The New RCA AR-60 Receiver—In

● In the design of a high frequency radio receiver there are four qualities of the greatest importance which must be considered. These are usable sensitivity, selectivity, frequency stability and reliability. These qualities have been given careful consideration in the design of the Type AR-60 Receiver as outlined in the following paragraphs.

The sensitivity of this receiver is limited only by the tube noise originating in the first tube and its associated circuits. A large part of this noise is due to "shot" effect and thermal agitation in the first tuned circuit. A signal, to be readable, must produce a voltage on the grid of the same or greater order of magnitude than this inherent noise voltage. Therefore, an efficient coupling system between the antenna and the first tuned circuit of the receiver is of great importance. This has been the subject of considerable development, and the system used on this receiver gives optimum coupling with antenna or transmission line impedances between 50 and 500 ohms over the entire frequency range of the receiver. The question of band changing by means of plug-in coils, separate switch coils or tapped switch coils was decided in favor of the tapped switch coils only after it was proven that the additional tuned circuit loss over that of plug-in coils was negligible in comparison to the resistance load imposed on the first tuned circuit by optimum coupling to a suitable antenna.

The second quality of a receiver, selectivity, is necessarily a compromise with fidelity of the reproduced signal. This receiver is designed to have the maximum selectivity consistent with the fidelity requirements of the various communication services.

To secure good frequency stability, rugged construction of parts and wiring in the high frequency heterodyne oscillator circuit has been included in the design. This, together with voltage stabilization of the oscillator plate supply and proper oscillator excitation provides a high degree of stability.

Equipment

The receiver is supplied in three types, as follows:

(a) Type AR-60-R (rack-mounted type).
(b) Type AR-60-T (cabinet type, standard black wrinkle finish).
(c) Type AR-60-S (cabinet type, special two-tone gray finish).

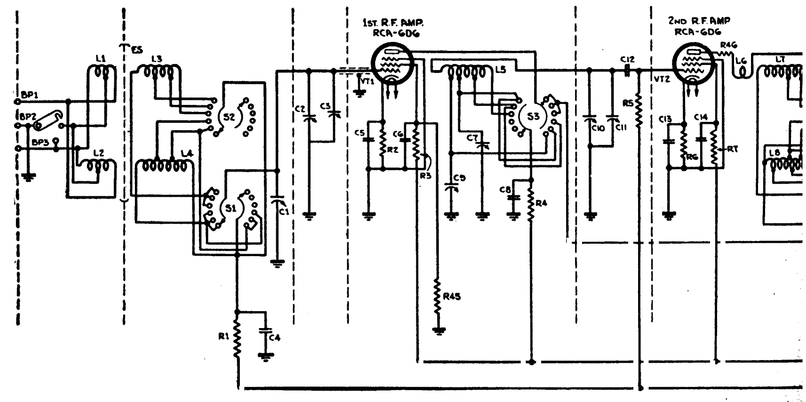
RCA tubes, one set, including:
4 RCA-6D6, RF and IF Amplifiers
2 RCA-6C6, First Detector and First Oscillator
1 RCA-6B7, IF Amplifier, Second Detector and A.V.C.
1 RCA-6F7, CW (beat) Oscillator and Audio Amplifier
1 RCA-41, Output Stage
1 RCA-84, Power Supply Rectifier
1 RCA-991, Voltage Regulator.

Ciruit Arrangements

General. The circuit is shown schematically in Figure 1. It consists of two stages of RF amplification, first detector, first heterodyne oscillator, three stages of IF amplification, second detector, second heterodyne oscillator, AF amplifier stage, output power stage and power supply system.

Input Coupling. The antenna coupling system is designed to provide optimum coupling from transmission lines (50-500 ohms) or from conventional antenna and ground systems. The coupling is variable and controlled from the front panel. The coupling coils are electrostatically shielded from the

