MESSENGER 323A

CITIZENS RADIO TRANSCEIVER

PART NO. 242-0323-xxx

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

SECTION 1
GENERAL

1.1 SCOPE OF MANUAL

This service manual includes service and alignment instructions for the Johnson Messenger 323A Citizens Radio Transceiver, Part No. 242-0323-xxx. Revision sheets, service bulletins and service manual additions will be published as this transceiver is changed. For easy reference, file these notices at the back of this manual.

1.2 DESCRIPTION

The Johnson Messenger 323A is a 23 channel citizens radio transceiver which includes a 10 crystal frequency synthesizer to provide the transmit and receive mixing frequencies. The receiver includes two crystal IF Filters and three IF Amplifiers for outstanding selectivity, a Noise Blanker that works in conjunction with the Audio Noise Limiter to eliminate impulse type noise from the receiver, an Automatic Gain Control (AGC) circuit to maintain a constant receiver audio output and an S/RPO meter that indicates received signal strength and relative power output.

The transmitter contains a 4.3 MHz Oscillator which is mixed with the synthesizer output by the Transmit Mixer to provide the transmitter frequencies. The transmitter also contains three RF stages to provide a full, legal four watts RF output power. The audio portion of the transmitter can be utilized for a Public Address (PA) with the addition of a PA speaker connected to the PA jack without activating the transmitter.

The Messenger 323A will operate with 13.8 VDC negative or positive ground, or from the external AC power supply, Part No. 239-0122-103.

1.3 ACCESSORIES

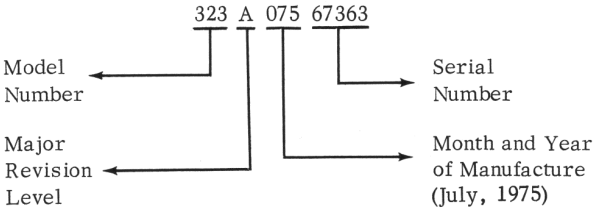
Refer to Table 1-1 for a list of available accessories which can be purchased as extra cost items.

TABLE 1-1
ACCESSORIES

Description	Part Number
110-120 VAC Power Supply	239-0122-103
External Speaker (Charcoal Gray)	250-0064-001
Power Pack	250-0855-003
Battery Charger for Power Pack	250-0846-001

1.4 SERIAL NUMBER INTERPRETATION

The transceiver serial number is printed on a white adhesive backed cloth which is attached to the rear panel of the transceiver. Each serial number contains the transceiver model number, the alphabetical major revision level designator, the month and year the transceiver was manufactured and a five digit serial number as indicated in the following example:



1.5 FACTORY CUSTOMER SERVICE

A liaison between the customer and the factory is provided by the E. F. Johnson Company Customer Service Department. This department is available for consultation and assistance on technical problems, parts information and availability of local and factory repair facilities.

If you write to the Customer Service Department, please include any information that may be helpful in solving your problem. Contact:

E. F. Johnson Company
Customer Service Department
Waseca, Minnesota 56093
Phone (507) 835-2050

1.6 FACTORY RETURNS

Normally, repair service is available locally through authorized Johnson Service Centers. A list of authorized service centers is packed with each transceiver when it leaves the factory. Do not return any equipment to the factory without authorization from the Customer Service Department.

1.7 REPLACEMENT PARTS

The authorized Johnson Service Centers stock commonly needed replacement parts. When a part is not available locally, it can be ordered from the Customer Service Department. When ordering, please supply the following information:

Part Number of the transceiver
Serial number of the transceiver
Description of the part
Part number of the part

SECTION 2
SPECIFICATIONS

2.1 GENERAL

(Measurements made per EIA Standard RS-382 and are nominal unless otherwise stated.)

