CHAPTER 3

OPERATING PRINCIPLES OF A REPRESENTATIVE VHF RADIO COMMUNICATIONS RECEIVER SET, AN/URR-27

INTRODUCTION

The Radio Receiver Set, AN/URR-27 is a complete receiver system which is designed to provide means for reception of voice amplitude-modulated (A-3) and MCW (A-2) transmissions in the frequency range of 105 to 190 mc. The theory of operation of the system receiver is discussed in this chapter. The AN/URR-27 receiving set replaces the RCK receiving equipment which is now obsolete. An acceptable substitute for the AN/URR-27 is the AN/URR-21, or 21A. The AN/URR-21, 21A is the same as the RCK except that it uses miniature tubes.

GENERAL DESCRIPTION

The Radio Receiver Set, AN/URR-27 (fig. 3-1) consists of: (1) a radio receiver, R-516/URR-27; (2) a pair of auxiliary angle brackets for relay rack mounting; (3) four plugs to mate with receptacles on the receiver for making external connections; and (4) two copies of the equipment technical manual.

The system components are grouped, on a functional basis, into five major sections: (1) preselector (fig. 3-2); (2) IF/AF; (3) power supply; (4) cable filtering (fig. 3-3); and (5) the front panel (fig. 3-1).

The first three sections are assembled within the chassis frame (Fig. 3-2), and the front panel section is attached to the front of this frame. The cable filtering section (band suppression filter) is mounted against the rear wall of the cabinet (fig. 3-3).

The purpose of each of these sections is implied in the section name. The preselector section consists of the r-f amplifier-converter and the oscillator-multiplier subsections. The ganged tuning capacitors in the two subsections are geared together through a common dial drive assembly. The receiver is tuned by a single front panel tuning control. The front panel section contains all controls and meters which are required for operation and monitoring of the receiver circuits.

The band suppression filter assembly contains r-f noise filter circuits for the power

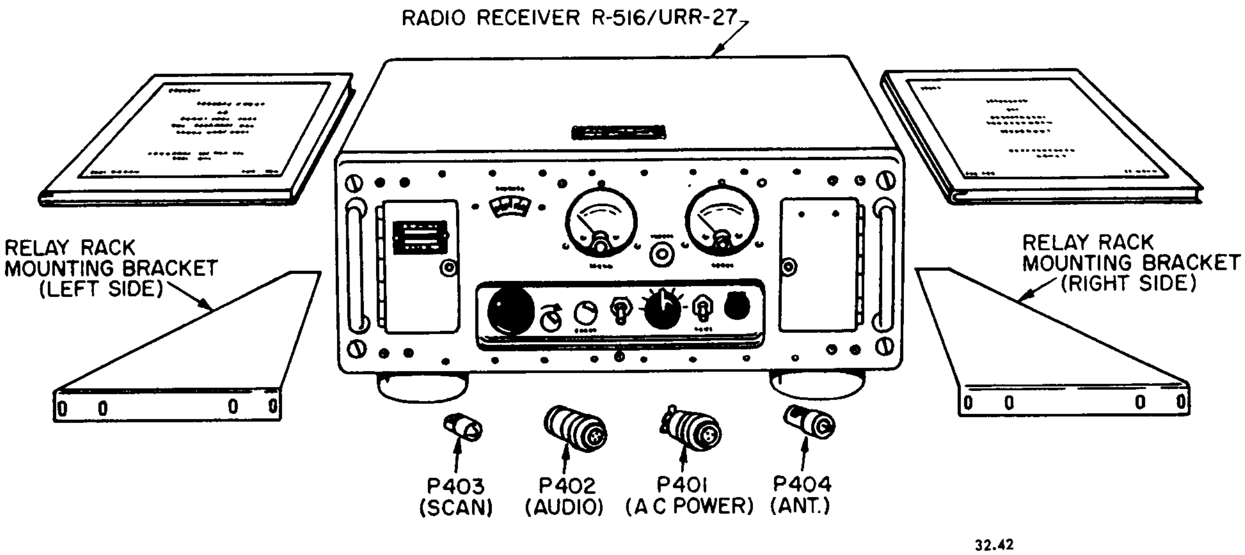


Figure 3-1.—Radio Receiving Set, AN/URR-27 (complete).

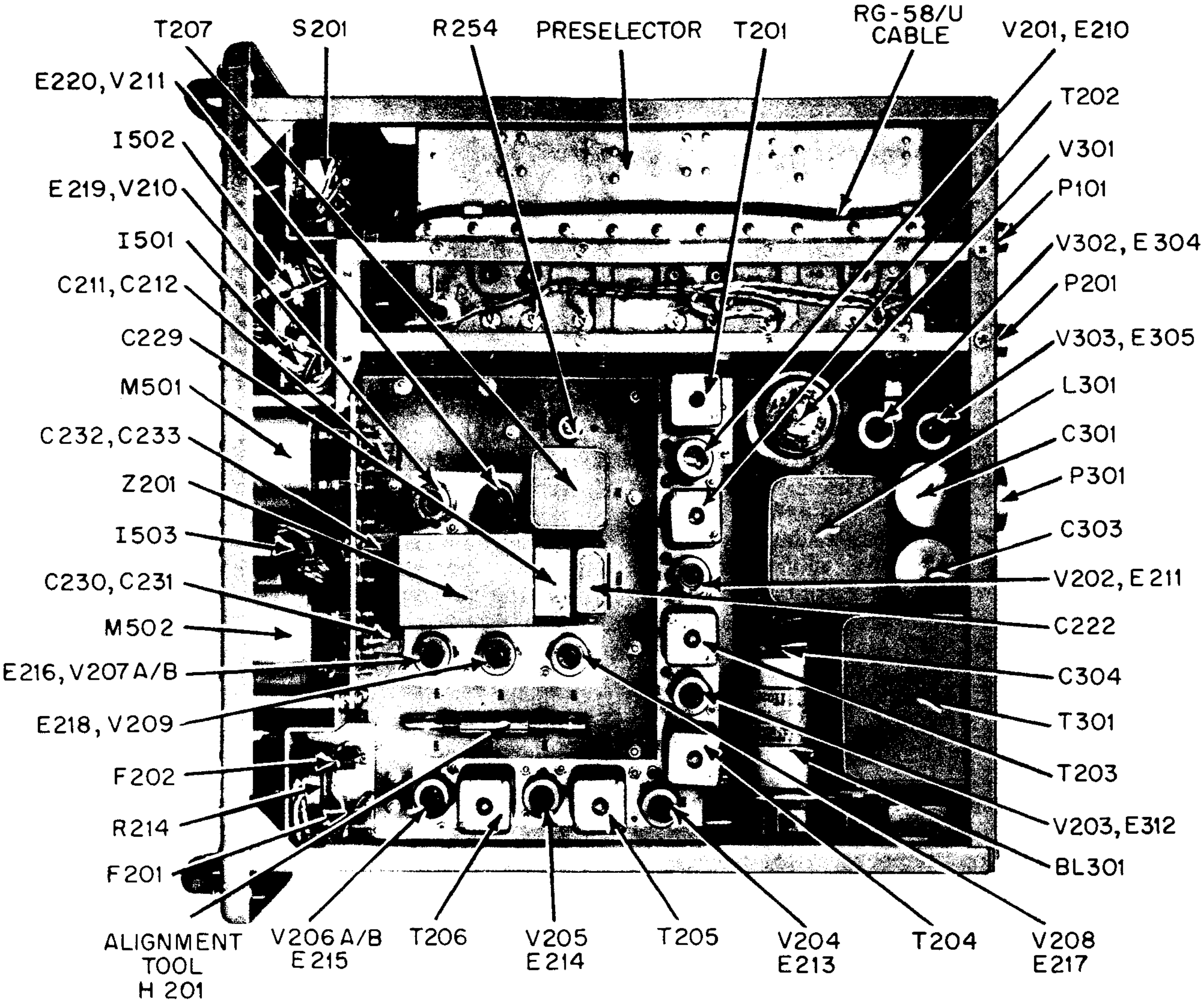


Figure 3-2.—Preselector Section. 32.43

input and audio output circuits. It provides connections from the receiver proper to the antenna input and scan channel output circuit connectors. The antenna input and scan channel terminating plugs contained on the filter section require a 50-ohm coaxial transmission line for impedance matching.

The Radio Receiving Set, AN/URR-27 is a v-h-f superheterodyne type of receiving equipment, designed primarily for operation as a pretuned single-channel crystal-controlled receiver. The crystal (holder), fuses, and various receiver controls are located behind small doors, in panel compartments, to the right and left of the receiver chassis (fig. 3-4). By employing a suitable crystal any channel within the frequency range of the receiver may be selected.

$$\text{Crystal frequency} = \frac{\text{Channel frequency} + 18.6 \text{ mc}}{6}.$$

Continuously variable manual tuning is also a feature of this receiver.

A single tuning control E501 (fig. 3-4) is employed for tuning to any frequency for either crystal-controlled or manual tuning operation. Either of these two methods of operation is selected by an oscillator switch (CRYSTAL-MANUAL) on the receiver front panel.