Front View of Type AR-60-S Receiver



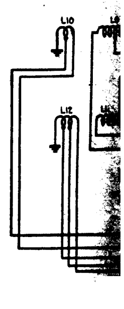
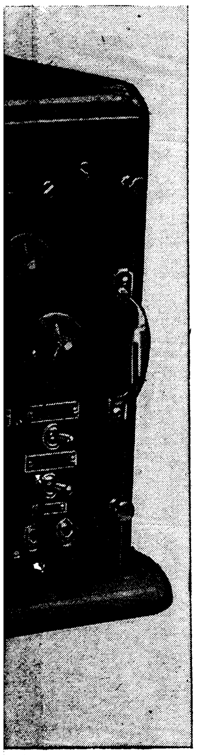
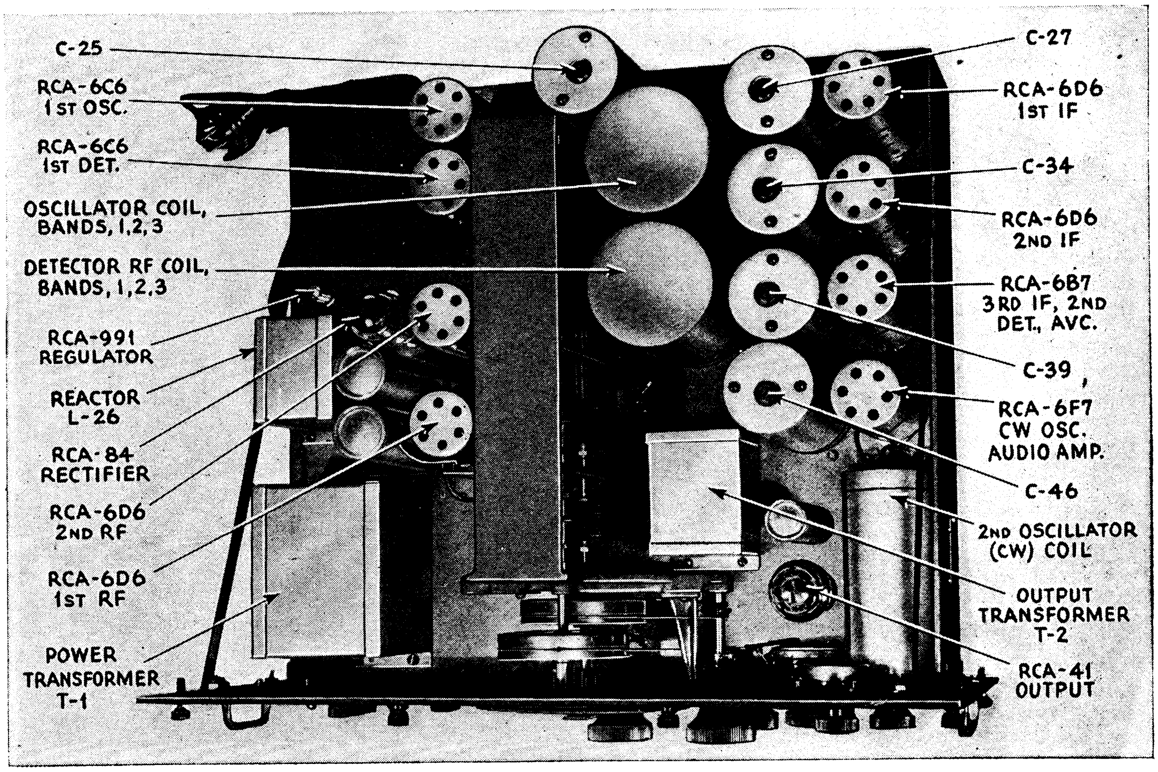


FIG. 1—LEGEND

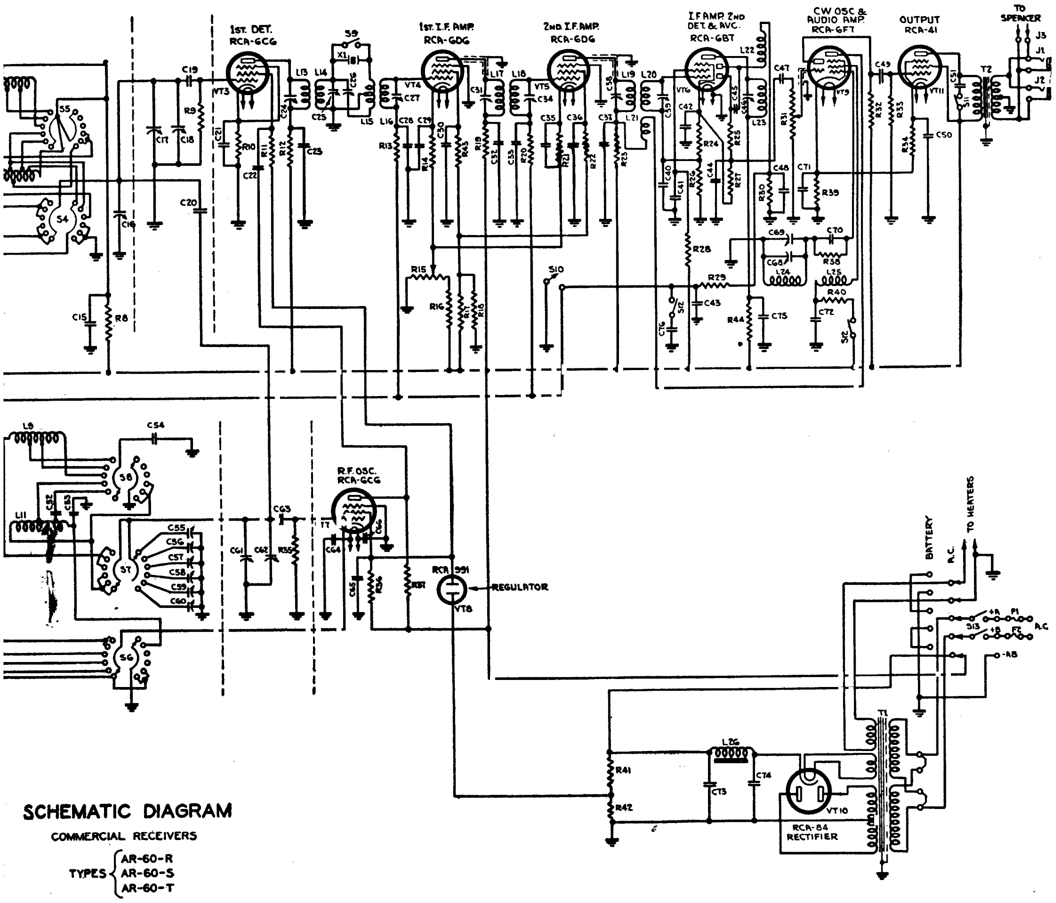
C1—50mmf. C2, 10, 17, 61—11-40mmf. each.
C3, 11, 18, 62—8-19mmf. each.
C4, 5, 6, 13, 14, 21, 22, 47, 49, 64, 65, 66—.01mfd.
C7, 9, 16, 56, 58, 59, 60—Variable max. cap. 15 mmf.
C8, C23—0.1mfd. C12, 19, 63—800 mmf.
C15, 28, 33, 36—.01mfd. C20—3mmf.
C24, 31, 38—Trimmers.
C25—Input trans. coil trimmer.
C26—Crystal neutralizing capacitor trimmer.
C27, 34, 39, 46, 69—Trimmer condensers.
C29, 30, 32, 35, 37, 40, 41, 42, 71, 72, 75—Capacitor packs comprising three 0.1mfd.
C43, 48, 51—.005. C44—200mmf.
C45—200mmf. C50—12 mfd. C52—300 mmf.
C53—440mmf. C54—2000mmf.
C55, 57—18mmf. variable.
C68—CW Osc Trimmer. C70—.001mfd.
C73, 74—20mfd. C76—0.25mfd.
ES—Electronic Screen.
L1, 2—Antenna Coupling.
L3—1st RF coil, 3 HF bands.
L4—1st RF coil, 3 LF bands.
L5—2nd RF coil, 3 HF bands.
L6, 7—Detector Coil, 3 HF bands.
L8—Detector Coil, 3 LF bands.
L9, 10—Osc. Coil, 3 HF bands.
L11, 12—Osc. Coil, 3 LF bands.
L13, 14—Crystal input trans.
L15, 16—Crystal output trans.
L17, 18— 2nd IF trans. coil.
L19, 20, 21—3rd IF trans. coil.
L22, 23—2nd Det. plate coupling coil.
L24, 25—Beat (CW) Osc .coil.
L26—Filter Reactor. R1, 5, 9, 27—1 meg. R2, 6—330 ohms. R3, 7—82,000 ohms. R4, 8, 12, 19—5600 ohms. R23, 37, 44—5600 ohms. R10, 36—27,000 ohms. R11, 22, 28, 43—10,-00 0ohms. R13, 20, 35—100,000 ohms. R14, 21—18,000 ohms. R15—5000 ohms. R16—39,000 ohms. R17—33,000 ohms. R18, 26—8,200 ohms. R24—3,90 0ohms. R25—225,000 ohms. R29, 33—470.000 ohms. R30—2.2 megs. R31—500,000 ohms. R32—22,000 ohms. R34—680 ohms. R38, 40, 45—56,000 ohms. R39—220 ohms. R41—12,000 ohms. R42—1200 ohms. R46—100 ohms. S1, 2, 3, 4, 5, 6, 7, 8—Single section, 12 contact, band selector switch. S9—Crystal on-off switch.
S10, 11—AVC or audio filter switch.
S12, 13—On-off switches.
T1—Power Transformer.
T2—Output Transformer.
J1, 3—Phone jacks.
X1—Quartz Crystal, 750 KC.

