OPERATING AND SERVICE INSTRUCTIONS

RADIO RECEIVER
MODEL SX-88

HALLICRAFTERS SX-88 RECEIVER

SECTION 1.

GENERAL DESCRIPTION

The Hallicrafters SX-88 represents the ultimate in precision communications equipment. This superb twenty tube communications receiver contains virtually every feature essential for top performance, operating ease, and dependability. It offers continuous coverage from 535 kc to 33 mc and provides for the reception of AM phone, single-sideband phone, and CW signals over its entire tuning range. Electrical bandspread, calibrated for the 160, 80, 40, 20, 15, 11, and 10 meter amateur bands, provides for fine tuning on bands 2 through 6. Band changing is accomplished from the front panel of the receiver, without the use of plug-in coils.

The receiver employs dual conversion on all six bands. As a result, images are practically nonexistent, rejection varying between 60 and 120 db, depending on the band. Its 3 stage 50 kc second IF with 8 tuned circuits provides "razor sharp" selectivity ... selectivity greater than most crystal circuits because of the extreme steepness of its selectivity curve. Receiver selectivity is variable in six steps from 250 cycles to 10 kc at the "nose" and 850 cycles to 24 kc at the "skirt".

Two tuned r-f stages on all bands except the broadcast band where one stage is adequate, assures maximum sensitivity and a high signal-to-noise ratio for outstanding reception of weak signals. An antenna trimmer, adjustable from the front panel, permits peaking of the 1st r-f stage to compensate for loading effects of various antennas. Receiver sensitivity for a 10 to 1 signal-to-noise ratio measures 1 microvolt on bands 2 through 6 and 10 microvolts on band 1. A manual sensitivity control prevents overloading on strong signals.

Outstanding frequency stability is achieved by means of ceramic coil forms in the oscillator section, temperature compensation, voltage and current regulation in the 1st conversion oscillator, and the use of a crystal controlled 2nd conversion oscillator.

Tuning is accomplished by a precision anti-backlash gear-train mechanism to insure extremely close calibration and accurate resetability. The ratio of each tuning control to its associated tuning dial is 24 to 1, i.e., 24 complete revolutions are made by the control while the dial makes one complete band coverage. A logging scale on each dial, calibrated from 0 to 24, indicates the revolutions made by the control. Since the metal skirt of each control is calibrated from 0 to 100, this system of tuning makes it possible to divide each frequency band on the main and bandspread tuning dials into 2400 readable settings. A lock on each tuning dial provides positive locking action without affecting its frequency setting. Smooth flywheel tuning assures maximum traverse speed and operating ease.

A built-in 100 kc crystal calibrator provides marker signals at every 100 kc on the dial for checking the calibration accuracy. Any calibration adjustment required can be made from the front panel, by means of the adjustable dial pointers. A trimmer capacitor, accessible from the top of the chassis, permits adjustment of the calibrating crystal to exactly 100 kc by comparison with the frequencies transmitted by station WWV.

The amplified and delayed AVC circuit in the receiver functions on both AM and CW signals to keep the output level of the receiver constant regardless of input-signal variations. This type of AVC circuit is advantageous in that it provides excellent control over a wide range of signal strengths and yet maintains full receiver sensitivity on weak signals.

An automatic series noise limiter circuit, controlled by a switch on the front panel, eliminates interference from electrical equipment and other sources of pulse type noise such as ignition noise.

A tuned buffer amplifier stage isolates the beat frequency oscillator from the detector and provides for two levels of injection, low level injection for CW reception and high level injection for single-side band reception. A three-position toggle switch on the front panel permits selection of either level, and also turns the beat oscillator off for AM reception. The frequency of the beat oscillator is controlled by the Pitch control on the front panel which varies the audible beat note from zero to plus or minus 2500 cycles.

An "S" meter is used when receiving AM signals to indicate the accuracy of tuning and the relative strength of received signals. The meter is calibrated in microvolts, "S" units from 1 to 9, and in decibels above S-9 to + 40 db.