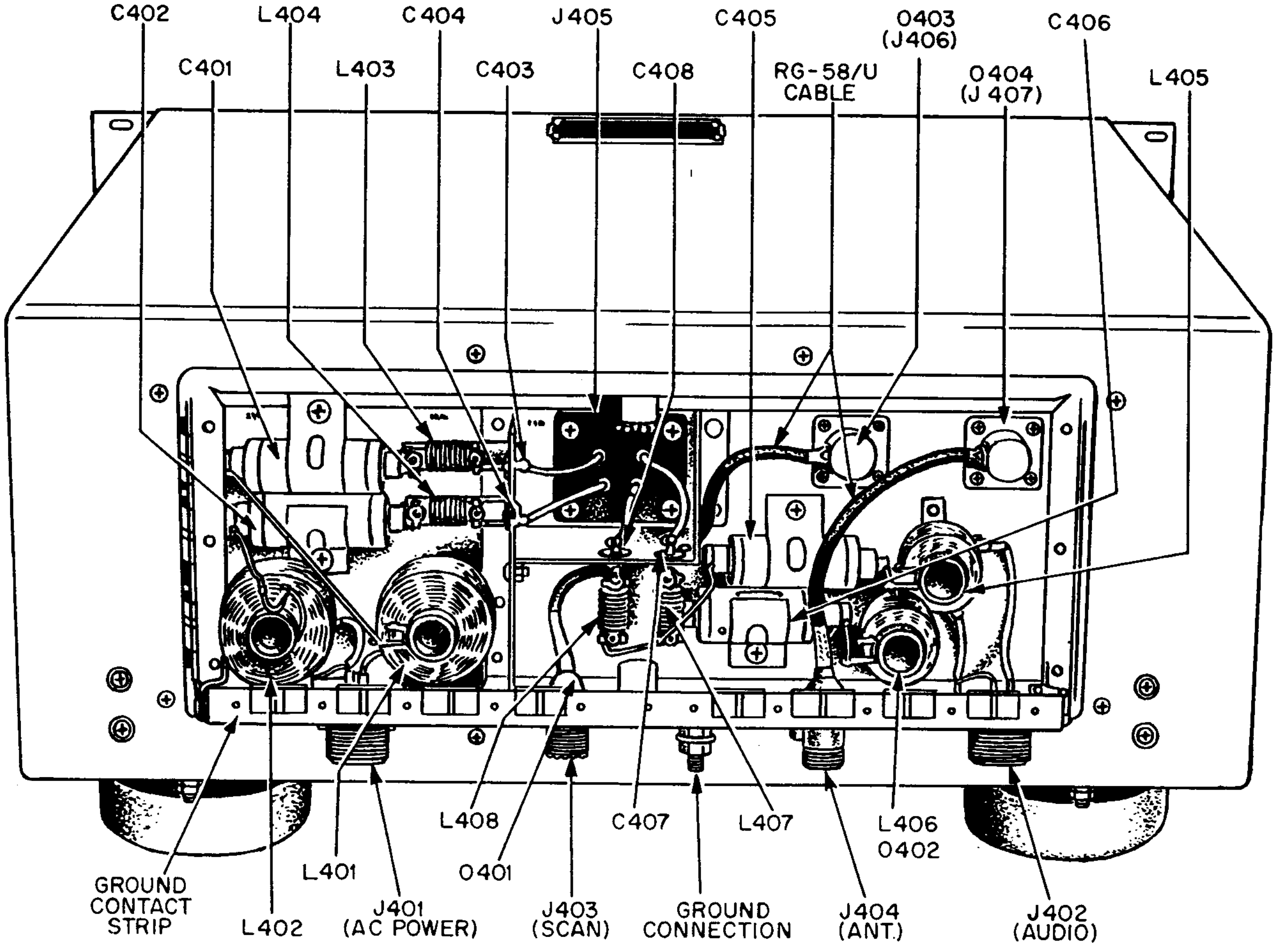


Figure 3-3.—Cable Filter Section. 32.44

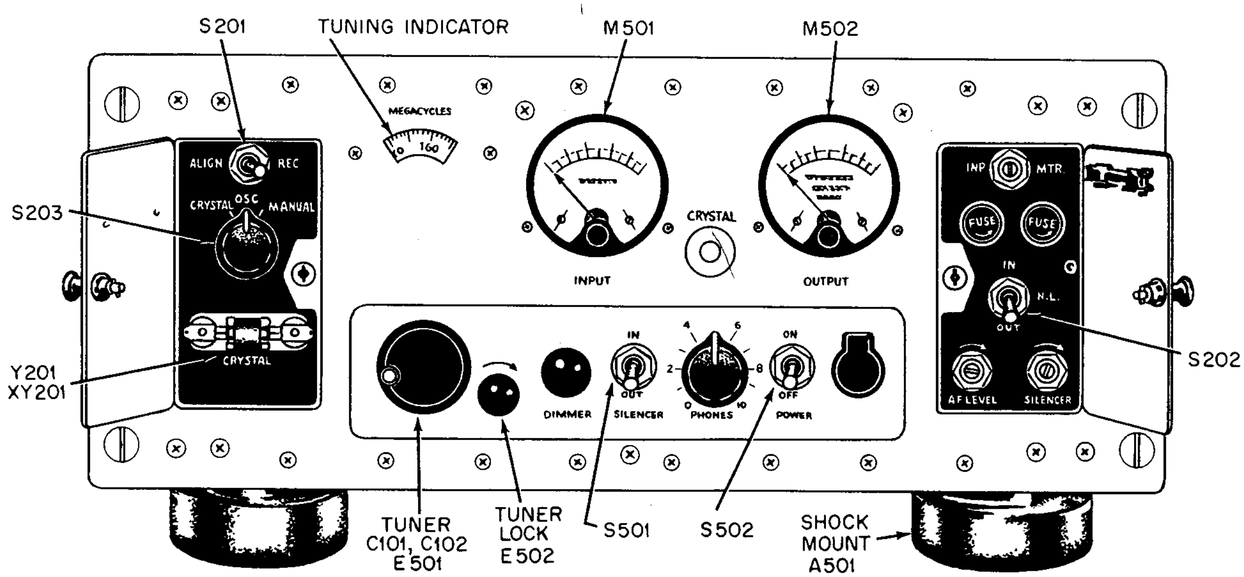


Figure 3-4.—Front Panel, doors open. 32.45

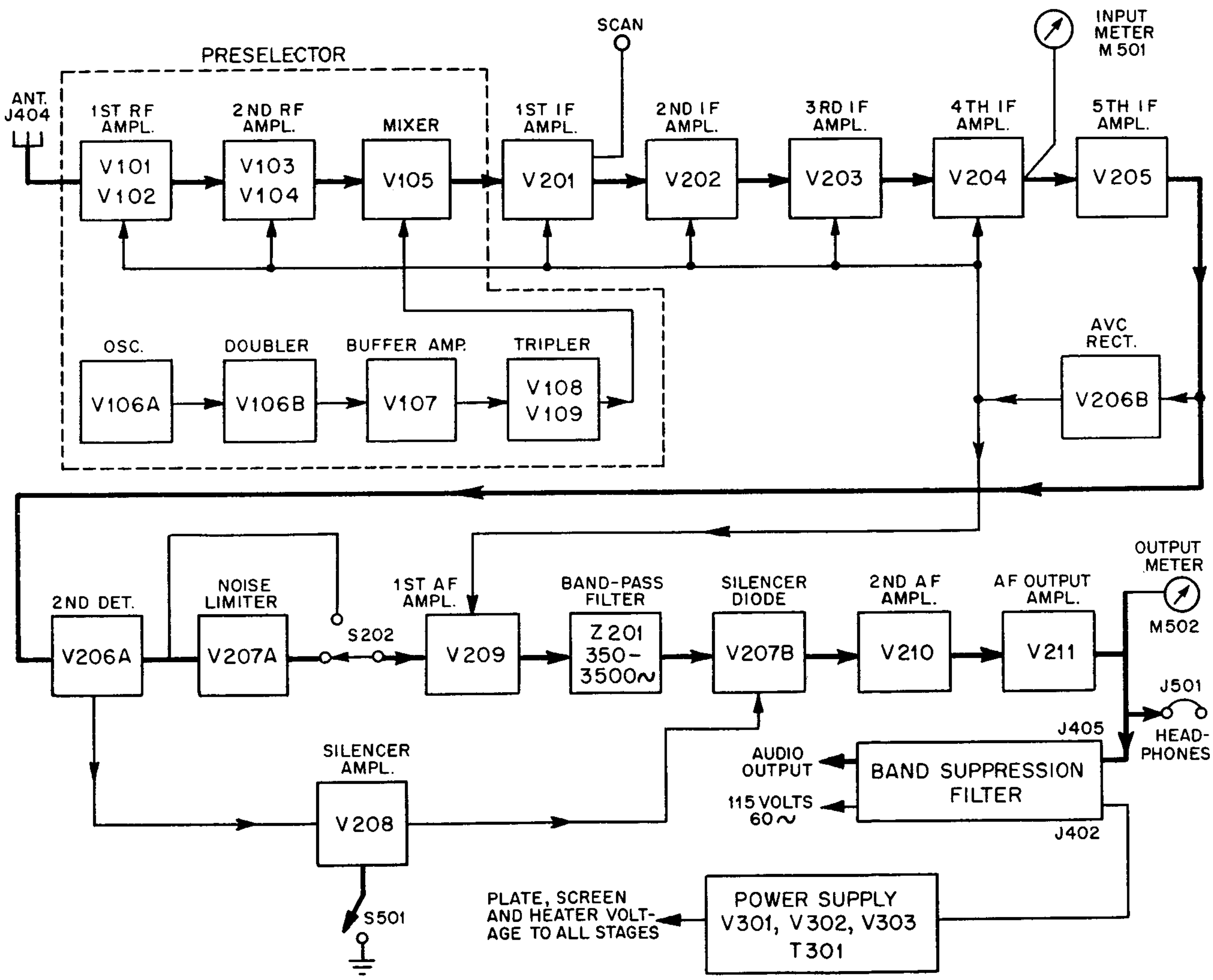
The receiver produces a 10 db signal-to-noise ratio from a 5 microvolt input, and uses an 18.6 mc intermediate frequency. Stable operation and freedom from spurious radiation from the receiver antenna is accomplished by using balanced push-pull circuit arrangements in the r-f amplifier and oscillator-multiplier circuits.

BLOCK DIAGRAM

The block diagram (fig. 3-5) reveals that the receiver is of conventional design. Because of the high frequencies at which the receiver operates (105-190 mc), however, many special circuits are employed which improve the overall efficiency of the receiver.

The received signal from the antenna is coupled via J404 to the first r-f amplifier, which comprises V101 and V102 in a push-pull circuit arrangement. The amplified output of V101 and V102 is applied to the second r-f amplifier (comprising V103 and V104 in push-pull) and thence to the mixer, V105. The local oscillator signal is obtained from an oscillator stage, V106A, followed by three stages of frequency multiplication, V106B through V109.