n Which Is Incorporated Many Advanced Features





Top View of Receiver Chassis



SCHEMATIC DIAGRAM

COMMERCIAL RECEIVERS

TYPES AR-60-R, AR-60-S, AR-60-T

first tuned circuit to maintain transmission line balance and to prevent voltages picked up by the transmission line from being coupled to the first tuned circuit. Since the coupling is variable, one value of inductance in the coupling coil is sufficient for a considerable range of frequencies. The two coupling coils, which cover the entire frequency range of the receiver, are in parallel. The coils have been so designed that the unused coil causes negligible loading of the coil in use. The center tap of both coupling coils is connected to a terminal which may be grounded if it is found desirable to do so. The first tuned circuit is provided with a trimmer condenser adjustable from the front panel. This insures the proper tuning of this circuit with any antenna system and with any degree of coupling.

RF Amplifier. The RF amplifier is designed to provide ample selectivity ahead of the first detector for minimizing cross-modulation and blocking effects from strong interfering signals and for obtaining a high degree of image signal suppression. The amplification is adjusted to provide optimum signal to noise ratio by making noise contributions of circuits following the first tube negligible in comparison with the noise contributed by the first RF grid circuit. That is, each tuned circuit in the receiver contributes some noise voltage, but by making the gain of the first tube as high as practicable, the noise contributed by succeeding circuits is unimportant. Only one stage of RF is used on the lower frequency bands, since sufficient gain is obtained and the image response is inherently much better on the lower frequencies because the image occurs at a frequency differing from the RF circuit resonance by a greater amount.

Band Spread. Band spreading is accomplished by means of a separate capacitator gang of suitably small capacity. This capacitator gang is connected in parallel with the main gang at all times and permits adequate band spreading at any frequency in the range of the receiver.