Frequency Range	26.965 to 27.255 MHz
Channels	23
Circuitry	1 integrated circuit, 25 transistors and 20 diodes
Frequency Control	±0.005% crystal, -30 to +60°C
Metering	Illuminated "S" meter and relative RF output
Microphone	Ceramic element, cycolac case, push to talk switch
Power Requirements	13.8 VDC at 0.5 amperes squelched receive, 1.2 amperes fully modulated transmit, positive or negative ground
Circuit Protection	2 ampere fuse
Antenna Impedance	50 ohms
Dimensions of Enclosure	6.35 cm H x 20.3 cm W x 24.1 cm D (2.5 in H x 8 in W x 9.5 in D)
Weight	
Unit	2.4 kg (5.3 lbs)
Shipping	3.0 kg (6.6 lbs)
Compliance	FCC Type Acceptance Part 95 (D) DOC Type Approved RSS 136

2.2 RECEIVER

Sensitivity	12 dB (S+N)/N at 0.5μV
Selectivity	6 kHz bandwidth at -6 dB 20 kHz bandwidth at -60 dB
Spurious Rejection	55 dB
Image Rejection	45 dB
Audio Output Power	4 watts
Tight Squelch	100μV
Squelch Sensitivity	1 dB or less signal change for 40 dB quieting at 1μV
Intermediate Frequency	4.3 MHz
AGC Characteristics	Flat within ±6 dB from 500,000 to 5μV with 15 dB rolloff from 5 to 0.5μV
Noise Limiting	IF noise blanker plus audio noise limiter
Speaker Impedance	3.2 ohms
Audio Frequency Response	+1, -20 dB from 300 to 3000 Hz

2.3 TRANSMITTER

Emission	6A3 amplitude modulated
RF Power Output	4 watts maximum at 13.8 VDC
RF Spurious and Harmonic Attenuation	50 dB minimum
Audio Frequency Response	+1, -14 dB from 300 to 3000 Hz
Modulation	High level AM, Class AB modulator, speech compression, audio filtering

2.4 MINIMUM PERFORMANCE SPECIFICATIONS

(The specifications listed in this section are absolute service minimums.)

RECEIVER	
Sensitivity	8 dB (S+N)/N at 0.5μV input
Spurious Rejection	35 dB
Image Rejection	35 dB
Audio Output Power	0.1 watt at 0.5μV input and 3 watts with less than 10% distortion at 500μV input
Tight Squelch	50μV to 200μV
AGC Characteristics	15 ±8 dB rolloff from 500 to 0.5μV
TRANSMITTER	
RF Power Output	4.0 watts maximum at 13.8 VDC 2.8 watts minimum at 13.8 VDC
Modulation	100% maximum, 70% minimum

SECTION 3
INSTALLATION

3.1 MOBILE INSTALLATION

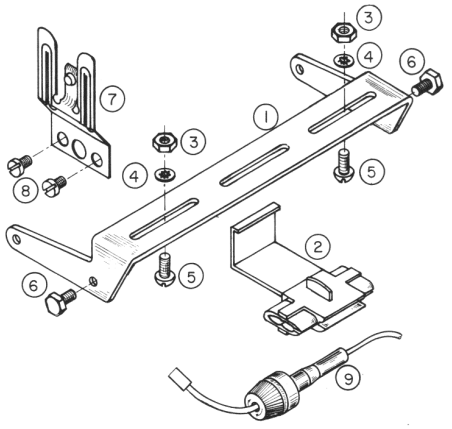
3.1.1 Antenna

A good antenna installation is essential for satisfactory transceiver performance. Select a suitable antenna location and install the antenna following the antenna manufacturer's installation instructions.

3.1.2 Transceiver Installation

Refer to Table 3-1 for a list of items supplied for installation.

TABLE 3-1
ITEMS SUPPLIED FOR INSTALLATION



Item No.	Qty.	Description	Part Number
1	1	Transceiver mounting bracket	017-1363-001
2	1	Tap connector	023-2209-001
3	2	Hex nut 10-32 x 125 CPS	560-1110-012
4	2	Lockwasher internal tooth 10-32	596-2110-012
5	2	Slotted round head screw 10-32	575-1410-020
6	2	Flanged hexhead screw 1/4-20	575-1914-010
7	1	Microphone clip	537-9004-002
8	2	Panhead #4 sheet metal screws	575-9504-006
9	1	Battery cable	023-1652-001
	2	Fiberwashers	018-0822-001

a. Hold the transceiver in the intended mounting location with the mounting bracket attached. Mark the mounting bracket location.