The Receive-Standby switch on the front panel silences the receiver but leaves the power on to provide instant reception between transmission periods. Provision has also been made in the receiver for remote receive-standby control, and for transmitter control with the standby switch. An auxiliary sensitivity control, located on the top of the chassis, is switched in the circuit when the receiver is in the "standby" position to permit monitoring of your transmitter signal. A neon lamp, connected across the secondary of the antenna coil, protects the receiver against possible damage from excessive r-f voltage at the antenna terminals during transmission. Protection is provided for terminal voltages up to 50 volts.

A push-pull 6V6 audio output stage with inverse feedback delivers 10 watts of audio power. Audio output connections include terminals for 3.2 and 8 ohm speakers as well as a 500/600-ohm line or speaker output. A front panel jack for headphones is also provided, and the speaker is automatically disabled when the headphones are plugged in. The response of the audio amplifying system is essentially flat from 20 to 20,000 cycles. A 5-position full range tone control provides responses for normal, communications, and full fidelity reception.

The SX-88 operates from a 105-125 volt, 50-60 cycle AC power source. The universal model, the SX-88U, operates from 25-60 cycle AC sources at voltages ranging from 100 to 250 volts. Both models also have provisions for operation from an external power supply or batteries for emergency service in areas where AC power is not available.

This receiver is certified by the FCDA under Specification M6-1, Item #R12.

SECTION 2.
INSTALLATION

2-1. UNPACKING

After unpacking the receiver, examine it closely for damage which may have occurred in transit. Should any sign of damage be apparent, file a claim immediately with the carrier stating the extent of damage. Carefully check all shipping labels and tags for instructions before removing or destroying them.

CAUTION

When removing the receiver from the carton be extremely careful not to place any strain on the tuning knobs. Failure to observe this precaution may result in serious damage to the precision tuning mechanism.

2-2. LOCATION

The receiver may be placed in any location that will permit free air circulation through the ventilation holes and openings in the cabinet. Avoid excessively warm locations such as those near radiators and heating vents. The external speaker may be located in any convenient position although it is recommended that it not be placed on top of the receiver for reasons of ventilation.

If rack mounting is desired, the receiver may be removed from the cabinet by removing the two screws at each side of the front panel, the four screws at bottom of the cabinet, and then sliding the receiver out of the cabinet. The 8-3/4" x 19" front panel of the receiver has holes suitably spaced to fit the standard 19-inch radio relay rack.

2-3. ANTENNAS

The r-f input of the receiver is designed for operation from either a single-wire antenna, or a half-wave doublet or other tuned antenna with transmission line impedances from 52 to 600 ohms. Antenna connections are made to a three terminal strip at the rear of the receiver marked "A1", "A2", and "G". Mounting holes are also provided, adjacent to the antenna terminals, for installation of an AN type SO-239 connector for coaxial cable installations.

A. SINGLE WIRE ANTENNA

The simplest antenna and one which will provide satisfactory results throughout the entire tuning range is a conventional single-wire antenna, 50 to 100 feet long. This type of antenna should be erected as high as possible and kept free from surrounding objects. When using a single-wire antenna, attach the antenna lead-in to terminal "A1" and connect the jumper link between terminals "A2" and "G". In some locations, reception may be improved by connecting a ground wire between terminal "G" and a cold water pipe or outside ground rod.

B. HALF-WAVE DOUBLET

For top performance, especially on the shortwave ranges, the use of a half-wave doublet or other type of antenna employing a 52 to 600-ohm transmission line is recommended. The doublet antenna should be cut to the proper length for the most used frequency or band of frequencies. The overall length in feet of a half-wave doublet is determined by the following formula:

$$\text{Length in feet} = \frac{468}{\text{Frequency in megacycles}}$$

The doublet antenna may be fed with either a balanced or unbalanced transmission line. When a balanced transmission line such as "twin-lead" or a twisted pair is used, the two leads are connected to terminals "A1" and "A2", and the jumper link between terminals "A2" and "G" is disconnected. When using an unbalanced transmission line such as coaxial cable, the inner conductor connects to terminal "A1", the outer braid connects to "A2", and the jumper link connects between "A2" and "G".

