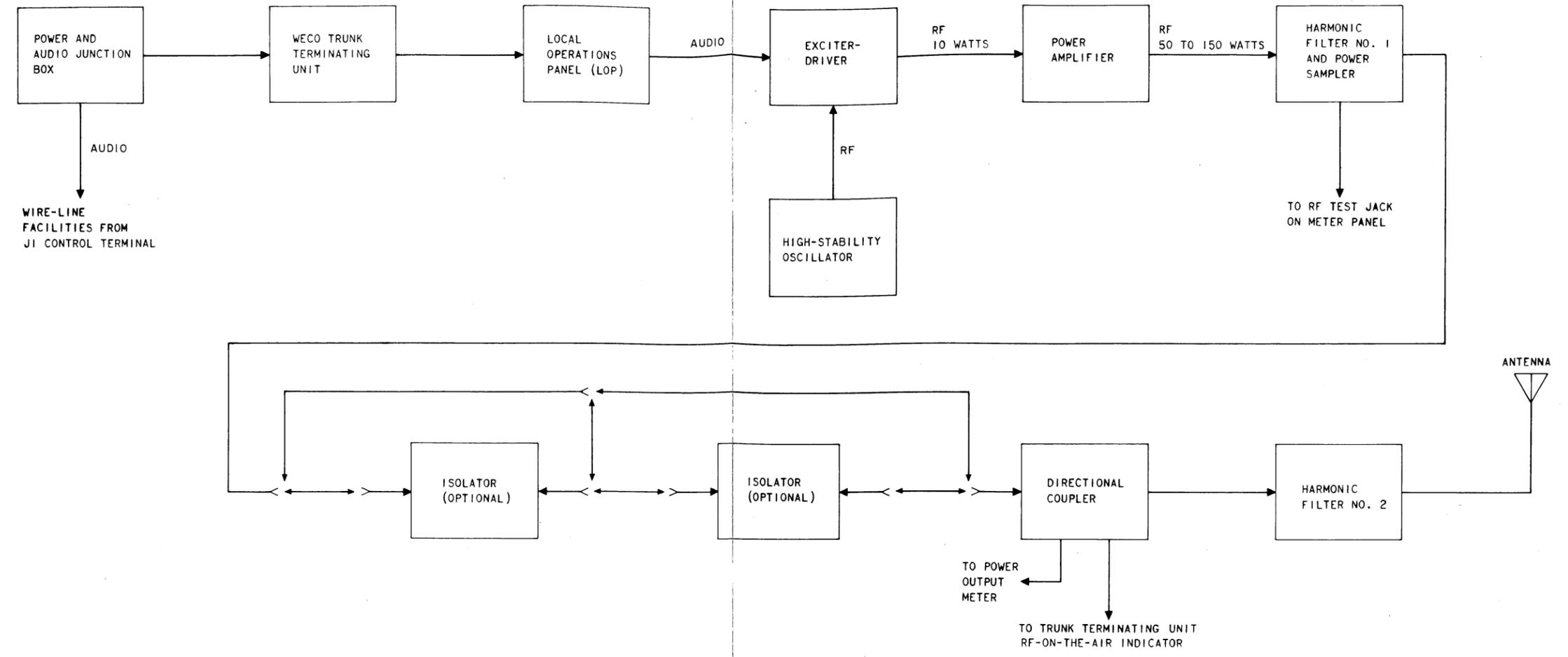


Fig. 4—Transmitter Block Diagram

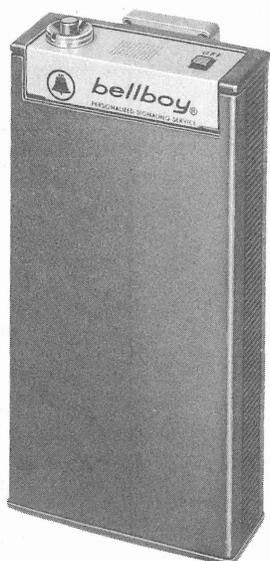


Fig. 5—KS-20432,L1 Receiver

switch and the other is a nonlocking reset button. The ON-OFF switch provides battery power to the receiver, and when switched on, triggers the alert tone only if the battery is sufficiently charged to adequately power the receiver. The reset button is used to manually turn off the alert tone. If the alert tone is not manually disabled, it automatically shuts off in approximately 15 seconds to prevent battery depletion.