b. Remove the mounting bracket from the transceiver. Hold the bracket in the mounting location and mark the mounting hole locations. Center punch and drill the mounting holes.

c. Install the mounting bracket using items 3, 4 and 5 as shown in Table 3-1.

d. Connect the DC power cable to the battery using the tap connector (item 2). Tap the DC power from any readily accessible accessory power line.

e. Connect the antenna transmission line to the antenna jack on the transceiver rear panel and connect the DC power cable to the DC power jack on the transceiver rear panel.

f. Install the transceiver in the mounting bracket using item 6 as shown in Table 3-1. The microphone hanger can be mounted on the mounting bracket using item 6 or it can be mounted elsewhere using item 8 (#4 sheet metal screws).

3.2 BASE STATION INSTALLATION

3.2.1 Antenna

a. Install the antenna following the antenna manufacturer's installation instructions. The maximum height of the antenna is determined by FCC regulations. Refer to Part 95 for details.

b. Route the transmission line from the antenna to the transceiver location. The length of the transmission line should be kept as short as possible. However, an effective tradeoff can be made between lead-in length and antenna height.

3.2.2 Transceiver

a. Select a location that provides adequate ventilation and operating convenience.

b. Attach the AC power supply.

1. Position the transceiver upside down on a flat surface.

2. Place the power supply on the transceiver, align the screw holes in the transceiver cabinet with the captive screws in the power supply and tighten the screws. Restore transceiver and power supply to right side up position.

3. Connect the DC power cable to the DC power jack on the transceiver rear panel. Connect the power supply line cord to a 110-117 VAC 50-60 Hz outlet.

SECTION 4
CIRCUIT DESCRIPTION

4.1 GENERAL

The Messenger 323A is a fully transistorized 23 channel Citizens Radio transceiver. The frequency synthesizer provides the receive frequencies and in transmit the synthesizer output is mixed with the 4.3 MHz transmit oscillator. The synthesizer output is diode switched between transmit and receive.

The receiver is a single conversion type with two crystal filters and three IF amplifiers to provide selectivity and image rejection. An audio noise limiter and a noise blanker circuit effectively eliminate impulse type noise from the receiver. The audio output stage is comprised of a linear integrated circuit which provides 4 watts of audio output. An external speaker jack is also provided.

The transmitter mixes the frequency synthesizer output with 4.3 MHz from the transmit oscillator to provide the transmit frequencies. The transmitter also consists of an RF Predriver, an RF Driver and a Power Amplifier to amplify the 26.965-27.255 MHz signals to 4 watts RF output power.

4.2 FREQUENCY SYNTHESIZER

4.2.1 General

The frequency synthesizer consists of 10 crystals, two oscillators, a mixer and a diode switching network. The synthesizer output is 4.3 MHz below the channel frequency for both the transmit and receive modes.

TABLE 4-1
CRYSTAL SYNTHESIZER SCHEME

Channel	HF Oscillator Crystal		LF Oscillator Crystal		Synthesizer Output	Carrier Frequency
1	Y205	32.845	Y201	10.180	22.665	26.965
2	Y205	32.845	Y202	10.170	22.675	26.975
3	Y205	32.845	Y203	10.160	22.685	26.985
4	Y205	32.845	Y204	10.140	22.705	27.005
5	Y206	32.895	Y201	10.180	22.715	27.015
6	Y206	32.895	Y202	10.170	22.725	27.025
7	Y206	32.895	Y203	10.160	22.735	27.035
8	Y206	32.895	Y204	10.140	22.755	27.055
9	Y207	32.945	Y201	10.180	22.765	27.065
10	Y207	32.945	Y202	10.170	22.775	27.075
11	Y207	32.945	Y203	10.160	22.785	27.085
12	Y207	32.945	Y204	10.140	22.805	27.105
13	Y208	32.995	Y201	10.180	22.815	27.115
14	Y208	32.995	Y202	10.170	22.825	27.125
15	Y208	32.995	Y203	10.160	22.835	27.135
16	Y208	32.995	Y204	10.140	22.855	27.155
17	Y209	33.045	Y201	10.180	22.865	27.165
18	Y209	33.045	Y202	10.170	22.875	27.175
19	Y209	33.045	Y203	10.160	22.885	27.185
20	Y209	33.045	Y204	10.140	22.905	27.205
21	Y210	33.095	Y201	10.180	22.915	27.215
22	Y210	33.095	Y202	10.170	22.925	27.225
23	Y210	33.095	Y204	10.140	22.955	27.255

NOTE: All frequencies are in MHz.