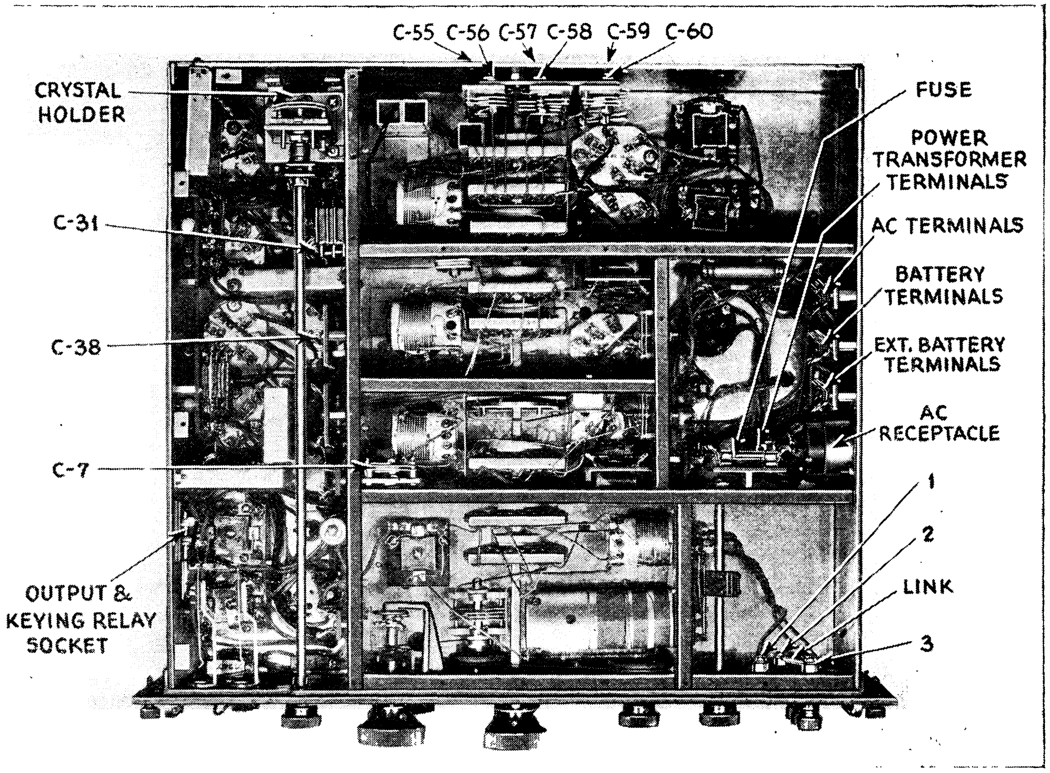
Tuning Inductance. The tuning inductance systems used in the first RF grid, detector grid and oscillator grid circuits each consist of two coils wound on Isolantite forms

(Please turn to next page)

and tapped to provide a total of six different values of inductance. The second RF circuit utilizes one coil with three taps, this stage being used only on the three higher frequency bands. This system of inductances for band changing gives substantially the same RF selectivity and gain as a good plug-in coil system with the added advantage of ease and speed of operation. "Dead spots" or spots of low sensitivity are entirely avoided by shorting possible resonant circuits in the coil sections which are not in use.

Band-Change Switch. A specially designed gang switch is used so that the necessary inductance changes for the various bands are accomplished by a single panel control. Particular care has been taken in the design of the switch not to add undesired losses in the tuned circuit.

First Heterodyne Oscillator. The first heterodyne oscillator is aligned to track with the RF amplifier at 750 KC higher than the signal frequency, thus producing a 750 KC intermediate frequency in the first detector plate circuit which is amplified further in the IF stages. The oscillator voltage is regulated by the RCA-991 regulator tube to provide maximum frequency stability under conditions of variations in power supply voltage. The maximum possible amount of coupling is used to the detector circuit which will not produce objectionable reaction with the RF circuits. This helps to minimize cross modulation and blocking effects, since in general, blocking of a weak signal does not occur until the voltage from the strong signal on the first detector is about equal to the heterodyne oscillator voltage.



Bottom view of receiver chassis, covers removed.

Crystal Control. For operation on a fixed frequency, crystal control for the first heterodyne oscillator can be furnished. This feature is not supplied as standard equipment, but can be incorporated in the receiver assembly if desired. The arrangement consists of a low temperature coefficient crystal operating in conjunction with the first heterodyne oscillator. Temperature control may be provided additionally for cases of extreme temperature variation. By use of this device, the receiver tuning can be accurately stabilized on a predetermined frequency.

Intermediate Frequency Crystal Filter. The first detector plate circuit is tuned to the intermediate frequency and a balanced link circuit is used to couple the first detector plate and first IF grid circuits. A 750 KC crystal is connected in one arm of the link circuit and a neutralizing capacitor which is controlled from the front panel, is connected in the other. The impedances of the coils in this link circuit are designed so that the crystal selectivity characteristic is not impractically sharp. The band width at two times resonant input may be adjusted from approximately 125 to 700 cycles. The band width at ten times resonant input varies from approximately 600 to 2600 cycles. A second control is the neutralizing capacitor controlled from the front panel. By variation of this control, the band width at two times resonant input remains substantially constant but the shape of the selectivity characteristic is varied in such a manner as to cause rejection of certain frequencies. Thus, without affecting the desired signal response, an interfering signal only a fraction of a kilocycle removed from the desired signal may be rejected. This is shown by the curves of Figure 2. These curves show the amount of the rejection in D.B. of a particular frequency off resonance. The crystal "broad-sharp" adjustment on the chassis (C25) is in the "broad" position for these curves. When in the "sharp" position, the amount of the rejection is increased about 10D.B. These curves also show the change in the band-width at 10, 100 and 1000 times resonant input which occurs with different settings of the "Crystal Selectivity" control. The design is such that introduction of the crystal filter into the circuit produces a negligible change in gain. The use of an intermediate filter preceding the IF amplifier has advantages as compared to an audio filter, in that changes of blocking are reduced by suppression of interfering voltages before they are amplified by the IF system. Atmospherics and tube noises are reduced more for a given frequency-band width, since the audio image signal is highly attenuated.