The doublet antenna provides optimum efficiency only at the frequency for which it is cut. Therefore, it may be desirable for reception on frequencies remote from the antenna frequency to utilize the antenna as a single wire type. This is accomplished by connecting the two transmission line leads together and connecting them to terminal "A1". The jumper link in this case should be connected between terminals "A2" and "G".

In an installation where the receiver is used in conjunction with a transmitter, it may be advantageous to use the same antenna for receiving as for transmitting. This is especially true when a directive antenna is used since the directive effects and power gain of the transmitting antenna are the same for receiving as for transmitting. Switching of the antenna from the transmitter to the receiver may be accomplished with a double-pole, double-throw antenna changeover relay or knife switch connected in the antenna leads.

For further information regarding antennas, refer to the "Radio Amateur's Handbook" or the "A.R.R.L. Antenna Book", both published by the American Radio Relay League; West Hartford, Conn., U.S.A.

CAUTION: When using the SX-88 receiver in close proximity to transmitting equipment, avoid excessive r-f voltage at the antenna terminals of the receiver during transmission. Nearby antennas or even short lengths of transmission line between the receiver and antenna relay can pick up high r-f potentials. Voltages in excess of 50 volts at the receiver antenna terminals can destroy the protective neon lamp and antenna stage coils.

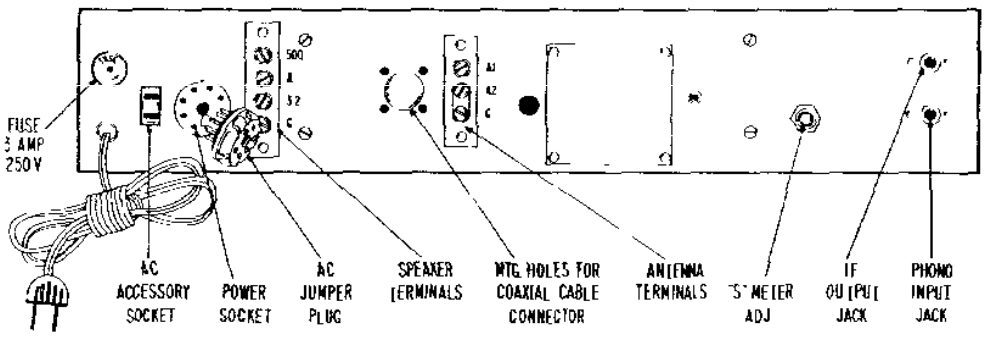

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Fig. 1. Rear View of Receiver

2-4. POWER SOURCE

The SX-88 receiver is designed for operation on 105-125 volt, 50-60 cycle AC current while the universal model, the SX-88U, operates on 100-250 volt, 25-60 cycle AC current. The normal power consumption of each receiver is 138 watts. Each receiver is also equipped with a DC power input socket to permit operation on an external power supply or batteries for portable or emergency service in areas where AC power is not available. This socket is located at the rear of the receiver and is marked "POWER SOCKET". In addition to equipping the receiver for DC operation, the POWER SOCKET also supplies 300 volts DC at 10 ma between pins 1 and 3, and 6.3 volts AC at .6 amp between pins 1 and 6 for operating accessories.

A. AC OPERATION

Insert the line cord plug into any convenient AC power outlet of the proper rating. If in doubt about your power source, call your local power company before plugging in the receiver.

CAUTION: When operating the SX-88U, it is essential that the power selector switch (located on the rear of the power transformer) be set for the voltage at the AC outlet before plugging in the receiver. Failure to observe this precaution may result in serious damage.

NOTE: The receiver will not operate from an AC source unless the AC JUMPER PLUG is inserted in the POWER SOCKET at the rear of the receiver. (See Fig. 1.)

B. DC OPERATION

The receiver may be operated from an external DC source, such as a vibrator power supply or batteries, by removing the AC JUMPER PLUG normally located in the POWER SOCKET at the rear of the receiver, and replacing it with a similar octal plug wired as shown in Fig. 2. Note that pins 7 and 8 of the DC plug are connected together by a jumper wire so that the 4H4 current regulator tube is automatically disconnected to supply the correct heater voltage to the 6U8 tube when operating from an external 6-volt source. The voltage and current requirements for DC operation are as follows: "B" supply, 300 volts at 200 ma; "A" supply, 6 volts at 6 amps.