4.2.2 Low Frequency (LF) Oscillator

The LF oscillator consists of Q201 and crystals Y201 through Y204 which operate at their fundamental frequency. The channel selector switch, S201A, selects an LF crystal (Y201 through Y204) and applies the crystal frequency directly to the base of Q201; refer to Table 4-1 for the Crystal Synthesizer Scheme. The LF oscillator operates as a modified Colpitts oscillator with the output taken from the emitter and coupled to the base of the Synthesizer Mixer, Q202, through coupling capacitor C203.

4.2.3 High Frequency (HF) Oscillator

The high frequency oscillator, Q203, operates with third overtone crystals, Y205 through Y210. Switch S201B selects one of the HF crystals at the same time as S201A selects an LF crystal. Refer to Table 4-1 for the Crystal Synthesizer Scheme. The signal from the crystal is applied to the base of Q203 where it is amplified and applied to the output circuitry, C215, C217 and T203. The HF oscillator frequency is then coupled to the emitter of the Synthesizer Mixer, Q202, through R218.

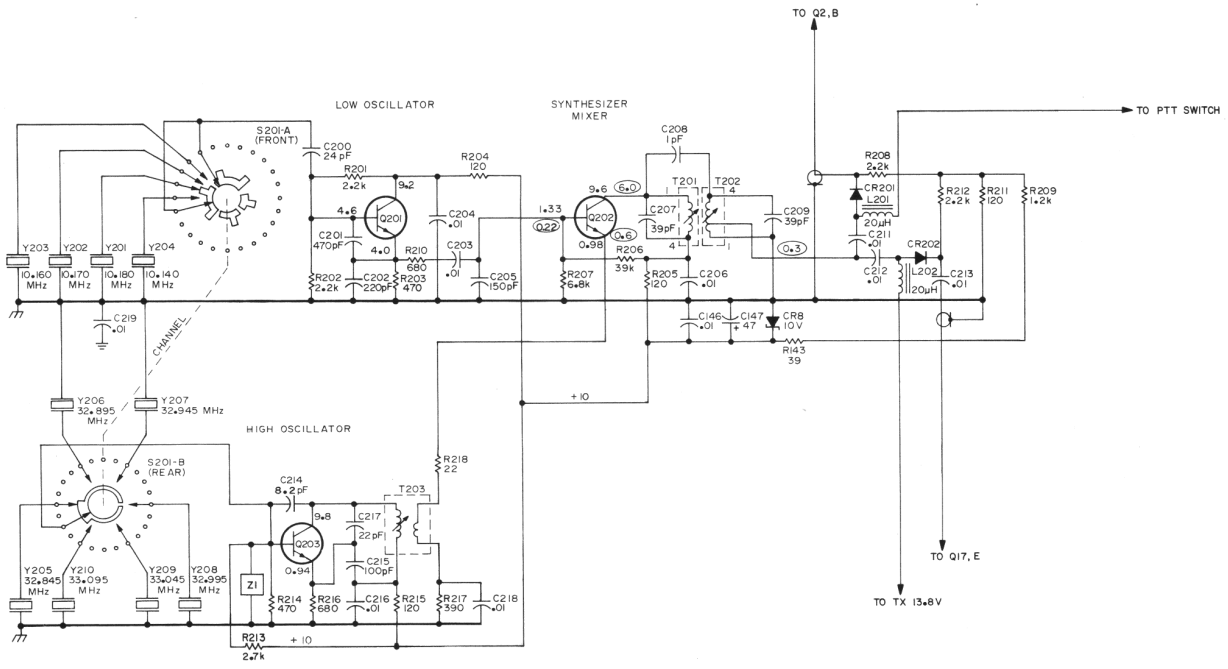
4.2.4 Synthesizer Mixer

The LF oscillator signal is applied to the base of Q202 and the HF oscillator signal is applied to the emitter of Q202 and the difference frequency of these two signals is selected by the collector circuit of Q202. The collector output circuit of Q202 consisting of C207, C208, C209, T201 and T202 is tuned to pass the difference frequency of the LF and HF oscillators which is always 4.3 MHz below the received channel frequency. For example: with S201 in the channel 1 position, HF crystal Y205 (32.845 MHz) and LF Y201 (10.180 MHz) are connected into their respective circuits. Therefore the Synthesizer Mixer output is 32.845 MHz - 10.180 MHz = 22.665 MHz. This frequency is then applied to the diode switching network of C211, CR201, L201, C212, CR202 and L202.