The audio image signal appears only in CW reception. This is the signal, on the opposite side of the second heterodyne (CW) oscillator frequency from that of the desired signal, which would produce the same audio frequency in the receiver output as the desired signal. As an example, if two signals differing by 2 KC are received they would produce intermediate frequencies differing by 2KC which would both pass through the IF amplifier if it had a sufficiently broad frequency band-pass characteristic. If the CW oscillator frequency is midway between the two signals, each would produce the same audio signal frequency of 1000 cycles. The two signals therefore cannot be separated with any amount of selectivity in the audio circuits. With sufficient selectivity in the IF circuits, either one of the signals may be received and the other rejected.

Intermediate Frequency Amplifier. Three stages of IF amplification are used. The first two stages use type RCA-6D6 tubes and the final stage utilizes the Pentode portion of an RCA-6B7, the two diode plates being used for the second detector and AVC. The first IF transformer has its primary and secondary tuned and is coupled through the crystal filter link as described above. The second and third transformers have primary and secondary tuned, the couplings being permanently adjusted to produce the desired frequency primary and untuned secondary feeding the detector and AVC diodes.

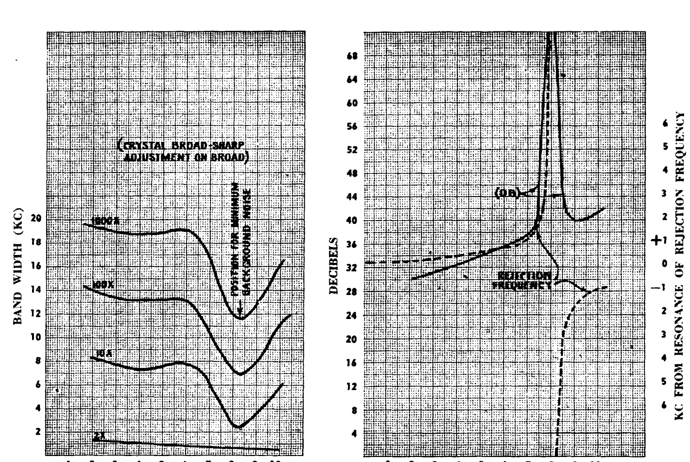


FIG. 2—Curves showing change in band width and rejection (in D.B.) with variation of crystal selectivity control.

Note: Control position for minimum background noise will vary with each receiver.

The third IF stage is not connected to the AVC or manual volume control; consequently, a better AVC characteristic with less overload distortion is obtained. This also

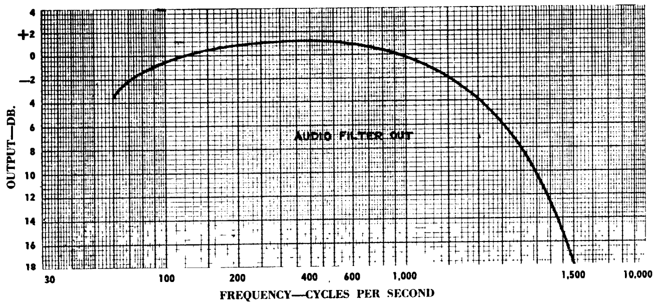


FIG. 3—OVERALL FIDELITY CHARACTERISTIC.

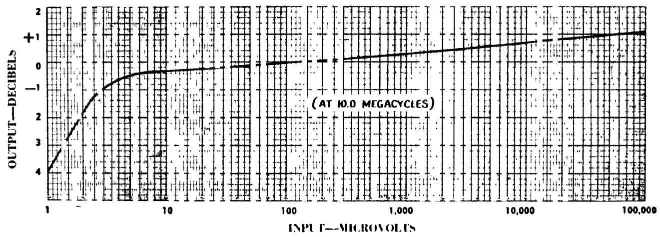


FIG. 4—AUTOMATIC VOLUME CONTROL CHARACTERISTICS.

permits the CW oscillator to be coupled to the grid circuit of this stage, giving a comparatively high detector excitation voltage with small electrical coupling to the oscillator circuit.

Second Heterodyne Oscillator. The second heterodyne (CW) oscillator is the pentode section of an RCA-6F7 and is electronically coupled to the final IF stage. A panel control is provided by means of which the frequency of the heterodyne oscillator and resultant audio beat note may be varied. Particular care has been taken in the design of the circuit constants to minimize oscillator harmonics. The triode section of this same tube is used as an audio frequency amplifier.

Automatic Volume Control. The AVC diode of the RCA-6B7 is biased approximately 12 volts in order to produce delayed action. After the signal voltage reaches this value, a negative voltage is produced in the diode circuit which is fed back to bias the RF and IF amplifiers. The gain of the receiver is such that the AVC starts to control with a signal input of the order of one microvolt. The audio frequency gain is high enough so that maximum power output may be obtained with a 30% modulated signal with the AVC in use. A switch is provided on the front panel to disconnect the AVC.

The second heterodyne (CW) oscillator excitation voltage is just lower than the AVC diode bias voltage so that it does not decrease the sensitivity of the receiver and the AVC may be used on CW telegraph signals equally as well as on modulated signals. The CW switch automatically connects an additional capacitor in the AVC circuit to increase the time constant, so that at normal keying speeds, the AVC continues to function and the background noise does not come up between characters. This also avoids introduction of irregularities in characters.

Manual Volume Control. Two manual controls are provided; an audio gain control which is employed when the AVC is in use to obtain the desired output level, and an IF gain control for use with AVC "Off".