The tuning arrangement for the two push-pull connected r-f amplifier (comprising V101 through V104) and the mixer stage, V105, is geared to that of the local oscillator and multiplier stages to provide single-control tuning. This control is shown as E501 in figure 3-4.



32.46

Figure 3-5.—Block Diagram, radio receiver.

The local oscillator functions as either a crystal-controlled or self-excited circuit, depending upon the position of the CRYSTAL-MANUAL switch S203 in figure 3-4. All oscillator and r-f stages (front end) are part of the preselector subassembly.

The mixer, V105, output signal at a frequency of 18.6 mc, is fed to a first i-f amplifier, V201, which is arranged as a split-load amplifier; the tube functions as both the first i-f amplifier and as a cathode follower to provide output for a scanning channel indicator (panoramic adapter). The first i-f amplifier, V201, amplifies the 18.6 mc signal and applies its output to the second i-f stage, V202.

The stages comprising V202, V203, V204, and V205 (fig. 3-5) are conventional intermediate amplifiers. These stages amplify the 18.6 mc i-f signal from V201. The i-f output from V205 is rectified and filtered in the detector stage, V206A, and by the AVC rectifier, V206B.

The AVC voltage developed is applied to the grids of both r-f amplifiers, the first four i-f amplifiers and the first a-f amplifier. The input meter, M501, located at V204 is provided to indicate the approximate incoming signal strength, and it also serves as an alignment indicator for the oscillator-multiplier section.

The output of the audio detector passes through a series diode noise limiter, V207A, (which may be bypassed by switch S202, figure 3-4) into the first a-f voltage amplifier, V209. The output of this amplifier passes through an a-f band-pass filter, Z201, having a pass-band of 350 to ?500 cps, and through silencer diode V207B into the second amplifier V210. The amplified audio signal from V210 is then applied to the a-f output stage V211, the output of which drives the headset or external speaker.

The audio output stage, V211, applies its signal to the headphone jack, J501; to the output meter, M502; and via the connector, J405, for external use through the output jack, J402, located at the rear of the cabinet, as shown in figure 3-3. The band suppression filter is located between jacks J405 and J402 to filter out all external r-f fields.

The silencer diode, V207B, between the band-pass filter, Z201, and the second audio amplifier, V210, is controlled by the silencer amplifier, V208, which permits the diode to conduct when a signal is present at the audio detector. If no signal is present, the diode cuts off, preventing any noise from reaching the second audio stage. The noise silencer may be cut IN or OUT by action of the silencer switch, S501 (fig. 3-4), which is in the cathode circuit of V208.

All power necessary for operation of the equipment is obtained from a built-in power supply which can be adjusted to operate from a 105-, 115-, or 120-volt 60-cps single-phase input power source. The power transformer, T301, and rectifier tube, V301, produce the d-c voltage necessary for the plates and screens of the amplifying tubes. Voltage regulation as required for best operation of the oscillator and various other stages is accomplished by voltage regulator tubes V302 and V303. Bias voltage is also obtained from this power source. Filament power is derived from the filament windings of T301. The input power is filtered in the band suppression filter section (fig. 3-3) to minimize radio-frequency interference.

CIRCUIT ANALYSIS

The Radio Receiver Sets, AN/URR-27 (VHF) and AN/URR-35A are almost the same except for their range in frequency, special circuits (noise limiter and silencer) and occasional minor internal circuit design changes, and the additional i-f stage in the AN/URR-35A.

At the present time more u-h-f and fewer v-h-f receivers are being used in the fleet. Therefore, Chapter 4, Representative UHF Radio Communications Receiver Set, AN/URR-35A, covers in more detail explanations of circuits that are common to both equipments. Circuits or variations of circuits peculiar to only the AN/URR-27 are discussed in detail in this chapter.

PRESELECTOR SECTION

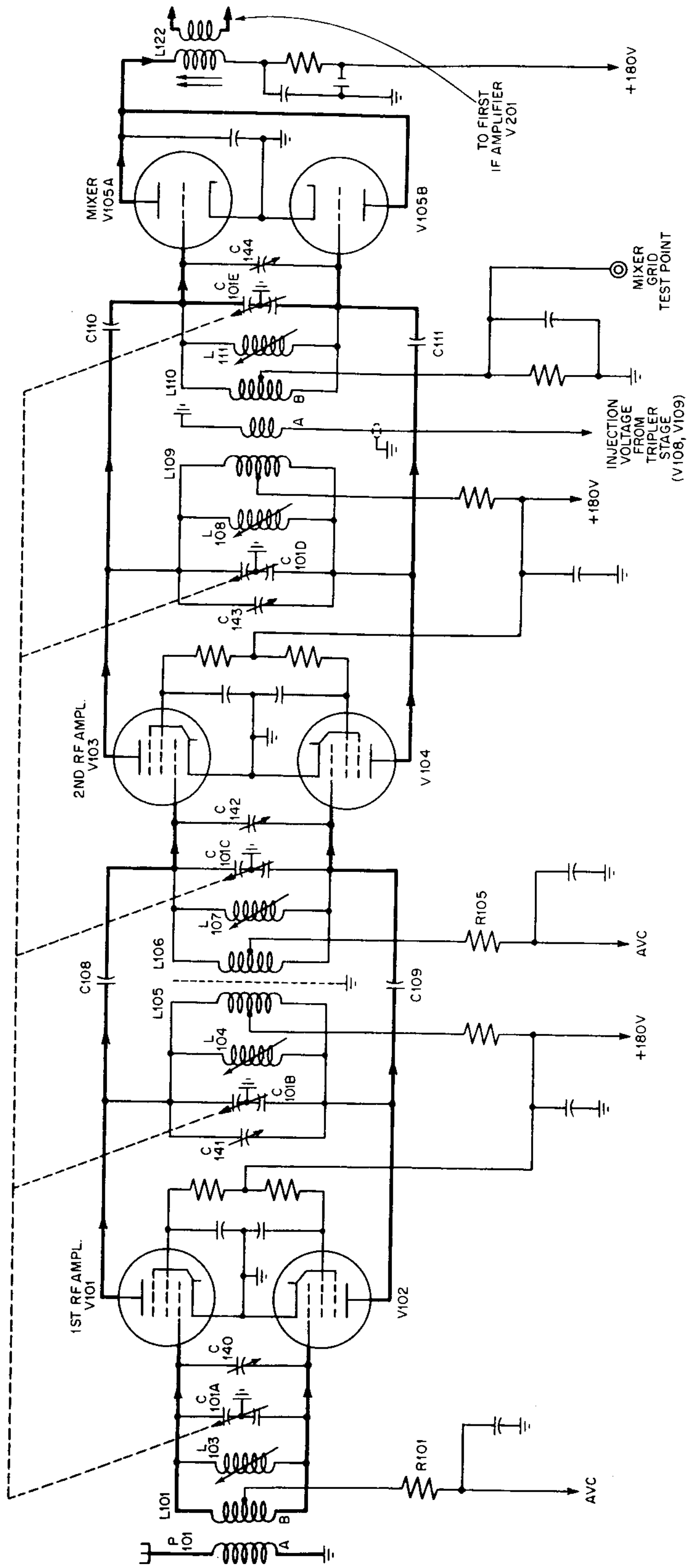
The preselector section contains the r-f and multiplier-oscillator sections.

Antenna Input

The antenna input is the same in both sets except that in the URR-27 the inner conductor from P101 extends to the inductance, L101, and is coupled to the input circuit of the first r-f amplifier stage (fig. 3-6). Antenna coupling coil, L101 serves to transform the unbalanced coaxial input to a balanced circuit.

R-F Amplifiers

The grid and plate circuits of the two r-f amplifier stages (fig. 3-6), comprising V101 through



32.47

Figure 3-6.—R-f Amplifier Section of Preselector.

V104, and the grid circuit of the mixer stage, comprising V105A and B, are arranged in push-pull, and are tuned by a balanced-type five-ganged air dielectric capacitor, C101. Each section of this capacitor (fig. 3-6) consists of a split-stator plate and a rotor plate which are mounted on a common metal shaft.

Concentric-type trimmer capacitors, C140 through C144, are used for aligning the high frequency end of the tuned circuits in the r-f amplifier and mixer stages.

Alignment at the low frequency end of the tuning range is accomplished by trimmer inductances, L103, L104, L107, L108, and L111.

The input signal is coupled to the grids of the push-pull stage, V101 and V102, by L101. The push-pull arrangement reduces the lengths of the connecting leads and cancels spurious radiation of unwanted signals into the antenna. This arrangement tends to approximately halve the effect of tube capacitance, permitting a greater range of frequency coverage with higher circuit efficiency.

The output of the first r-f amplifier is coupled directly to the grids of the second push-pull stage, V103 and V104, through capacitors C108 and C109, respectively. Plate and screen voltage supply circuits in the preselector section are of conventional design.

Note that operating bias for the first r-f amplifiers, V101 and V102, is obtained from the AVC circuit through R101 and the center tap of L101B. The second r-f amplifiers, V103 and V104, are biased in the same way through R105 and the center tap of L106. These are conventional AVC circuits.

The output of the second r-f amplifier is coupled directly to the grids of the mixer stage, V105A and B through capacitors C110 and C111, respectively.

Mixer

The signals coupled to the grids of the mixer stage, V105A and B, are mixed with multiplier oscillator signals which are link coupled to the mixer grids through L110A. The mixer output is link coupled to the first i-f amplifier, V201, through L122.

Oscillator-Multiplier

The oscillator-multiplier section of the preselector (fig. 3-5) generates the local injection signal which is 18.6 mc higher in frequency than the received signal. The basic oscillator frequency is generated in a cathode-coupled crystal-controlled circuit, comprising V106A and B. The oscillator circuit arrangement is that of a Butler oscillator, V106A, and a cathode follower doubler, V106B, (figure 3-7).

The V106 oscillator functions as a crystal-controlled circuit when the OSC switch, S203, is in the CRYSTAL position, as shown. The crystal, V201, operates in a series resonant mode (harmonic mode) to establish the frequency of the feedback voltage from the cathode of V106B to the cathode of V106A. Capacitor, C159, connected in series with the crystal, is used to resonate with the inductance of the crystal leads, so that zero phase shift exists between the two cathodes.