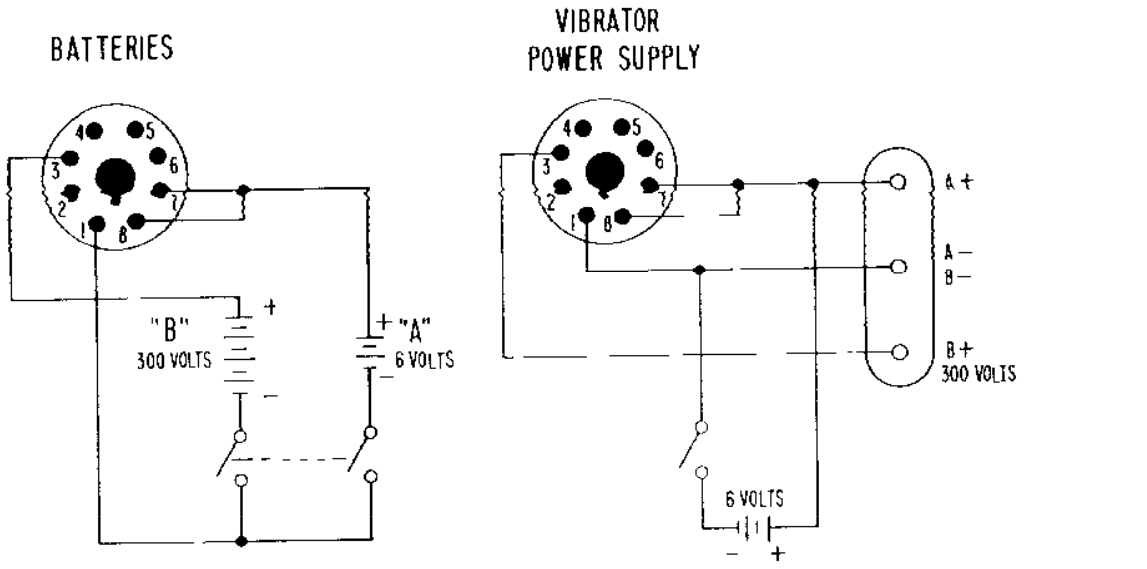

Fig. 2. Wiring Diagram for DC Operation

2-5. SPEAKER CONNECTION

A four-terminal strip, marked "G-3.2-8-500", is provided at the rear of the receiver for the speaker connections. Approximately 10 watts of audio power are available at these terminals. Any speaker having an impedance of either 3.2 or 8 ohms can be used with the receiver by simply connecting one lead from the speaker to the common ground terminal marked "G" and the other lead to the numbered terminal which corresponds to the speaker voice coil impedance. For optimum results, the use of the Hallicrafters R-46 or R-46A speaker is recommended. The R-46 speaker has a built-in matching transformer and connects to terminals "G" and "500" while the R-46A, which has no matching transformer, connects to the terminals marked "G" and "3.2". When using a speaker with an impedance other than 3.2 or 8 ohms, a matching transformer should be used to insure optimum performance. The matching transformer should have a 10-watt power rating, a 500-ohm primary impedance, and a secondary impedance to match the impedance of the speaker being used.

2-6. HEADPHONES

The headphone jack, marked PHONES, is located on the front panel of the receiver and is wired so that the speaker is automatically disabled when the headphones are plugged in. The headphone output load impedance is not critical and any commercial type headphones may be used, including crystal types as no direct current flows in the headphone circuit. For maximum headphone output, the use of high-impedance magnetic or crystal phones is recommended.

2-7. RECORD PLAYER CONNECTIONS

An audio input jack, marked PHONO, is provided at the rear of the receiver for attachment of a record player using either a crystal pickup, or a magnetic pickup with a suitable pre-amplifier. Connection to the PHONO jack is made with a standard single-pin phono plug. Shielded type cable should be used to prevent hum, connecting the inner conductor to the center prong of the plug, and the outer metal braid to the shell of the plug.