Output Tube. The output tube is resistance-coupled from the AF amplifier and operates into an output transformer which matches the tube to a 600 ohm line. The center-tap of the output transformer secondary is grounded and an electrostatic shield is provided to maintain balance to ground. The 600 ohm output circuit is provided to facilitate operation over long telephone connections and with the newer type low-impedance phones. Two output jacks are provided so that local monitoring may be obtained at the same time a telephone line or loudspeaker is in use.

Audio Filter. An audio filter "On-Off" switch on the front panel connects a capacitor across the output tube plate circuit resonating the output transformer to approximately 800 cycles and permitting a reduction in noise level on telegraph or phone reception where reproduction of higher and lower frequencies is not required.

Power Pack. The power pack mounted on the receiver chassis consists of a power transformer, rectifier tube, and filter. By a simple wiring change, the transformer is adaptable for operation from 110 or 220 volt, 40-60 cycle supplies.

Shielding. Interstage shielding is provided to insure stability under all operating conditions. Complete external shielding prevents coupling to any portion of the circuit except through the antenna circuit, and minimizes radiation from the oscillators.

Filtering. All power leads are filtered with resistance-capacitor filter where necessary to eliminate interstage coupling and reduce feedback through the power supply leads. The detector and audio circuits are sufficiently filtered so that no appreciable radio frequency is obtained in the receiver output circuit.

Construction

General. The receiver is arranged for either cabinet or rack mounting, and all operating controls are on the panel. A self-contained power supply is mounted on the chassis for complete AC operation.

Panel. The aluminum panel is 19″ long, $10\frac{15}{32}$″ high and $\frac{3}{16}$″ thick. The following controls are on the front panel:

1. "Main Tuning"
2. "Band Spread" tuning
3. "Band change switch"
4. "Antenna Coupling"
5. "Antenna Trimmer"
6. "Volume" (audio gain)
7. "Sensitivity" (IF gain)
8. "Beat Frequency"
9. "Crystal Selectivity" (in conjunction with this, a switch operated by the same control cuts the crystal in or out of operation).
10. "AVC" switch
11. "CW-MOD" switch, controlling beat frequency oscillator
12. "Audio Filter" switch
13. "Antenna" and "Ground" binding posts
14. "Output" jacks (2)
15. "Power" switch

Adjacent to each of these controls are suitable nameplates clearly indicating the function of the control.

In addition, an equipment nameplate is attached to the panel. When used with a

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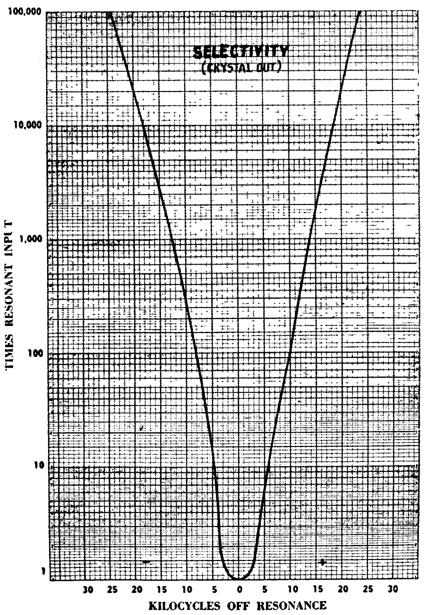

FIG. 5
SELECTIVITY CURVE (CRYSTAL OUT)

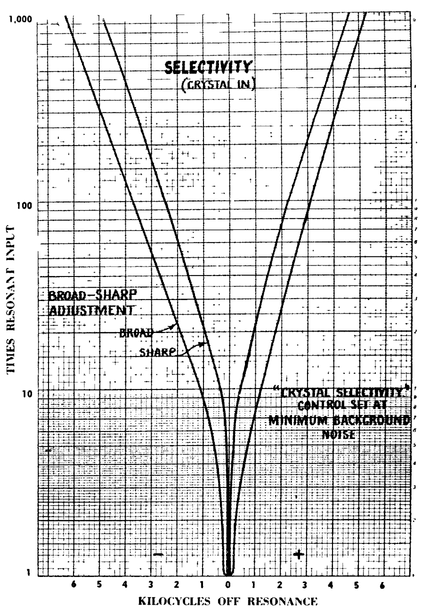

FIG. 6
SELECTIVITY CURVES (CRYSTAL IN)

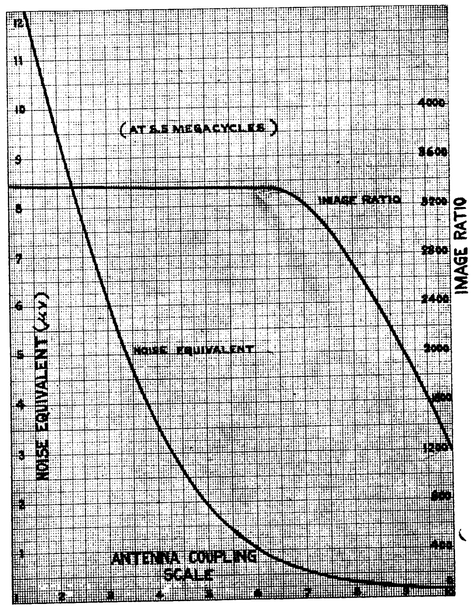

FIG. 7
CURVES OF NOISE EQUIVALENT AND IMAGE RATIO WITH VARIATIONS IN ANTENNA COUPLING.