With S203 in the CRYSTAL position, the final local oscillator frequency to the mixer, V105 (fig. 3-5), will lie between 123.6 and 208.6 mc as determined by the crystal selected. Since the crystal frequency is multiplied 6 times (see fig. 3-5), any crystal having a fundamental frequency between 20.6 and 34.766 mc may be used.

For manual tuning, the crystal is shorted out by placing switch S203 in the MANUAL position; V106A then functions as a free-running oscillator, the frequency of which is determined by the setting of tuning capacitor, C102A. The stability of the free-running oscillator is not as great as the crystal-controlled circuit since the feedback path of the cathodes is not frequency selective.

During manual operation, the range of the oscillator is from 20.425 to 35.0833 mc. The frequency at the output of the multiplier stages (fig. 3-5) will range from 122.55 to 210.50 mc. Thus, the radio receiver will be operative over a range of input frequencies from 103.95 to 191.9 mc.

The original factory adjustments and alignment of the receiver were made with a crystal in the socket. It follows therefore, that the dial calibration will be more accurate, and the receiver gain greater, if the receiver is operated in the same manner during MANUAL operation in the field. The receiver may be operated however, with or without a crystal in the crystal socket.

This calibration inaccuracy is attributable to the fact that there is some capacity between the crystal, crystal-holder, and ground which influences the oscillator frequency even though the crystal is shorted by S203. Removing the crystal from its socket lowers the capacitance and thereby causes an increase in the frequency of the oscillations.

Buffer amplifier, V107, is a conventional amplifier circuit, which provides isolation between the oscillator and the tripler stages. In the

AN/URR-35A, V107 becomes a doubler stage which increases the final output multiple to the mixer to 12 as compared to 6 in the AN/URR-27.

The tripler stage employs two tubes, V108 and V109, in push-pull. The plate circuit is tuned to resonance at a frequency three times its grid input frequency, which results in an output frequency 18.6 mc higher than the frequency to which the receiver r-f amplifier is tuned. This output is inductively coupled through coil L113A to L113B, link coupled through L113B-L110A, and inductively coupled from L110A through L110B (fig. 3-6) on the r-f chassis, to the grid circuit of the mixer stage.

Tracking control of the multiplier-oscillator section is maintained by C102A, B, C and D. Trimmer capacitors, C145 to C148, and inductor, L112, provide for high and low end adjustment of the tuned circuits.

Test points are provided at the grids of all the multiplier stages to measure the d-c bias on their respective tubes. The measured voltage is indicative of the amount of drive which is being provided by the preceding stage.

A -3 volt holding voltage is provided for the buffer amplifier and tripler stages to prevent excessive rise in plate current if the driving voltages are removed.

A tap at the junction of resistors R120 and R121 provide a metering point for checking the driving voltage applied to the grids of the tripler tubes, by measuring the grid-leak bias developed across resistor R121. The tap is also connected to the ALIGN position of switch S201 (fig. 3-10) for alignment purposes.

IF/AF SECTION

The greatest difference between the AN/URR-27 and the AN/URR-35A lies in the i-f circuitry. The AN/URR-27 contains five i-f amplifier stages (fig. 3-8). The first amplifier stage includes a scan channel output, followed by two conventional i-f amplifier stages. The fourth amplifier stage includes an output to a meter, M501, circuit, followed by another i-f stage to the detector.

The AN/URR-35A contains six stages and differs in that a separate scan channel input is provided for a scan channel stage, along with the first amplifier stage. A second mixer and local oscillator stage is placed between the first and second i-f amplifiers, followed by only a third i-f amplifier stage to the detector. However, the URR-35A provides the meter output in the second i-f stage instead of the fourth i-f stage.

First I-F and Scan Channel Amplifier

The first i-f amplifier, V201 (fig. 3-8), is arranged as a split-load amplifier, which functions as both the first i-f amplifier and as a cathode follower to provide output for a scanning channel indicator (panoramic adapter. The scanning output is taken from resistor R202, brought through connector P201, on the IF/AF chassis to jack J406 (fig. 3-13), on the base plate of the cable filter (ban suppression filter), and through a short piece of coaxial cable to the SCAN output jack, J403, on the rear of the filter.

The signal from the mixer is applied to the grid of V201 through transformer T201. The primary is an untuned, low-impedance winding; the secondary is tuned and is resistance-loaded to provide a scanning band-width of 600 kc.

The V201 plate output is coupled to the second i-f amplifier by a doubler tuned transformer, T202.

I-F Amplifiers

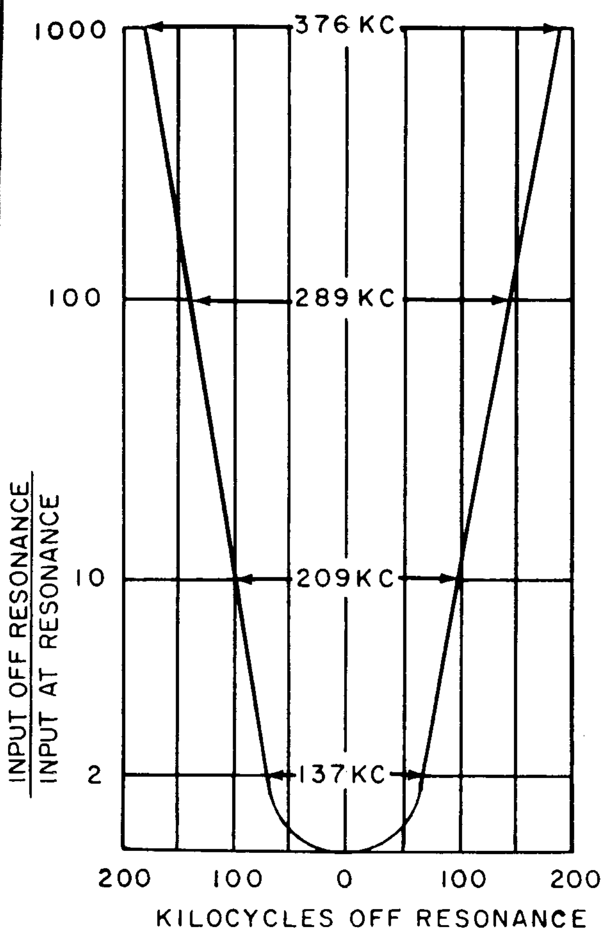
I-f amplifiers, V202 through V205 (fig. 3-8), are conventional amplifiers connected in cascade. Each amplifier utilizes a remote cutoff pentode, with double-tuned transformers used as the interstage coupling device. The i-f transformer overall i-f selectivity curve is shown in figure 3-9. The gain is maximum at resonance. In other words, the ratio of the input off resonance to the input at resonance (for an output of 1 milliwatt into a 600-ohm load) is unity at resonance and increases sharply with the deviation from resonance. All transformers used in the i-f section are tuned by powdered iron cores.

Screen voltage for all tubes is obtained from the regulated 105-volt tap on the power supply, and plate voltage from the 180-volt tap. The grid circuits of the second, third, and fourth i-f amplifiers are returned to the AVC line. AVC is not applied to the fifth i-f amplifier, V205; instead, terminal 6 of transformer T205 is grounded. Grid bias for V205 is developed across cathode resistor R217, which is bypassed by capacitor, C213A.

The fourth i-f stage also provides a metering circuit to determine the incoming signal strength and to aid in receiver alignment.

Metering Circuit

The input meter M501 (fig. 3-8) in the AN/URR-27 is identical to that in the AN/URR-35A. That is, they both indicate approximate



32.50
Figure 3-9.—Overall I-F Selectivity Characteristics.

incoming signal strength and serve as an alignment indicator for the oscillator multiplier section. Note: The AN/URR-35A input for the meter circuit is connected to the screen, whereas, in the AN/URR-27 this connection is made from the plate tank terminal 3, T205.

The action of both meter circuits is similar in that both circuits are balanced when no signal is present in the receiver. When a signal is received, the resulting AVC voltage increases the bias to the meter stage grid, and the resulting reduction in plate current decreases the voltage drop across the load resistor R216, in figure 3-8. A voltage difference now exists across the meter terminals, and an indication is obtained on the meter.

The input meter functions in the same manner when used for alignment purposes. However, the AVC voltage is replaced by grid-leak bias when aligning the oscillator multiplier section.

Filament circuits to all i-f stages are provided with h-f chokes, L202, and bypass capacitors, C204B, as shown in figure 3-8, for eliminating high frequency interference.

Audio Detector and Noise Limiter

The simplified schematic diagram of the audio detector and noise limiter is shown in figure 3-10. One-half of a dual diode is used in a conventional diode circuit. I-f transformer T206 couples the signal from the fifth i-f stage, V205, to the detector. Resistors R224, R225 and R226 constitute the diode load. The audio-frequency output, obtained at the junction of resistors R224 and R225, the detector test point, is coupled through capacitor C220 to the first a-f amplifier grid when noise-limiter switch S202 is in the OUT position.

When noise-limiter switch S202 is in the IN position, a series diode noise limiter is placed in the circuit between the audio detector and first audio stage.

The voltage developed across audio detector resistors R224 and R225 is applied through resistor R221 to capacitor C215, building up on the lower plate of this capacitor a negative potential equal to the total average rectified d-c voltage, as measured between terminal 6 of T206 and ground. The audio-frequency component of the rectified voltage is taken from the detector diode circuit at the junction of resistors R224 and R225. The rectified audio-frequency voltage keeps the plate of V207A positive with respect to its cathode (normally conducting). The conducting and nonconducting conditions of V207A determine the signal-pass and signal-stop condition. Therefore, when V207A is conducting the audio-frequency signal path is through V207A, across switch S202, and through capacitor C220 to the grid of the first audio amplifier V209. Note that the cathode of V207A is at approximately the same potential as terminal 6 of T206, which is more negative than the plate potential of V207A because of the voltage divider action of R224 and R225, and therefore, the a-f path has been established through this tube.