4.2.5 Synthesizer Diode Switch

In the receive mode, 13.8 volts is connected through S2A (the PA switch) and the push to talk (PTT) switch to the anode of CR201 which forward biases the diode and allows the synthesizer output frequency to pass to the Receive Mixer.

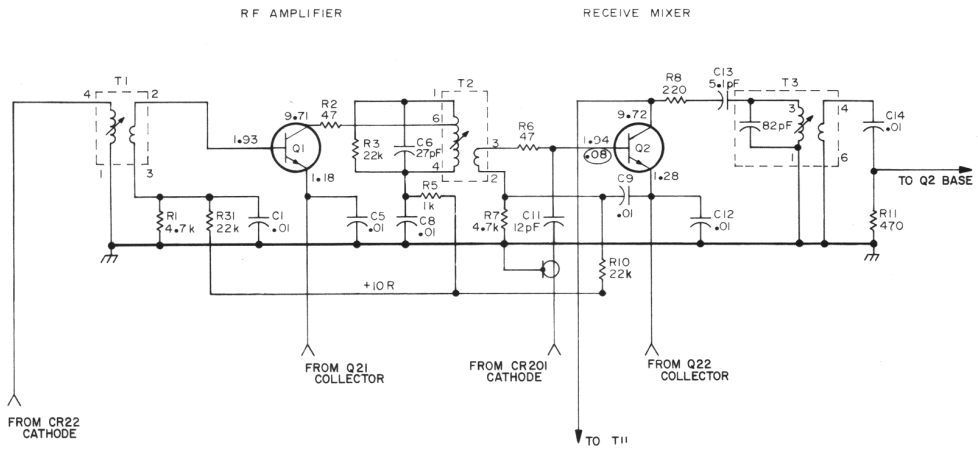
In the transmit mode, the PTT switch is closed to switch the 13.8 volts from CR201 to CR202. With CR202 forward biased and CR201 reverse biased, the synthesizer frequency is coupled to the Transmit Mixer.



4.3 RECEIVER

4.3.1 RF Amplifier and Receive Mixer

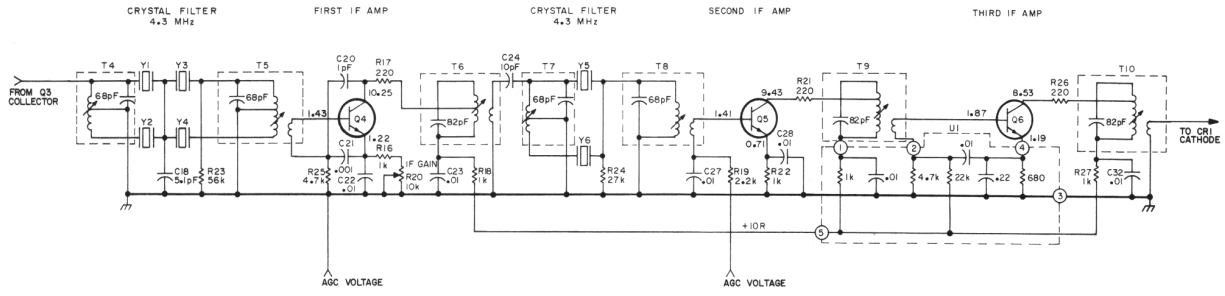
In the receive mode the antenna switch diode, CR22, is reverse biased to allow the antenna to be connected to the receiver input through T1. T1 is tuned to pass all frequencies between 26.965 MHz and 27.255 MHz which are then amplified by the RF Amplifier, Q1. The amplified RF is then coupled through the tuned transformer, T2, and applied to the base of the Receive Mixer, Q2. Along with the received RF on the base of Q2, the synthesizer frequency is coupled to the base of Q2 through C11. The Receive Mixer difference mixes these two frequencies and the collector transformer, T3, selects the resultant 4.3 MHz signal. The 4.3 MHz IF frequencies are coupled through C14 to the Noise Gate transistor, Q3. The Noise Gate is part of the Noise Blanker circuit and its function is discussed later.