RCA AR-60 Receiver

(Continued from page 23)

cabinet, handles are provided at each side for withdrawing the chassis from the cabinet.

Chassis. The chassis is attached directly to the panel and forms part of the RF shielding. It is flanged down on all four sides, with parts mounted both above and below it. Partitions on the underside form five compartments in which are located antenna coupling coils; RF coils; band change switches; tube sockets for RF first detector and orcillator tubes; and filters in the power supply leads. In one partition, separating two compartments at the front of the chassis, is an electrostatic shield through which coupling from the antenna coils to the first tuned circuit takes place. The bottom of the chassis is provided with a removable plated brass cover.

Tuning Capacitor. The tuning capacitor is a four-gang unit with two shafts and controls, built on a cast-bronze frame and mounted on three points with the shafts running from front to rear in the center of the chassis. The shafts are mounted one above the other, the lower one carrying the four main sections, and the upper one carrying four small "band-spread" sections, each in parallel with the corresponding main section for fine tuning. The stators are mounted on Isolantite insulators, and grid coupling capacitors are attached to the capacitor frame on Isolantite insulation supports. Each shaft is driven by a cord drive with approximately 9 to 1 reduction from the control shafts, which are carried in bearings on the capacitor frame. Each shaft extends through the panel carrying a pointer reading on a stationary dial on the front of the panel.

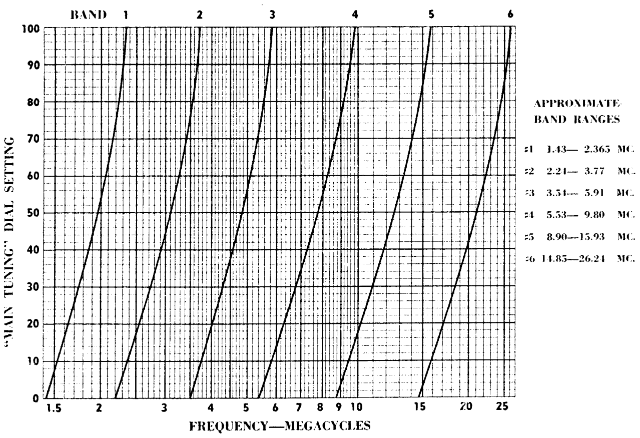

FIG. 8—Typical frequency calibration curves. Type AR-60 receivers. ("Band Spread" on 50)

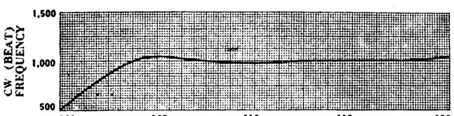

FIG. 9

Curve showing variation in CW (Beat) frequency with short period variations in line voltage (taken at 10.5 megacycles)

Band Change Switch. The band change switch is mounted underneath the chassis with its shaft parallel to and directly beneath the capacitor shaft. It consists of eight positions. The sections in the front shielded compartment switch the first tuned circuits of the first RF tube. In the second compartment from the front, another section switches the three higher frequency circuits for the second RF stage. In the third compartment are located the first detector switch sections and in the rear compartment the oscillator circuit switches. These sections are all individually supported to provide for self-alignment and are driven by a square stainless steel shaft which may be withdrawn without disturbing sections or wiring, so that any individual section may be removed. A detent and stops on the shaft locate the six operating positions to correspond with the frequency range positions on the panel.

Each section of the switch has its own bearing for the rotor. Both the stator plate and the rotating contact support are of Isolantite. Particular care has been taken in the design of the switch to obtain low contact resistance over long periods of time and to make the switches self-cleaning. Solid silver contact buttons are riveted to the rotating springs which made contact to heavy silver-surfaced studs mounted on the Isolantite stator plates. No pigtails are used, connections being made entirely by the double-armed contacts from one set of studs to another. Thus, no connection is made through bearing contacts and the shaft is insulated from RF circuits.

IF Transformers. The IF transformers are mounted in shield cans on the top of the chassis. They are composed of multi-section universal wound coils of Litz wire on Isolantite forms. Air dielectric padding capacitors are used. These are mounted on treated Isolantite bases and are adjustable from outside the shield cans.

Crystal Flter. The crystal filter unit is completely Isolantite insulated and is mounted at the rear of the chassis. A shaft from the crystal selectivity control capacitor extends to the panel and at the minimum setting of this control operates a switch which short circuits the crystal.

Materials and Finishes. Materials are selected for resistance against effects of moist, salt atmosphere. The use of ferrous materials except where necessary for magnetic purposes is kept to a minimum. All insulation material in RF and IF circuits is Isolantite. Other insulation material, such as used for resistor and terminal boards, is the best grade of cloth-base bakelite. All fixed capacitors, transformers and reactors are sealed against moisture. Audio transformers are specially impregnated and sealed to withstand actual submersion in salt water. The steel cases for transformers, filter capacitors and the reactor are given a double cadmium plate to insure complete protection. All brass and bronze parts are protected by nickel finish. Aluminum parts are protected by clear lacquer applied after a light sandblasting to secure adhesion.

Weight. The weight of the receiver complete for table mounting is approximately 80 pounds.

The weight of the receiver complete for rack mounting is approximately 72 pounds.