In the event of a sharp noise pulse, the long time constant of R221 and C215 does not permit capacitor C215 to become charged to the high transient voltage. However, terminal 6 of T206 rapidly follows the change, placing the plate of V207A at a more negative potential than the cathode, thereby cutting off current flow in the

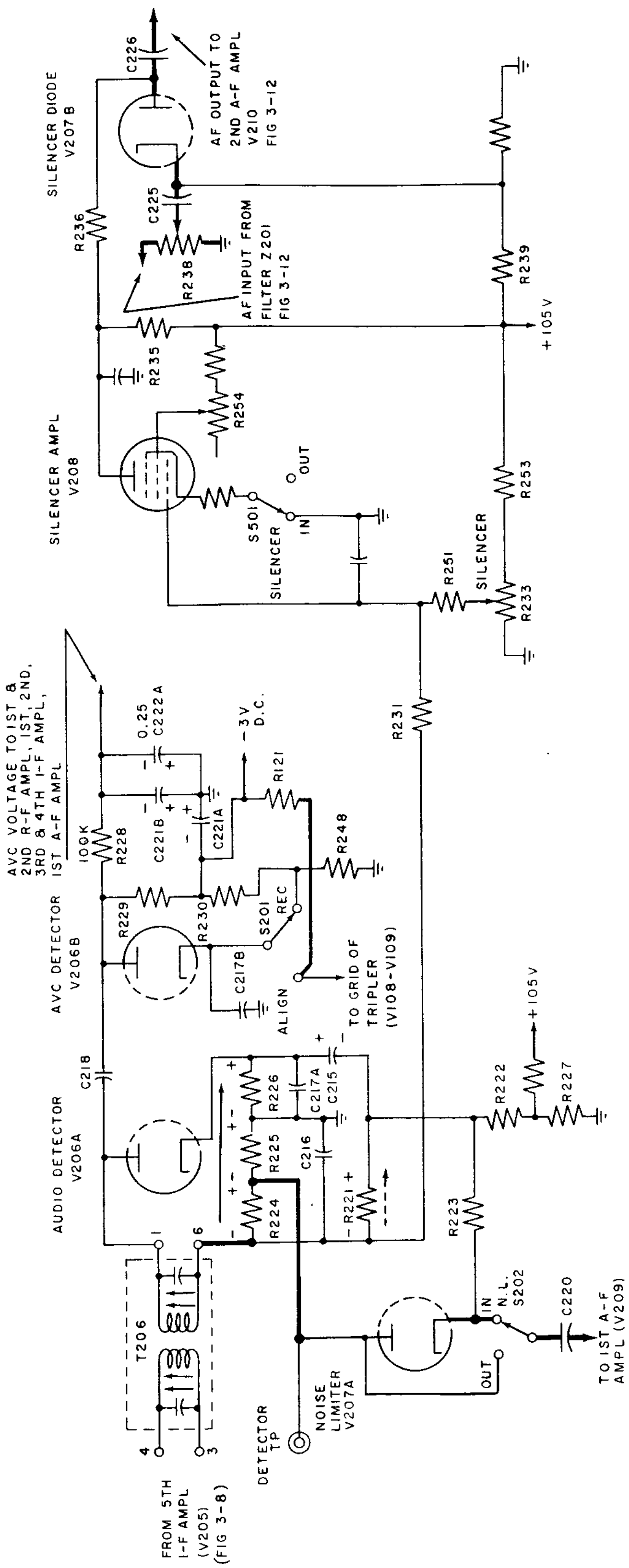


Figure 3-10.—Detector, Noise Limiter and Silencer Stages. 32.51

tube for the duration of the noise pulse. Consequently, the noise pulse does not enter the audio-frequency amplifier circuit.

To illustrate this action we shall assign voltage values to the detector load resistors R224, R225 and R226. Note that C215 charges to this total d-c assigned voltage value and will follow the audio-frequency d-c signal changes, as shown in figure 3-10 by the solid arrow between terminal 6 and the cathode of V206A.

To better understand the breakdown action of the noise limiter, refer to the simplified schematic of figure 3-11.

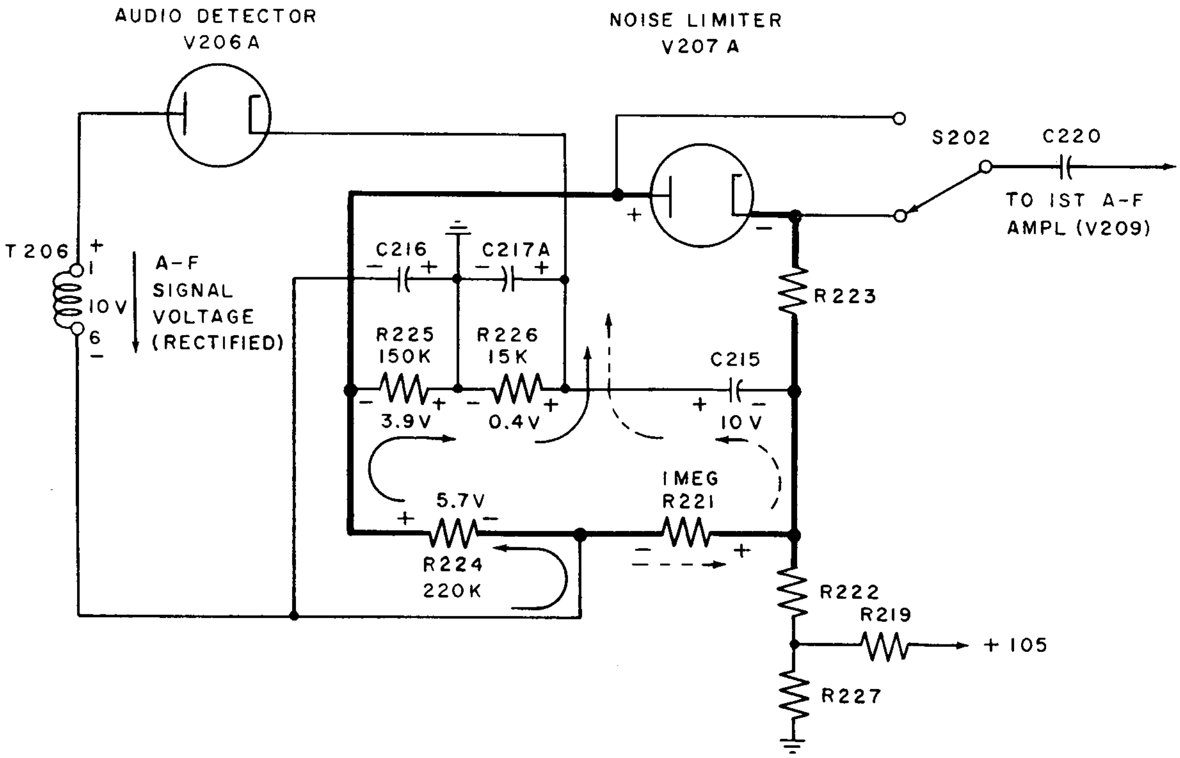
The voltage distribution ratio can be found by calculating the detector load resistance ratio. The voltage in the circuit (across the detector load) is distributed in this manner; 57% across R224, 39% across R225, and 4% across R226. Therefore, if we assign a total detector load voltage (solid arrow) of 10 volts (from T206 (rectified)), the distribution will be 5.7v. 3.9v, and 0.4v respectively. At the same time, the parallel charging path (dashed arrow) of R221 and C215 will permit C215 to charge up to this assigned 10 volt value.

Using Kirchoff's law, we can now determine that the plate of V207A is 5.7 volts positive with respect to its cathode. The heavy line path (fig. 3-11) shows that the 5.7 volt drop across R224 biases V207A in the forward (conducting) direction (plate +, cathode -). R223 is an isolating resistor and does not enter into the signal load path. There is no drop across R221 because C215 has charged up to the full assigned value of 10 volts.

If we increase the load voltage instantaneously by 10 volts, making the total detector voltage 20 volts, we find that the voltage distribution changes to 11.4v, 7.8v, and 0.8v respectively. Capacitor, C215, because of its long r-c time constant, cannot change instantaneously, and therefore, all of the 10 volt increase appears across R221 (dashed arrow).

Again using Kirchoff's law, we find that by going around the heavy line path (fig. 3-11) the V207A plate-to-cathode voltage is + 11.4-10 = + 1.4 volts (plate +, cathode -). This action permits the normal audio signal to be passed through V207A without distortion or loss.

Now let us increase the instantaneous voltage from 10 volts to 15 volts, making the total detector load voltage 25 volts. The detector voltage distribution is now 14.3v, 9.7v, and 1v. The voltage across R221 changes to 15 volts



32.52

Figure 3-11.—Simplified Schematic, Audio Detector and Noise Limiter.

and by going around the heavy line path the V207A plate-to-cathode voltage is + 14.3-15 = - 0.7 volt. Noise limiter V207A is now cut off and we have the instantaneous noise pulse removed from the audio signal coupling path.

The small voltage developed across R226 in the cathode of the audio detector acts as an accelerating circuit to bring the noise limiter diode V207A to the condition of nonconduction more quickly, when a noise pulse enters the receiver. The action can best be described as a positive pulse from the cathode end of R226 being coupled to the limiter-diode cathode through capacitor C215, and resistor R223. Thus, this positive voltage is initially present at the cathode of V207A, and aids in cutting off the tube.

Resistors R219 and R227 form a voltage divider across the 105-volt regulated supply, producing a positive voltage at the junction of approximately 1 volt. This voltage is applied through resistor R222 and R223 to the cathode of V207A. The positive bias is required to balance the contact potential of this tube, permitting operation of the diode as a noise limiter on lower levels of noise.

By normally operating the cathode of V207A, considerably more negative than the plate, allowance is made so that clipping does not occur on modulation peaks below a certain level.

AVC Rectifier Circuit

AVC rectifier, V206B, one-half of a dual diode, is utilized in the AVC rectifier circuit, which is shown in simplified form in figure 3-10. The diode is connected as a shunt rectifier across the secondary of transformer T206; coupling is accomplished through capacitor C218 and capacitors C216 (via ground connections) and C217B, in series.