For phono operation, set the BAND WIDTH control on the front panel at "PHONO" and operate the VOLUME and RESPONSE controls as explained under Sections 3-7 and 3-12. The remaining controls are inoperative and will have no effect on phono operation.

2-8. RELAY AND TRANSMITTER SWITCHING

One half of the dpdt REC-STANDBY switch on the front panel connects to pins 2 and 5 of the POWER SOCKET at the rear of the receiver, and is available for transmitter switching. (See Fig. 3) This half of the switch is wired so that it is closed when the REC-STANDBY switch is set at "STANDBY" and open when set at "REC". To reverse the switching sequence (i.e., to have the switch open when the REC-STANDBY switch is set at "STANDBY" and closed when set at "REC") disconnect the lead on the switch which connects to pin 5 of the POWER SOCKET and connect it to the unused terminal on the switch.

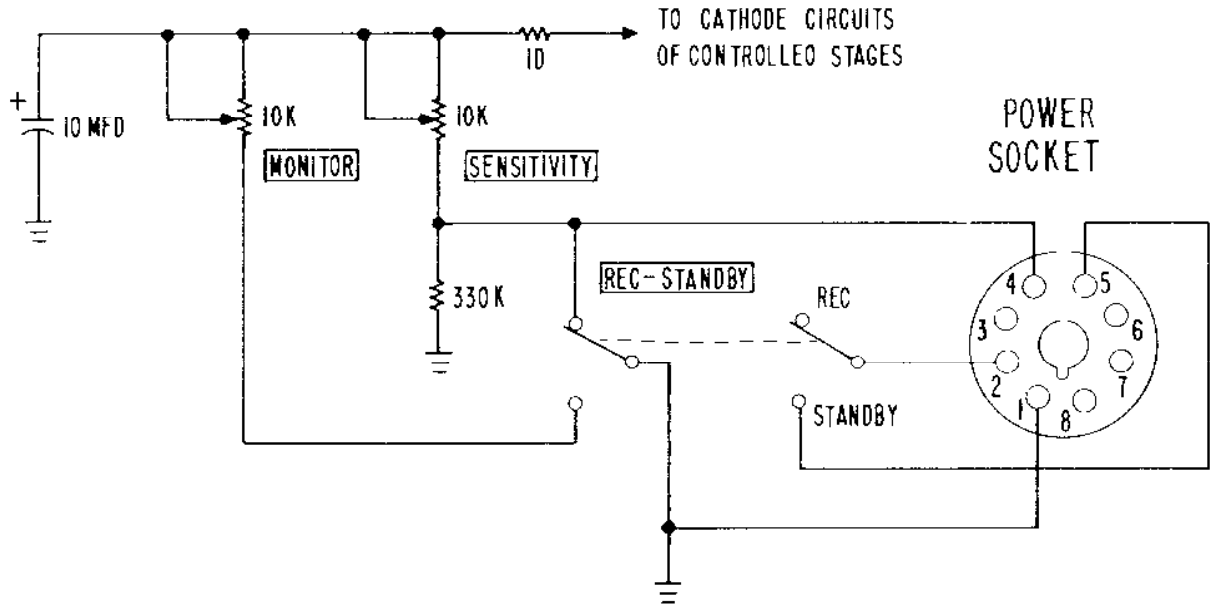

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Fig. 3. Schematic Diagram of Sensitivity and Monitor Control Circuits, and Rec-Standby Circuit.

2-9. REMOTE REC-STANDBY SWITCH

The receiver may be disabled remotely by connecting a remote spst switch between pins 1 and 4 of the AC JUMPER PLUG located in the POWER SOCKET at the rear of the receiver. (See Fig. 3). To operate the receiver from a remote location, set the REC-STANDBY switch on the front panel at "STANDBY" and use the remote switch to place the receiver in "receive" or "standby" operation.

2-10. AC ACCESSORY OUTLET

An AC outlet is provided at the rear of the receiver for operating a record player, oscilloscope, or accessories.

