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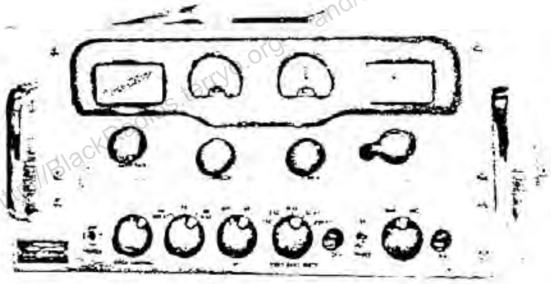
NEMS-CLARKE EQUIPMENT

SPECIAL PURPOSE RECEIVERS, 1301-A and 1302-A



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Vitro ELECTRONICS
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919 JESSUP BLAIR DRIVE • SILVER SPRING, MARYLAND
2301 PONTIUS AVENUE • LOS ANGELES 64, CALIFORNIA

UNCLASSIFIED

INSTRUCTION BOOK

FOR

MODEL 1301-A AND 1302-A

SPECIAL PURPOSE RECEIVERS

NEMS-CLARKE COMPANY
919 Jesup Blair Drive
SILVER SPRING, MARYLAND
A Division of Vitro Corporation of America

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ADDENDA TO SCHEMATIC DIAGRAM FOR MODEL 1302-A RECEIVER

The following errors exist in the schematic diagram of the Model 1302-A Receiver and are tabulated herein for the convenience of the purchaser. Future printings of this instruction book will have these corrections included.

Symbol	Change From	Change To
C-222	1-3.8 μμf	1-4 μμf
C-220	2-6 μμf	1-6 μμf
C-229	2-6 μμf	1-6 μμf

It is suggested that purchasers of this equipment transcribe these changes on the schematic for convenience and the elimination of possible error.

PUBLICATIONS SECTION

SM 3/15/62

ERRATUM
FOR 1301-A, 1302-A
SPECIAL PURPOSE RECEIVERS

In Table 1-1 Performance Specifications, make the following changes:

1. In column 1, change from: Absolute Sensitivity Measured without band-restricting filters to: *Absolute Sensitivity measured with 100KC low-pass filter.
2. In columns 2 and 3 opposite Input Impedance, change Approx. 50 ohms and Approx. 75 ohms to: 50 ohms nominal and 75 ohms nominal respectively.

* NOTE: The original reference to "band-restricting filter" refers to a narrow-band telemetry filter. The measurement of sensitivity is made with a 100KC low-pass filter which should not be confused with a band-restricting filter.