When switch S201 is placed in the REC position, the diode load consists of resistors R229 and R230. The junction of these two resistors is at -3 volts which places the diode plate at this same potential. The 3 volt potential is developed across resistors R230 and R248 by the -3 volt supply. The junction of these two resistors is at an approximate potential of -2 volts negative which places the diode cathode at this potential. Thus, a delay is provided in the AVC circuit by this resulting 1 volt reverse bias. This delay bias potential for V206B acts to prevent V206B conduction and the development of the negative AVC voltage during the reception of weak signals.

We can see this action by coupling a signal through V206B via C218, C216, and C217B in a positive (forward) direction. When the signal exceeds the delay bias in the positive direction, V206B conducts. The low conducting resistance of the tube essentially short circuits R229 and R230, which are connected in series across V206B. During this conduction period, C218 charges to approximately the peak value of the input pulse.

Negative input pulses will not permit V206B to conduct. Therefore only positive input pulses reinforce the charge developed across C218, causing a large current to be conducted through R229, R230, and R248, during the period of the negative input. The voltage that is developed across the divider and obtained at the junction of R229 and R228 is the negative-to-ground AVC voltage.

The long time constant of R228 and C222A prevents the AVC voltage from following rapid signal variations and is essentially a d-c voltage. Capacitor C221 is a dual r-f bypass unit. Suitable r-c decoupling networks are incorporated in the grid circuit of each of the gain controlled stages.

AVC voltage is applied to the r-f amplifiers, the first four i-f amplifiers and the first a-f amplifier through resistor R228.

When switch S201 is placed in the ALIGN position, the cathode of V206B is removed from the voltage divider across the -3 volt bias source and is connected to the grid return of the tripler stage (V108, V109). When in this position the diode load consists of resistors R229, R230, and R248 in the diode circuit, and resistor R121 in the tripler circuit (fig. 3-7). Now the cathode and plate are both at a -3 volt potential. As the tuned circuits of the oscillator, doubler, and tripler grids are tuned to resonance, the drive to the tripler circuit increases. This results in an increased tripler grid-leak bias developed across the resistor R121, which is applied to the AVC diode cathode.

Because this increase is negative at the cathode, diode current will flow, causing a negative voltage to appear on the AVC bus. This, in turn, will cause a reading on input meter M501, as previously described. The greater the drive and the grid-leak bias at the tripler grid, the greater will be the meter deflection, hence, oscillator-multiplier section alignment indication is obtained.

Noise Silencer Circuits

The noise silencer (squelch) circuits are used to prevent noise from reaching the audio section of the receiver in the absence of an incoming signal of some predetermined minimum level. A controlled dual diode V207B, between the first and second audio stages permits the audio signal to pass during conduction, and cuts off the audio signal when it is not conducting. The silencer amplifier V208, is a d-c amplifier which controls the diode.

The audio signal is fed to the cathode of V207B (fig. 3-10) from filter Z201 (fig. 3-12) through audio gain control R238 and capacitor C225. When the diode conducts, the audio signal reaches the second a-f amplifier through capacitor C226.

The silencer circuits function when the silencer switch, S501 (fig. 3-10), is in the IN position. During reception of a signal a negative voltage is developed at terminal 6 of the i-f transformer T206. This voltage is applied, through resistor R231, to the grid of the silencer amplifier tube V208, as negative bias.

An additional bias voltage is applied to the grid of V208 through R251 for the purpose of establishing the threshold of operation of the silencer tube. This voltage, which is positive at the arm of R233 is obtained from the regulated 105-volt supply through the voltage divider action of resistors R233 and R253. It can be adjusted from the front panel by silencer potentiometer R233.

When no signal is present the negative bias developed at the audio detector is quite low, and therefore, some noise will be present in the audio output of the receiver. The silencer control potentiometer acts to silence this no-signal noise output by increasing the positive bias on the grid of V208. When the grid of V208 goes positive, the plate current will increase and the voltage drop across resistor R235 will increase, thereby making the voltage applied through resistor R236 to the plate of the silencer diode, V207B, lower than the cathode voltage. This stops current flow in the diode and prevents the conduction of the audio signal through it.

When an input signal appears, the negative voltage developed at terminal 6 of T206 to V208, through R231 will increase, thereby reducing conduction in the silencer amplifier V208, raising the plate voltage. This action in turn, makes the plate of the control diode, V207B, sufficiently positive for conduction, and the output from the first audio stage is then allowed to pass to the second audio amplifier via the diode.

In this way, noise is prevented from reaching the second audio amplifier when no signal is present.

The level at which the silencer, V208, responds can be adjusted with R254, the setting of which determines the screen voltage applied to that tube. This adjustment is used to compensate for possible changes in circuit constants.

The silencer switch S501, in its OUT position, opens the cathode circuit of V208, thereby rendering the silencer circuits inoperative.

Audio Frequency Circuits

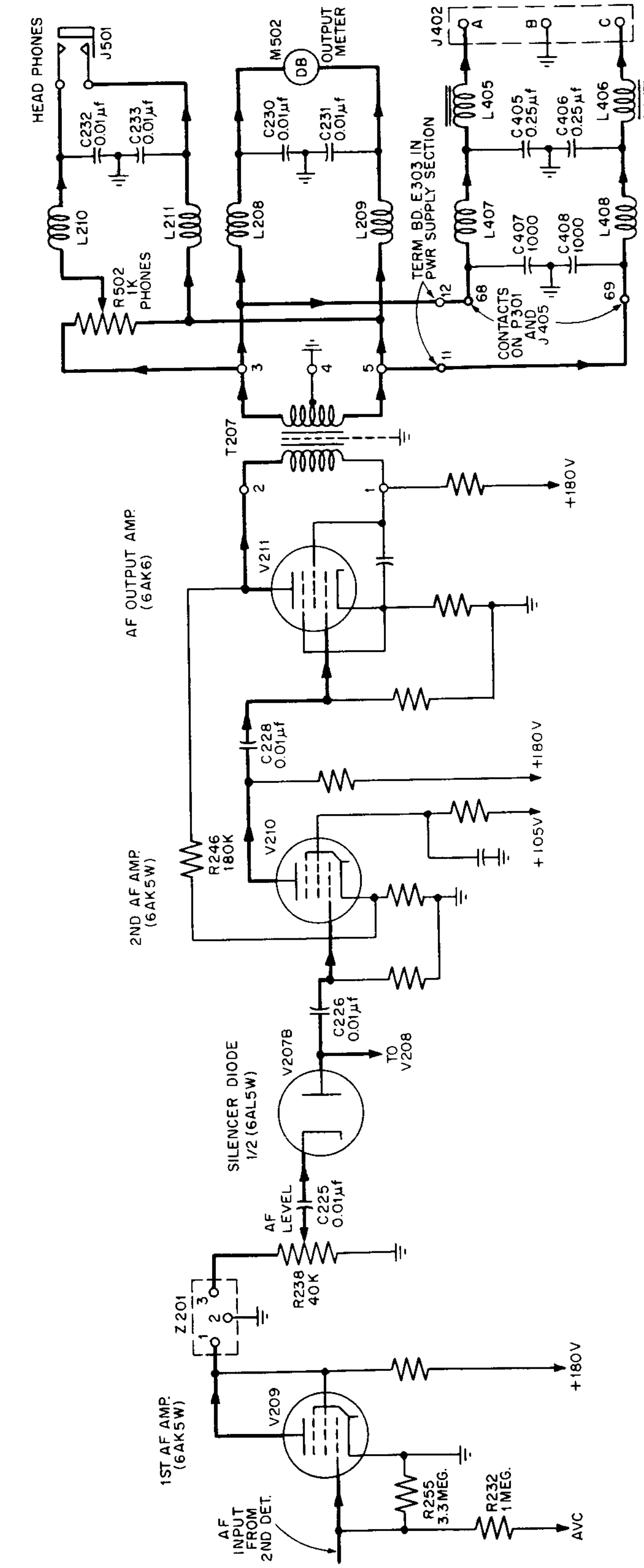
The three a-f stages are essentially conventional audio amplifiers. The first stage, V209, is a triode-connected pentode subject to AVC as shown in figure 3-12. The output of V209 is fed through a 350- to 3500-cycle band-pass filter, Z201, which discriminates against undesired frequency components but passes the required voice frequencies. The signal passes through the a-f level control, R238, and the silencer diode (previously described) to the grid of the second audio stage, V210.

Voltage amplifier, V210, is a conventional resistance-coupled pentode with an unbypassed cathode-bias resistor. Its output drives the final pentode power stage, V211, which also operates as an unbypassed cathode bias stage.

Negative feedback is used from the plate of the output stage, V211, to the cathode of the preceding stage, V210, in order to maintain a constant output voltage characteristic with a variation of output load impedance, that would result from the plugging in or withdrawing of headphones.

Audio signals from the a-f output amplifier are coupled via the electrostatically-shielded output transformer, T207, to the required output circuits. The secondary provides a balanced output. Signals from the secondary are fed via the r-f filter composed of L208, L209, C230, and C231 to the output meter, M502. Similarly, signals are fed via the phones gain control, R502, and associated r-f filter, L210, L211, C232, and C233, to the headphones jack, J501. A third circuit provides an audio output via the connector P301/J405 (fig. 3-13) for external use through the output jack, J402, located at the rear of the cabinet. This line is also filtered against external r-f fields by a combination of chokes, L405 to L408, and capacitors, C405 to C408. This filter is a part of the band suppression filter shown in figure 3-13.

When using the headphones, the front-panel PHONES volume control, R502 (fig. 3-12), provides an audio level adjustment auxiliary to the main a-f level control, R238.



32.53

Figure 3-12.—Audio Frequency Circuits.