2-11. IF OUTPUT JACK

The IF OUTPUT jack at the rear of the receiver provides a low impedance cathode follower output at the second intermediate frequency of 50 kc for feeding a teletype converter, oscilloscope, etc. The i-f output signal is obtained from the grid of the 3rd 50 kc IF amplifier, amplified by the AVC amplifier, coupled to the cathode follower, and then fed through a DC blocking capacitor to the IF OUTPUT jack. The IF OUTPUT jack will be operative only if the AVC switch is set at "ON".

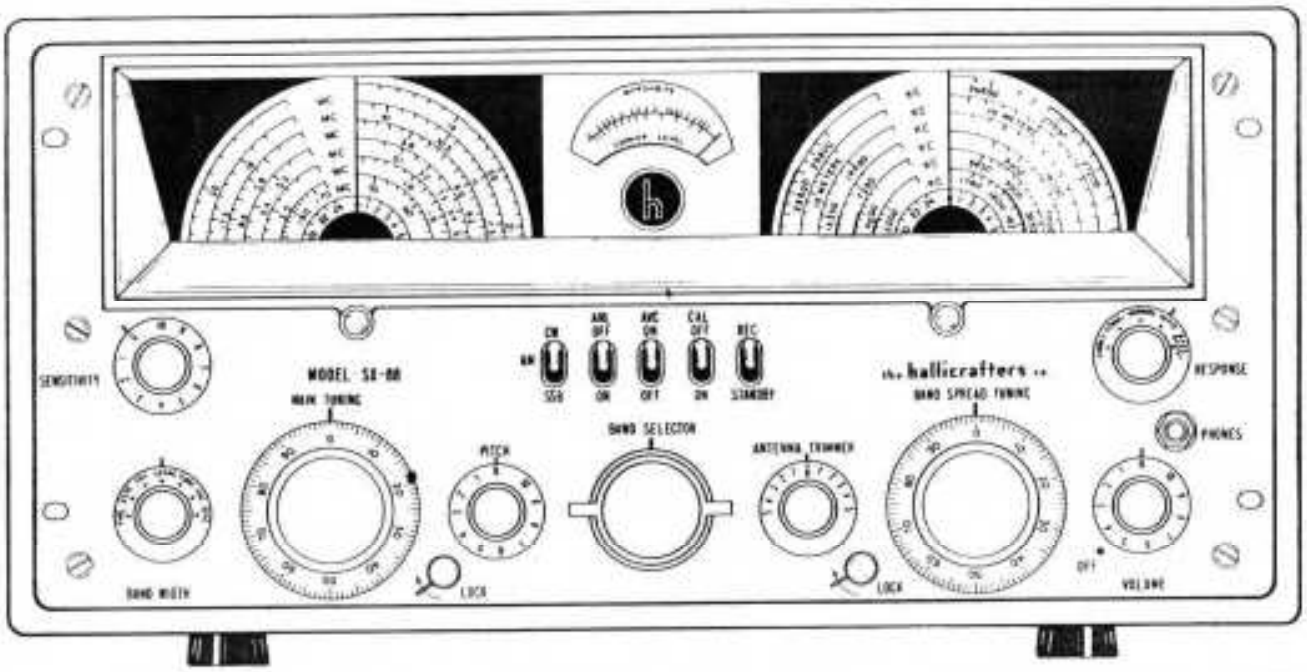

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Fig. 4. Operating Controls

SECTION 3.
FUNCTION OF OPERATING CONTROLS

3-1. SENSITIVITY CONTROL

The SENSITIVITY control varies the gain of the 1st and 2nd RF amplifier stages and the 1st, 2nd, and 3rd 50 kc IF amplifier stages. Maximum sensitivity is obtained with the control set at "10" (fully clockwise). In this position, the tubes being controlled are operated at maximum gain with minimum cathode bias. As the control is rotated counterclockwise, the bias on the tubes increases with a resultant decrease in gain.