4.3.2 IF Circuits

The bandwidth and selectivity of the receiver are determined by two 4.3 MHz Crystal Filters and the three IF Amplifiers.

The IF signal from the Noise Gate is applied to the first Crystal Filter through the impedance matching transformer, T4. The output of the Crystal Filter is also impedance matched to the First IF Amplifier by tuned transformer T5. The First IF Amplifier amplifies the IF to a sufficient level to be filtered again by the second Crystal Filter. Tuned transformers T7 and T8 match the input and output impedances to provide for maximum signal transfer and along with T4, T5, T6, T9 and T10 provide a flat topped, steep sided IF response curve which effectively establishes the selectivity and image rejection of the receiver.

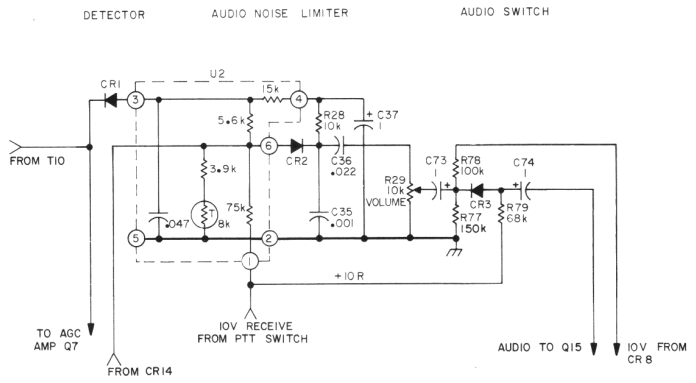


4.3.3 Audio Detector, Noise Limiter and Audio Switch

The amplified intermediate frequency is applied to the Audio Detector, CR1, by T10. With the IF signal applied, current will flow through CR1 only during the negative portion of the IF signal. This current causes the 0.047 μF capacitor in U2 to charge to the peak value of the rectified voltage on each negative half cycle. Capacitor C35 acts as a filter to remove the IF frequency component of the detector output so that the remaining DC portion varies only according to the modulation of the original signal.