Overall Dimensions. The overall dimensions of the three types are as follows:

	AR-60-R	AR-60-T	AR-60-S
Height, inches	10½	11 3/16	12½
Depth, inches	16¼	16⅝	17⅝
Width, inches	19	19½	22¼

Performance

Table 1 shows data taken on a sample receiver. The following statements of performance are the limits set for production receivers. The variations noted are due to practical manufacturing tolerances and normal variations in tube characteristics.

Frequency Range and Overlap. The frequency range is from 1500 to 25,000 KC, and is covered in six bands. Sufficient overlap is provided to assure freedom at all times from hiatus in the entire frequency range of the receiver.

The nominal frequency range of each band is given in the following table:

Band No.	Frequency Range (Megacycles)
1	1.50- 2,29
2	2.29- 3.63
3	3.62- 5.65*
4	5.65- 9.25
5	9.25-15.2
6	15.2 -25.0

* The 3.5 to 4.0 megacycle amateur band is completely covered on this band setting due to overlap of tuning ranges for each band.

Sensitivity. An input of 2 microvolts or less, 30% modulated at 1000 cycles, applied to the receiver input through a 300 ohm artificial antenna is required to produce 6m.w. output.

Noise Equivalent (Microvolts CW). In an effort to obtain quantitative information on the noise rating of different receivers, the term "Noise Equivalent" has been coined. Noise equivalent is the input in microvolts, through the normal input circuit, which would be required to product an output equal to the receiver noise output.

The value of the noise equivalent may be obtained by setting the receiver "Sensitivity" control to produce a readable deflection of an output meter due to receiver noise. For example, suppose the reading is 0.5 volt. A signal is then applied from a signal generator and the input to the receiver adjusted to produce any arbitrary output. Suppose the output of the receiver measures 3.0 volts with a signal input of 1.2 microvolts. Assuming that the output of the receiver varies in a straight line relationship to the input, which is correct up to the point where the receiver circuits overload, if 1.2 microvolts input gives 3.0 volts output then the output of 0.5 volt noise is equivalent to one-sixth as much input or 0.20 microvolts. This is then the noise equivalent.

It is further assumed that the reading of 3.0 volts is due entirely to the 1.2 microvolts signal and the noise voltage in the output is neglected. This assumption is permissible because the output signal and noise voltages add algebraically and are equal to the square root of the sum of the squares of the noise and signal voltages. An error of only about 1.0% is therefore introduced.

The noise equivalent should be checked under normal conditions of antenna loading, so in the measurements made on this receiver, a 300 ohm resistor was used in series with the signal generator output to simulate a transmission line or an average antenna.

Under this condition the AR-60 receiver will have a noise equivalent of 0.3 microvolts or less at the low frequency end of each band and 0.30 or less at the high frequency end of each band.

TABLE I

Band No.	-1 Noise Equiv. (CW) (Microvolts)	Image Ratio	-2 Modulated Signal/Noise Ratio (Microvolts)	Band Spread Range (KC)	-3 Frequency (KC)	% Overlap	-4 Stability (Parts per million per %)
1-LF	.26	30,000	2.0	28	1,430	4.7	0.7
1-HF	.22	14,600	1.5	150	2,360	4.8	2.0
2-LF	.21	10,800	1.7	45	2,250		0.9
2-HF	.17	3,800	1.5	200	3,720	6.1	2.7
3-LF	.20	3,000	1.6	80	3,500		1.4
3-HF	.15	1,050	1.3	340	5,820	5.3	3.7
4-LF	.18	172,000	1.5	110	5,520		1.3
4-HF	.17	22,000	1.4	550	9,725	8.3	1.0
5-LF	.22	25,400	1.7	175	8,950		1.0
5-HF	.20	3,000	1.5	975	15,750	5.6	3.3
6-LF	.33	5,700	2.1	350	14,900		2.2
6-HF	.23	930	1.5	1,500	26,050	4.2	6.4

-1—See Section VI.
-2—See Section VI.
-4—Line voltage changed from 100 to 120 volts. See curve, Figure 4.
-3—Band Spread set on 50.

Modulated Signal to Noise Ratio. With the receiver sensitivity adjusted for an output of 1.5 MW noise with an unmodulated signal output, approximately 2.7 microvolts 30% modulated at 1000 cycles at the low frequency end of each band and 2.2 microvolts at the high frequency end of each band are required to produce an output of 6.0 MW signal plus noise. With a straight line detector, such as employed in this receiver, this measurement may be converted to noise equivalent by using the above method and multiplying by 0.3 (the percentage of modulation). This figure will check the CW equivalent noise within the error of measurement. Because of the difficulty of making this measurement, it is suggested that the measurements of noise equivalent made on VW be used as a standard of comparison.

Selectivity. The selectivity band width (crystal out) is less than 35 KC wide at 1000 times normal input and more than 5KC at 2 times normal input. The curves, Figures 12 and 13, were taken on a sample receiver.

Power Output. The maximum power output is approximately 500 milliwatts.

Image Response. The image ratios for the various bands of the receiver are approximately as follows.

Band No.	Ratio
1	Above 5,000
2	" 2,000
3	" 500
4	" 15,000
5	" 1,000
6	" 500

A substantial increase in image ratio is readily obtainable if the antenna coupling is reduced by means of the control on the front panel. However, reduction in coupling will be accompanied by a decrease in signal to noise ratio except under conditions where the local noise level or static exceeds the inherent receiver noise level. (See curve, Figure 7.)

AVC Characteristics. The curve, Figure 4, shows the characteristics of the automatic volume control as taken on a sample receiver.