Coding Elements

1.25 Each receiver requires three KS-20432, L2 coding elements (Fig. 6), each of which responds to one of the 32 signaling tones. The three coding elements are chosen to correspond with the subscriber's code number for which the receiver is to respond. By changing the coding elements, the receiver's signaling code may be changed. The coding elements are accessible by removing a rectangular cover on the bottom end of the receiver. The frequency of the coding element as well as the corresponding tone number (see Table A) are indicated on each coding element.

Battery

1.26 The receiver is powered by a 2.6-volt rechargeable nickel-cadmium battery coded KS-20431, L1. The cylindrical battery compartment is accessible by removing the circular battery cap at the bottom end of the receiver. Both battery

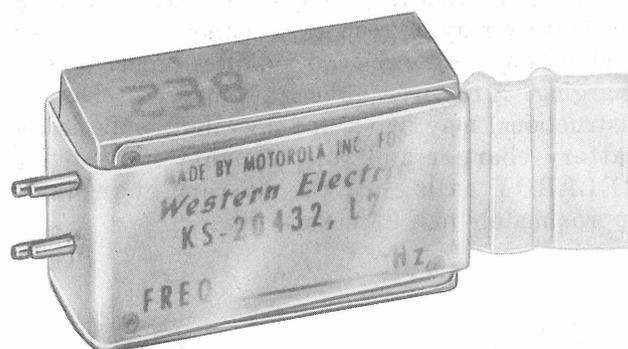


Fig. 6—KS-20432,L2 Coding Element



Fig. 7—KS-20428,L1 Battery Charger

and battery cap are mechanically polarized so that an improperly inserted battery neither powers the receiver nor accepts charge. With an overnight recharge, the battery powers the receiver for ten hours.

BELLBOY Battery Charger

1.27 The KS-20428, L1 battery charger (Fig. 7) is a desk-top unit designed to hold a BELLBOY receiver and recharge its battery. By

means of a KS-20428, L2 battery adapter (Fig. 8), the battery may be recharged without the receiver. A pilot lamp on the charger indicates proper battery charging. A receiver (although contrary to charging instructions) may be on and operating while in the battery charger and fully capable of receiving BELLBOY calls, but the battery charges at approximately half its normal rate.

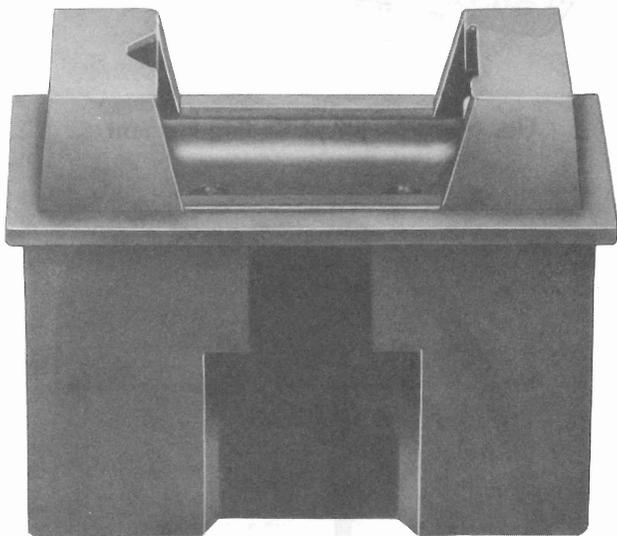


Fig. 8—KS-20428,L2 Adapter

Test Equipment

1.28 A list of test equipment suggested for the 150-Megahertz BELLBOY® System is contained in a current EM. Refer to the EM files for this information.