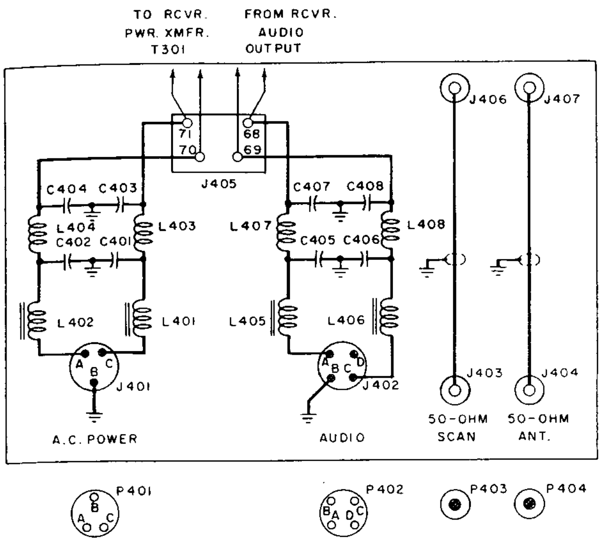


Figure 3-13.—Band Suppression Filter.

POWER SUPPLY

A single power transformer, T201, supplies heater power for all tubes and rectified high voltage d-c for plates and screens, as well as a small negative voltage used for bias. (See power supply schematic diagram, fig. 3-14.)

Blower, Thermostat and Primary Circuits

A blower and a thermostat are mounted in the primary section of the power supply, and are used to keep the operating temperature inside the receiver within safe limits. Whenever the inside ambient temperature reaches 60° C, the thermostat, S301, automatically turns on the blower, BL301.

The primary of T301 is tapped for operation from a 110-, 115-, or 120-volt 50-60 cps a-c line. Front-panel POWER switch, S502, opens or closes both sides of the input power line, when the receiver is either off or on. Circuit protection is provided by two fuses, F201 and F202. Line power is brought to the power supply via the band suppression filter, P301/J405, and input receptacle, J401, at the rear of the receiver. The circuit is filtered against external r-f fields by the two-section filter in the band suppression filter (fig. 3-13) composed of chokes, L401 to L404, and capacitors, C401 to C404.

Filament-Heater and Plate-Screen Supply

Three of the secondary windings of T301 are for filament or heater power. One provides filament power at 5 volts for the rectifier, V301; a second supplies 6.3 volts for the detector, AVC, noise-limiter and noise-silencer diodes, V206A and B, and V207A and B; and the third provides 6.3 volts for all other tubes.

The center tap of the diode heater secondary is connected to a 6 volt negative potential instead of to ground. This bias on the heaters minimizes hum.

A fourth secondary winding provides full-wave rectification (V301) of the high-voltage, which is supplied at + 180 volts for plates and at + 105 volts for screens. A separate regulated + 150 volt output is provided for use on the LO and first doubler stages of the oscillator-multiplier section. A regulator tube, V303, is used with resistors R307, R308, R310, in series to regulate the 150-volt oscillator supply. Regulator, V302, operates with its series resistors, R302, R303, R309, R230, R248, R301, to regulate screen voltage at 105 volts. Plate voltage is sufficiently stable without regulation. Filtering is accomplished by capacitors C301 to C303, and the reactor L301. The inductance of the coil, L301, between terminal 1 and 2 is series-resonant at the ripple frequency in conjunction with capacitor, C302, and provides a low impedance path for ripple currents, minimizing hum. Input capacitor, C301, and output capacitor, C303, are used in the conventional manner.

Bias Supply

The negative portion of the rectifier output is divided by resistors R248, R230, and R301 to provide a 3 volt negative potential for holding bias. The full 6 volt negative potential is applied to the heater of diodes V206 and V207 to minimize hum.

COMPARISON OF THE AN/URR-27 WITH THE AN/URR-21 OR 21A

Where the URR-27 is not available the AN/URR-21, or 21A may be used. (See fig. 3-15.)

The AN/URR-21, or 21A, differs from the URR-27 in that they are not as complex, and except for an availability of four quickly selectable preset crystal channels, an i-f frequency of

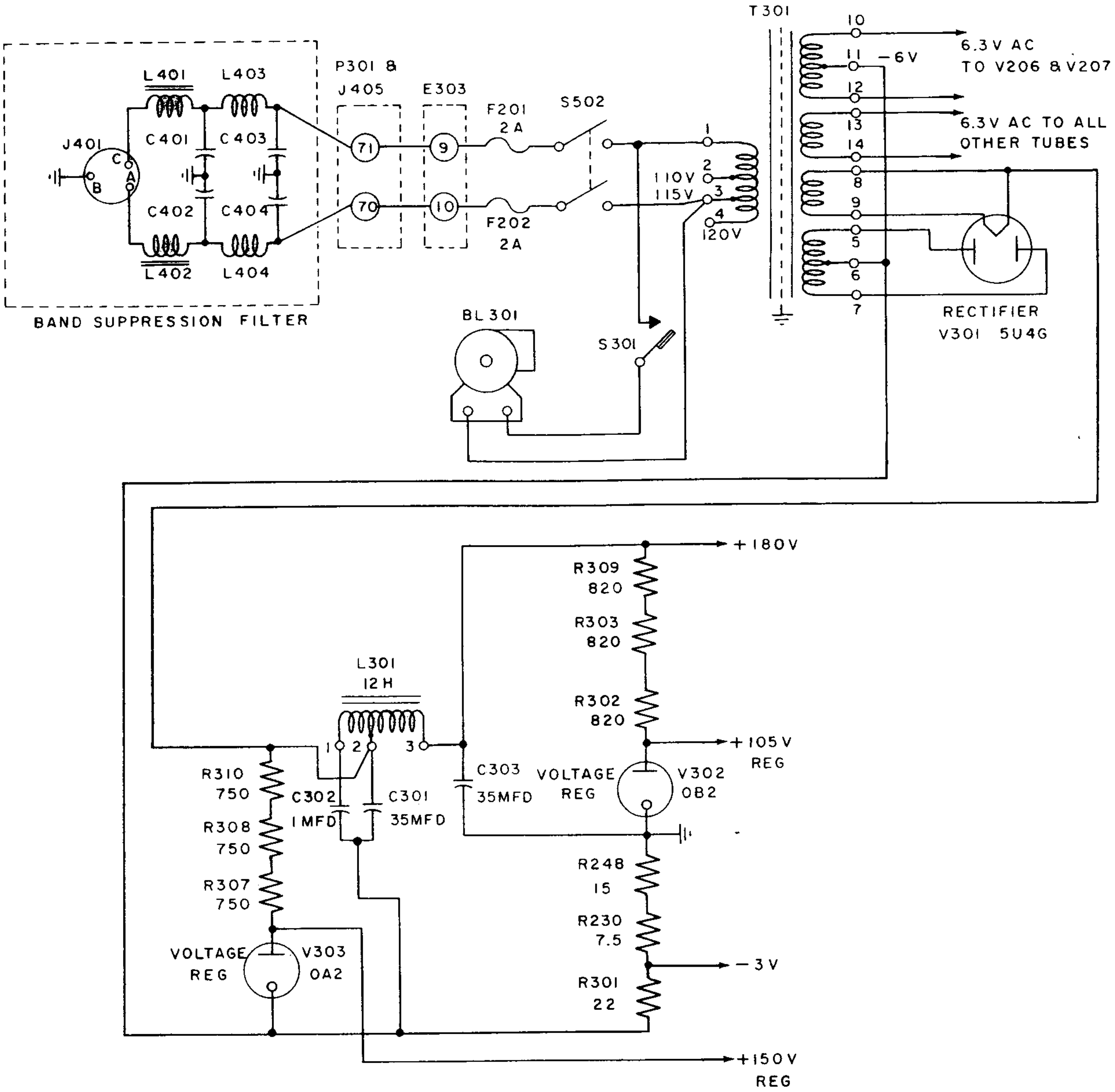
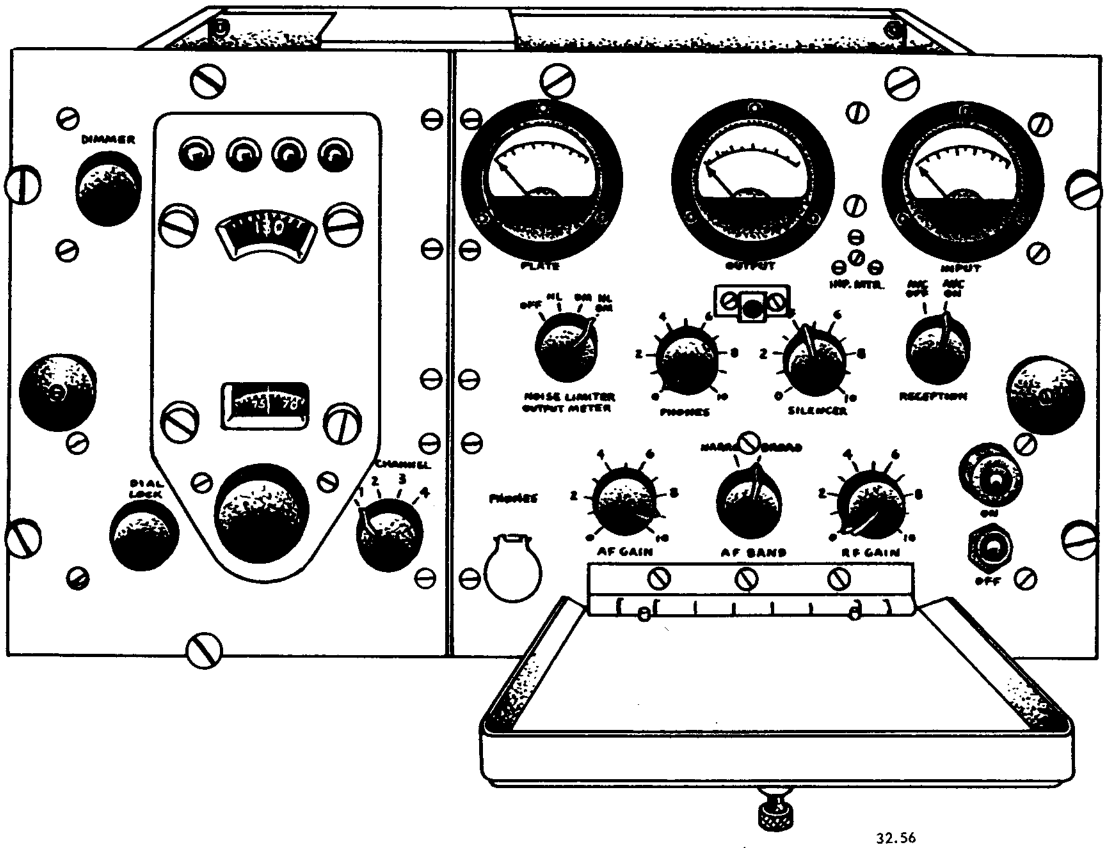


Figure 3-14.—Power Supply Section. 32.55

12 mc (instead of 18.6 mc) and an extremely low oscillator radiation (this precludes detection by enemy direction finding equipment) they are similar superheterodynes. Their range of frequency is 115 to 156 instead of the 105 to 190 mc of the URR-27.