3-2. CW-AM-SSB SWITCH

This switch, when set at "CW" or "SSB", applies plate voltage to the beat frequency oscillator (BFO) to render it operative for the reception of CW or single-sideband signals. The beat frequency oscillator employs a Hartley oscillator circuit and is voltage regulated to insure highly stable operation. Oscillator look-in is eliminated since the output of the beat oscillator is coupled to the second-detector through a tuned buffer amplifier. When the CW-AM-SSB switch is set at "SSB", the cathode bias resistor of the BFO buffer amplifier tube is decreased in value, thus providing increased BFO output for proper reception of single-sideband signals. The "AM" position of the CW-AM-SSB switch disables the BFO for normal reception of standard broadcast and AM phone signals.

3-3. ANL SWITCH

This switch, when set at "ON", places the automatic series noise limiter circuit in operation to reduce pulse type noise such as ignition noise and electrical interference. The limiter circuit allows the signal to pass through the receiver unaffected, but makes the receiver inoperative for noise amplitudes greater than those of the signal. It will work equally well on AM or CW signals and is self-adjusting, i.e., it automatically adjusts itself to the signal level.

The noise limiter circuit "chops" noise peaks received at the detector by means of a biased diode which becomes nonconducting above a predetermined signal level. The audio output of the detector must pass through the limiter diode to the grid of the audio amplifier when the limiter circuit is in operation. The limiter diode normally acts as a conductor for the audio signal as long as the diode plate is positive

with respect its cathode. When a noise peak is higher in amplitude than the signal, it instantaneously swings the plate negative with respect to the cathode, conduction ceases, and that portion of the signal is automatically cut off from the audio amplifier. The point at which the limiter diode becomes non-conducting is made sufficiently high so that the diode will not clip modulation peaks and thus impair intelligibility appreciably, but low enough to limit the noise peaks effectively.

3-4. AVC SWITCH

The AVC switch, when set at "ON", places the AVC circuit in operation to maintain the output level of the receiver constant regardless of normal input-signal variations. AVC voltage is applied to the 1st and 2nd RF amplifier stages, 2nd mixer, and 1st 50 kc IF stage. Since delayed AVC is employed in the receiver, the AVC circuit does not come into operation (i.e., it is delayed) until the carrier strength reaches a pre-determined level. The result is that no AVC voltage is applied to the grids of the controlled stages until the required carrier strength is reached. With this arrangement, the AVC bias on the controlled tubes is zero until the peak voltage applied to the plate of the AVC diode exceeds the delay voltage applied to its cathode. Thus, the AVC circuit offers very effective control on average and strong signals and yet maintains full receiver sensitivity on weak signals.

In the conventional AVC circuit, which uses the rectified carrier voltage developed at the detector, the use of AVC for CW reception results in a loss of sensitivity when the BFO is switched on. This occurs because the beat oscillator output acts exactly as a strong received signal, and causes the AVC circuit to put high bias on the controlled stages, thus reducing the receiver sensitivity. In the SX-88 receiver, this undesirable effect is eliminated by completely isolating the AVC circuit from the second detector by means of an AVC amplifier stage which obtains its input signal ahead of the detector stage, (and BFO), thus permitting the reception of CW signals with AVC functioning.

3-5. CAL. OFF-ON SWITCH

The CAL. OFF-ON switch controls the operation of the built-in crystal calibrator. When the switch is set at "ON", the crystal calibrator is turned on to provide marker signals at every 100 kc on the dial for checking the dial calibration accuracy. The crystal calibrator employs a crystal controlled, pentode oscillator circuit. The output of the crystal calibrator is capacitively coupled to the antenna input circuit. A trimmer capacitor, adjustable by the CRYSTAL ADJ control on the top front of the chassis, permits adjustment of the calibrating crystal to exactly 100 kc by comparison with the frequencies transmitted by WWV. This capacitor has been set at the factory and should normally not require periodic readjustment unless extreme calibration accuracy is required. If adjustment is required, proceed as outlined in Section 7-7.

3-6. REC-STANDBY SWITCH

The REC-STANDBY switch, normally set at "REC", permits disabling of the receiver during transmission periods, at the same time maintaining the heater and plate supplies operative for instant use when reception is again resumed. The receiver is disabled by setting the REC-STANDBY switch at "STANDBY".