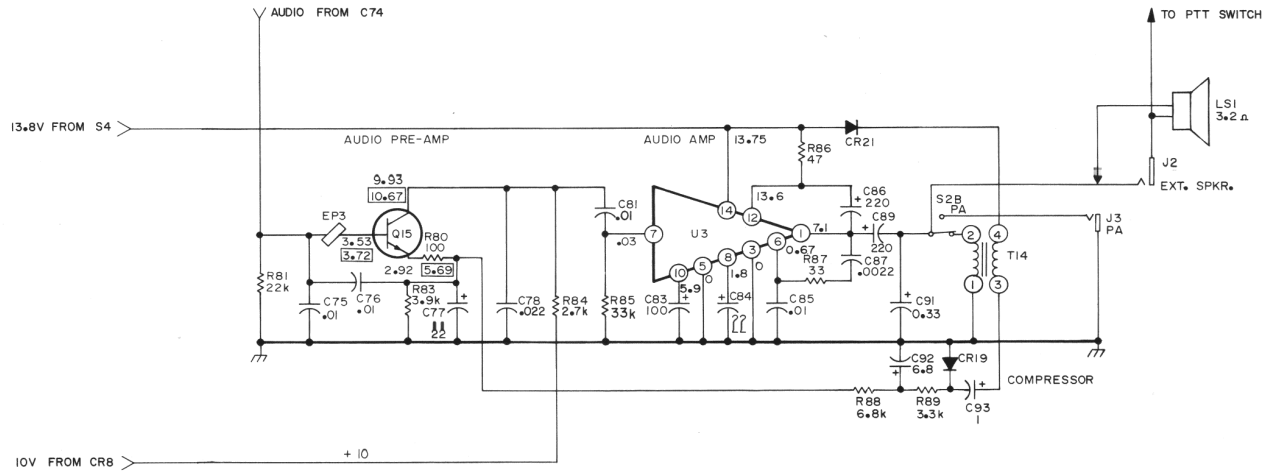
The Noise Limiter, CR2, is forward biased by the 10V receive line through the resistive divider in U2. The bias voltage is set up so that CR2 will conduct and pass the audio signals through the 5.6K ohm resistor in U2, through CR2 and C36 to the Volume control. In order to limit AM impulse noise, a portion of the audio signal charges C37. This voltage is developed across R28 as a positive voltage, the level of which is insufficient to reverse bias the diode. When a noise spike is rectified, the voltage on C37 increases enough to reverse bias CR2 which stops conducting momentarily causing peak clipping at approximately 30% modulation.

The detected, limited audio is then **coupled** through C36 to the Volume control which determines the signal level to be applied to the Audio Preamplifier. From the Volume control, the audio is coupled through the Audio Switch diode, CR3, which is biased "ON" by the 10V receive line through R79. Capacitor C74 then couples the audio to the base of the Audio Preamplifier, Q15. The Audio Switch, CR3, is biased "OFF" in transmit by **connecting** the 10V transmit line to the cathode of CR3.



4.3.4 Audio Output

The audio signal from the limiter is applied to the Audio Preamplifier, Q15, where it is amplified and coupled to the Audio Power Amplifier. The collector circuit of Q15 consisting of C78 and R84 provide the audio rolloff characteristic. The audio amplifier integrated circuit (IC) is a linear operational amplifier that provides four watts of audio output from pin 1 of the IC. The audio from pin 1 of U3 is connected through the external speaker jack, J2, to the speaker.



4.3.5 Noise Blanker

The Noise Blanker is designed to remove any impulse type noise from the receiver by gating the Noise Gate transistor "OFF" when a noise pulse is present. The Noise Blanker circuit consists of two IF Amplifiers, a Noise Detector. a Pulse Amplifier and the Noise Gate.

With the Noise Blanker switch in the "ON" position, AGC is applied to the base of the first Noise Blanker IF Amplifier, Q10. The IF frequency is selected by T11 and coupled to the base of the first Noise Blanker IF Amplifier, Q10. An IF sample is also coupled by C13 to T3 and to the emitter of the Noise Gate, Q3. The IF signal is amplified by Q10 and Q11 and applied to the Noise Detector diode, CR9. CR9 conducts only on positive portions of the IF signal causing C62 to charge to a positive DC voltage that corresponds to the received noise pulses. The audio portion of the IF signal is effectively removed by the audio filter made up of R54, C62, C63 and R57. The positive voltage from CR9 forward biases the Pulse Amplifier, Q12. When Q12 conducts, the collector voltage decreases, this negative going voltage is coupled through a pulse shaper network consisting of C65, L5 and C15, to the base of the Noise Gate, Q3. A negative going voltage on the base of Q3 acts as reverse bias to cause Q3 to cut off. Since the negative bias on Q3 corresponds with the IF noise pulses present on Q3 emitter, the Noise Gate is cut off only when the noise pulse is present.

The AGC voltage is connected to the base of Q10 and Q11 to vary the gain of the Noise Blanker IF. The negative AGC voltage acts as reverse bias to decrease the gating pulse amplitude when a large signal is received which overrides the noise and the Noise Blanker circuitry is not necessary.