The block diagram (fig. 3-16) indicates circuitry, to a lesser degree, that is similar to the URR-27. Note that the special circuits, noise limiter and silencer, are connected similarly. All included special circuits are discussed in either chapter 3 or chapter 4, and therefore, no detail shall be given here.

The availability of the four preset channel crystals feature does not sufficiently decrease the time used to change a frequency during a frequency shift to rate this feature as an advantage. This inability to decrease shift time comes from the necessity of having to peak-up the receiver after switching. An operator, by using one control, can tune and peak the receiver while selecting and inserting the new channel crystal.



32.56
Figure 3-15.—Radio Receiving Set, AN/URR-21A.

OPERATIONAL USES OF VHF RECEIVERS

V-h-f receivers are primarily intended for use aboard ships and naval air and shore stations for reception of amplitude modulated telephone signals.

During tactical operation, v-h-f receivers can be and are used for primary tactical command channels, secondary tactical command channels, primary or secondary combat information channels, distress and international distress channels. By using available auxiliary equipment v-h-f receivers may be used for a-m teletype, a-m photofacsimile, and coded signals reception.

V-h-f receivers are not being used much at the present time because of the impaired reception efficiency caused by local interference.

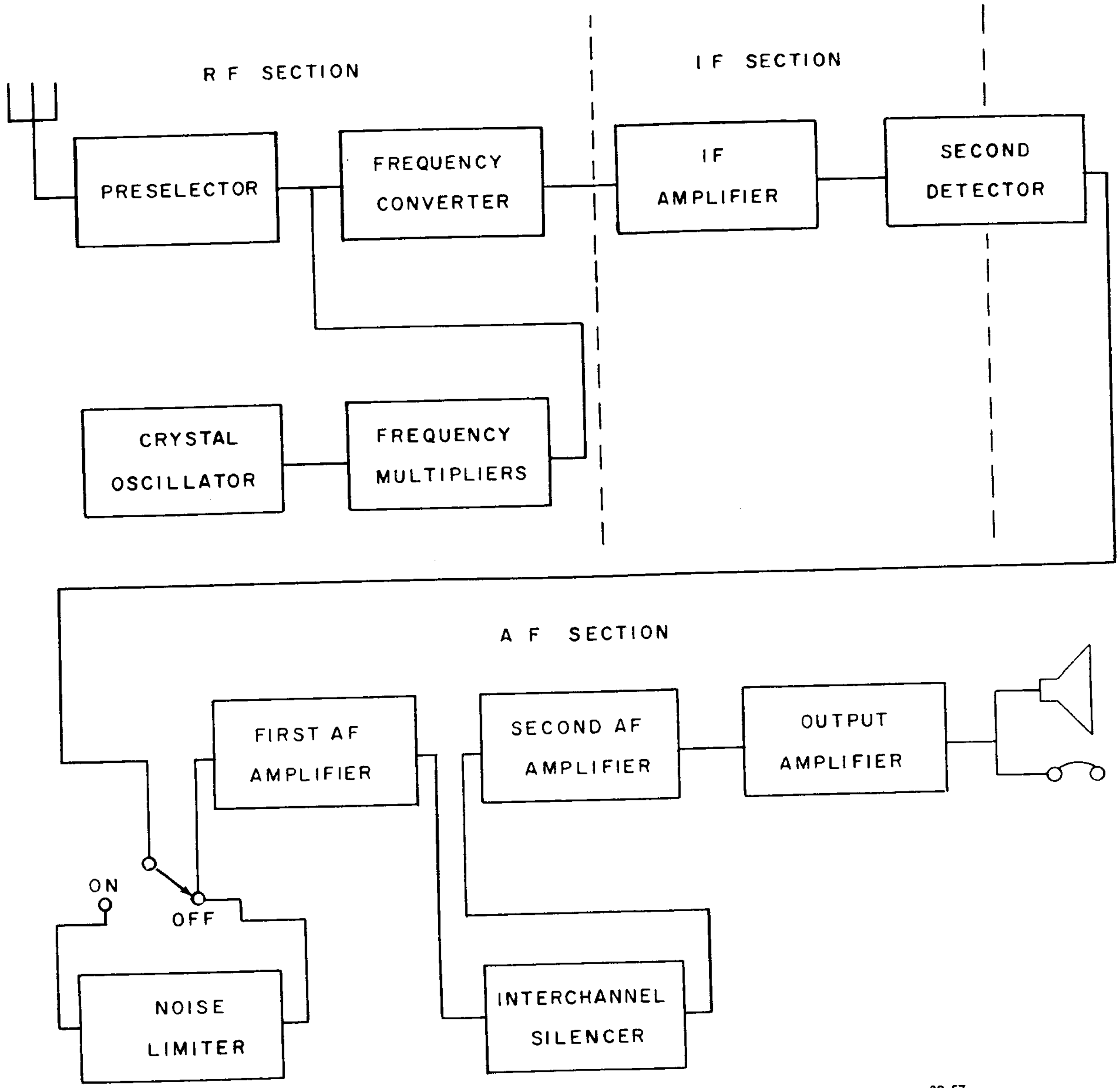
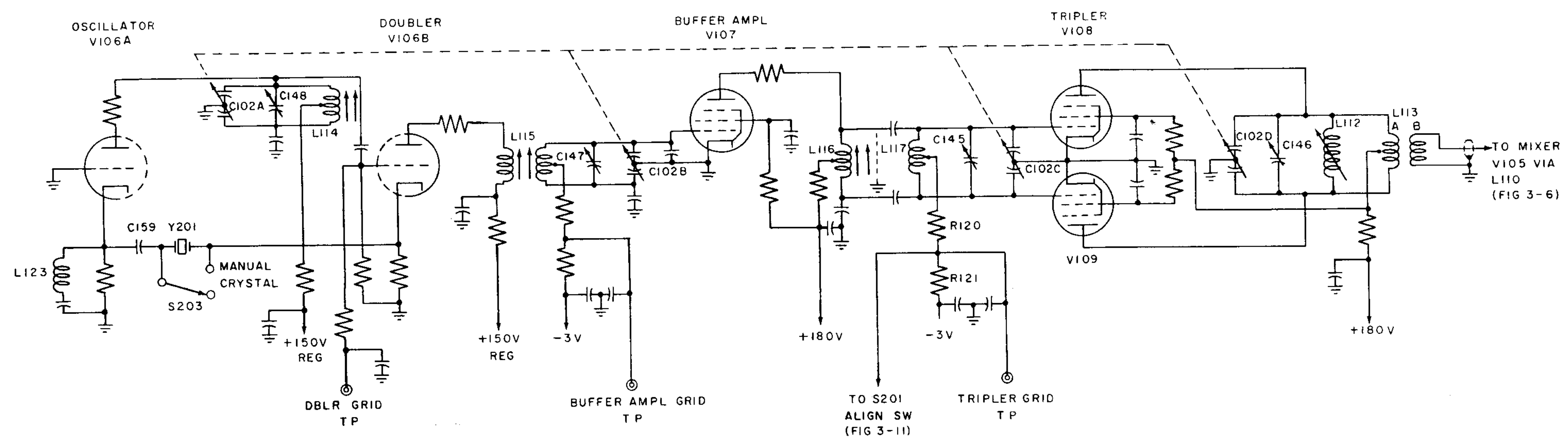
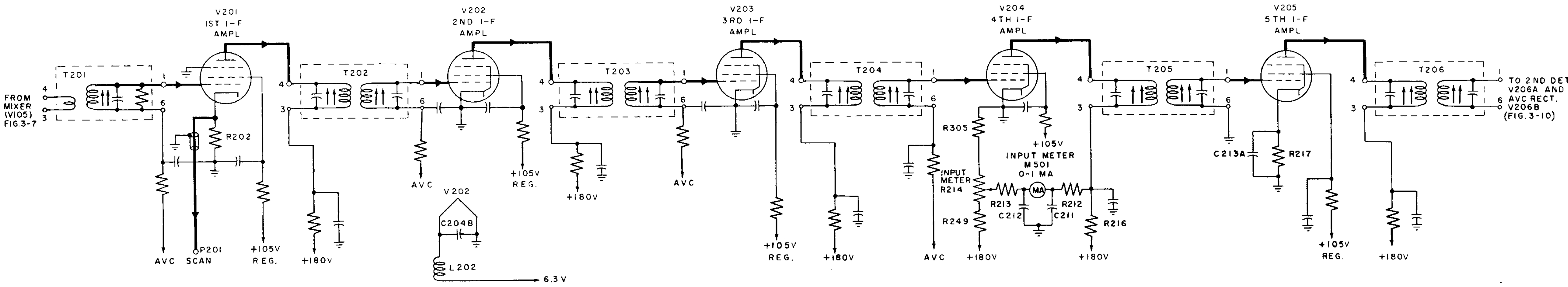


Figure 3-16.—Block Diagram of the AN/URR-21A Receiver.



32.48

Figure 3-7.—Oscillator-Multiplier Section of Preselector.



32.49

Figure 3-8.—Typical I-F Amplifiers, including Scan Channel and Meter Circuits.