> **NOTE:** When the REC-STANDBY switch is set at "STANDBY", the receiver may still be made operative, if desired, by means of the MONITOR control on the top rear of the chassis. This permits monitoring of your own transmitter signal when the REC-STANDBY switch is being used to control the transmitter. Only when the MONITOR control is rotated fully counterclockwise (zero sensitivity position) will the receiver be completely disabled when the REC-STANDBY switch is set at "STANDBY".

One section of the REC-STANDBY switch may be used for relay or transmitter switching, if desired. For connections and details, refer to Section 2-8.

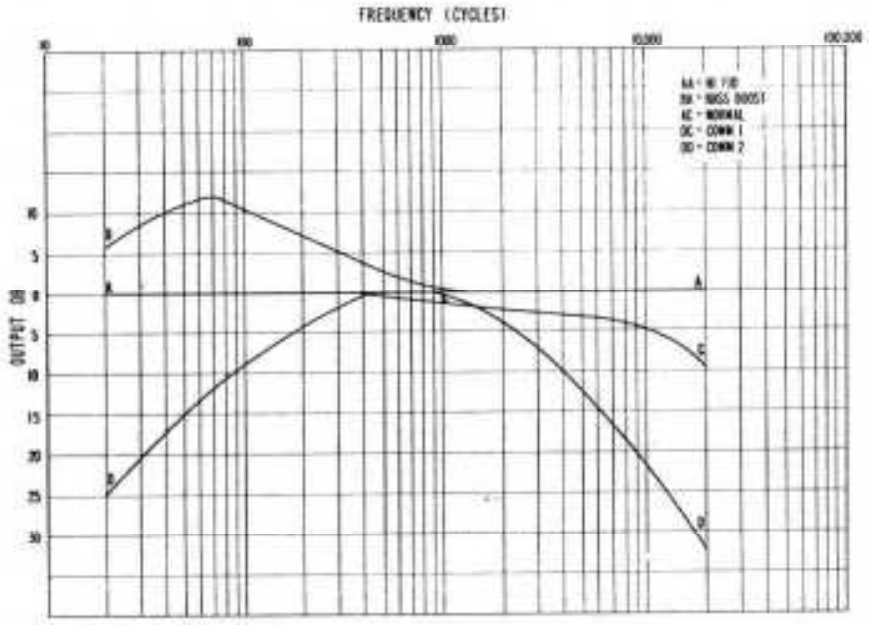

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Fig. 5. Audio Response Curves

3-7. RESPONSE CONTROL

The RESPONSE control varies the frequency characteristics of the receiver audio system. The five types of response available are BASS BOOST, HI FID, NORMAL, COMM 1, and COMM 2. For broadcast reception and phono operation, the BASS BOOST and HI FID positions are recommended while for the reception of CW and AM phone signals, where intelligibility rather than fidelity is the primary concern, the NORMAL, COMM 1, and COMM 2 positions are usually more desirable. Fig. 5 shows the frequency characteristics obtained with the control set in each of its five positions.

A. HI FID (High Fidelity)

This position provides an essentially flat response from 20 to 20,000 cycles, thereby providing as near true reproduction of the original signal as possible. This position is recommended for high fidelity reproduction of AM broadcast programs, tapes, and records.

B. BASS BOOST

In this position, the response at the high frequency end of the audio range remains the same as in the "HI FID" position; however, the level of the low audio frequencies is boosted approximately 10 db above that of the mid and high audio frequencies.

C. NORMAL

In this position, the response is essentially flat at the low and mid-frequencies and slightly attenuated at the high frequencies. The "NORMAL" position may be used to improve the signal-to-noise ratio when excessive background noise or static is experienced.

D. COMM 1 & COMM 2

These positions are especially useful for communication work under sharp selectivity conditions (BAND WIDTH control set at ".25 KC" or ".5 KC"). The "COMM 1" and "COMM 2" provide attenuation at both the high and low frequency ends of the audio range. The response in the two positions differs only in the amount of attenuation at the high frequency end, the "COMM 2" position providing considerably greater attenuation than the "COMM 1" position.