2. SUPPLEMENTARY INFORMATION

- 806-000-000—Equipment Design and General Equipment Requirements and Engineering Information—Radio Systems and Television Systems
- 806-140-150—Transmitter Trunk Terminating Unit—Personal Signaling System—Radio Systems
- 806-140-153—J1 Control Terminal—BELLBOY Personal Signaling System—Radio Systems
- 407-200-100—Personal Radio Services—150-Megahertz

TABLE A

STONE NO.	FREQ. (Hz)
1	517.5
2	532.5
3	547.5
4	562.5
5	577.5
6	592.5
7	607.5
8	622.5
9	637.5
10	652.5
11	667.5
12	682.5
13	697.5
14	712.5
15	727.5
16	742.5
18	772.5
19	787.5
20	802.5
21	817.5
22	832.5
23	847.5
24	862.5
25	877.5
26	892.5
27	907.5
28	922.5
29	937.5
30	952.5
31	967.5
32	982.5
33	997.5

Note: Tone 17 is not used in this system.

BELLBOY—Overall System—General Description

- 407-201-100*—Personal Radio Services—150-Megahertz BELLBOY—Base Station—KS-20429 Transmitter—Description
- 407-204-100*—Personal Radio Service 150-Megahertz BELLBOY—KS-20432 Receiver—Description
- 407-207-100—Personal Radio Services—150-Megahertz BELLBOY—J1 Control Terminal—General Description
- 407-210-100—Personal Radio Services—150-Megahertz

BELLBOY—Auxiliary Equipment—
J41643B Base Station Transmitter
Trunk Terminating Circuit—Description

* This Bell System Practice has not been issued as of this date. Consult future issues of indices to establish when this section becomes available.

3. DRAWINGS

3.01 This part contains a complete list of drawings for the BELLBOY radio equipment.

SD-2R103-01—BELLBOY 50- to 150-Watt Transmitter
SD-2R104-01—BELLBOY Receiver and Charger
SD-46800-01—Personal Signaling Service—Transmitter
Trunk Terminating Unit

4. EQUIPMENT

KS-20429—AT&TCo Std—50- to 150-Watt Transmitter

List 1—50- to 150-watt transmitter per SD-2R103-01, enclosed in an indoor cabinet. Isolators not included. Refer to Notes A and B.

List 2—50- to 150-watt transmitter per SD-2R103-01, enclosed in an indoor cabinet. Includes one isolator. Refer to Notes A and B.

List 3—50- to 150-watt transmitter per SD-2R103-01, enclosed in an indoor cabinet. Includes two isolators. Refer to Notes A and B.

List 4—50- to 150-watt transmitter per SD-2R103-01, enclosed in an outdoor cabinet. Isolators not included. Refer to Notes A and B.

List 5—50- to 150-watt transmitter per SD-2R103-01, enclosed in an outdoor cabinet. Includes one isolator. Refer to Notes A and B.

List 6—50- to 150-watt transmitter per SD-2R103-01, enclosed in an outdoor cabinet. Includes

two isolators. Refer to Notes A and B.

List 7—Add-to-isolator kit in addition to List 1 or List 4, if required.

List 8—Add-to-isolator kit in addition to List 2 or List 4, if required.

Notes

A. Specify transmitter frequency desired, 152.840 MHz or 158.100 MHz.

B. Each KS-20429, L1 through L6 transmitter requires a J41643B, L1 Transmitter Trunk Terminating Unit per SD-46800-01. Information on this unit is contained in Section 806-140-150.

KS-20432—AT&TCo Std—"BELLBOY" Receiver

List 1—Receiver per SD-2R104-01. Available for either 152.840 or 158.100 MHz. Specify one.

List 2—Coding element. Three required for each receiver to uniquely designate a customer. Specify element number 1-33 corresponding to frequencies in Table A.

KS-20428—AT&TCo Std—"BELLBOY" Charger

List 1—Charger per SD-2R104-01. One required for each customer's BELLBOY receiver

List 2—Battery Adapter. One required to recharge a KS-20431, L1 battery when the battery is out of the receiver.

KS-20431—AT&TCo Std—Battery

List 1—Battery. One required in addition to each KS-20432, L1 receiver.