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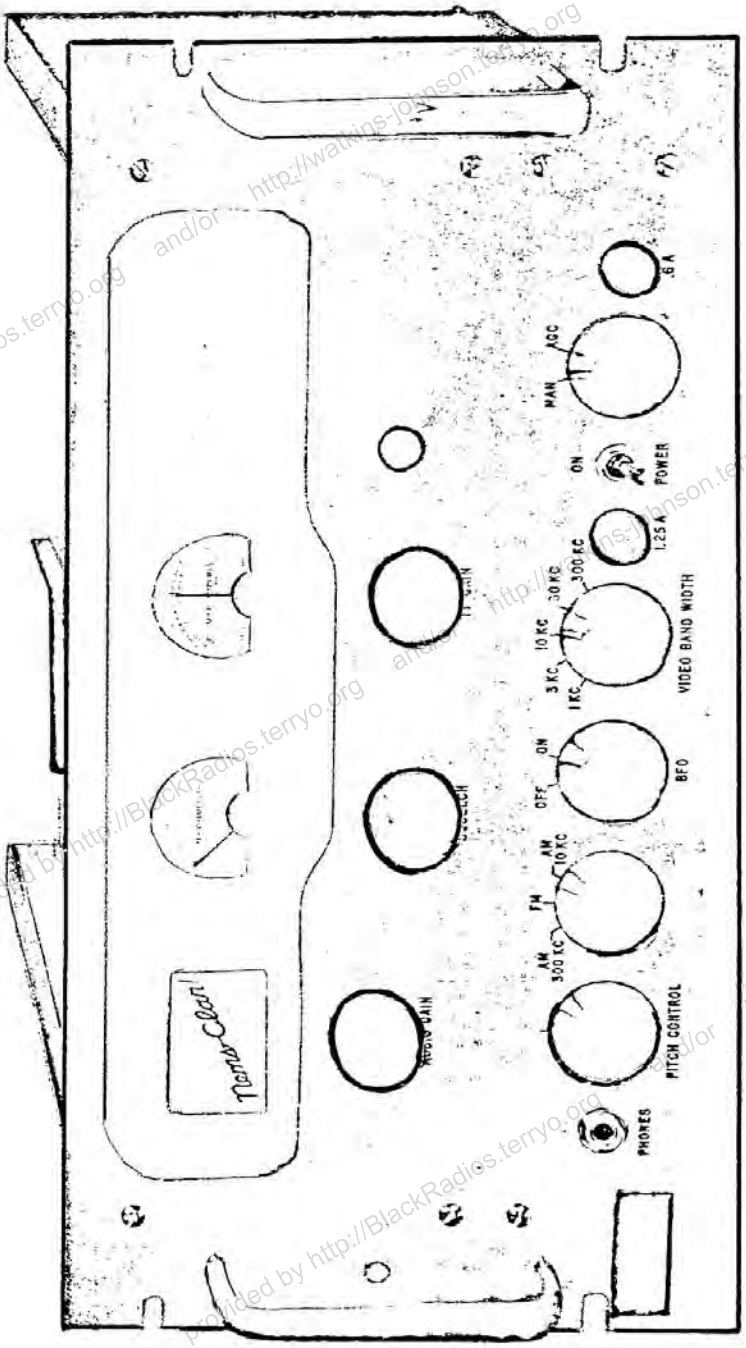

Fig. 1-1. Models 1301-A and 1302-A Special Purpose Receivers, Front View

PERFORMANCE SPECIFICATIONS

	Model 1302-A	Model 1301-A
Tuning Range	55-260 mc	55-260 mc
IF Rejection	70 db, minimum	70 db, minimum
Image Rejection	58 db, minimum	40 db below 130 mc. 30 db min. at any frequency.
Noise Figure	6 db, maximum	11.5 db, maximum
Absolute Sensitivity Measured without band-restricting filters.	4 μv produces at least 23 db S/N with 100 kc deviation, 1 kc modulation frequency.	8 μv produces at least 23 db S/N ratio with 100 kc deviation, 1 kc modulation frequency.
IF Frequencies	21.4 mc and 1 mc	21.4 mc and 1 mc
IF Bandwidth	300 kc and 10 kc	300 kc and 10 kc
Outputs Provided	1. Signal-Wide band for supplying high-impedance load. 2. Monitor-Panel mounted speaker headphones, or 600 ohms balanced output for external use.	1. Signal-Wide band for supplying high-impedance load. 2. Monitor-Panel mounted speaker headphones, or 600 ohms balanced output for external use.
FM Output	0.10 volt per kc, approximately.	0.10 volt per kc approximately.
AM Outputs 300 kc and 10 kc strips	Approx. 10V RMS for 500 μv input modulated 50% at 1 kc.	Approx. 10V RMS for 5 mv input modulated 50% at 1 kc.
FM Output Stability	Varies less than 2 db for inputs above 1 μv.	Varies less than 2 db for inputs above 4 uv.
AM Output Stability Both IF strips	7 db maximum variation for 40-db variation in input.	7 db maximum variation for 40-db variation in input.
Input Impedance	Approx. 50 ohms.	Approx. 75 ohms.
Video Response	10 cps to 300 kc	10 cps to 300 kc
Video Bandwidth Control	5 positions-1,3,10,30 and 300 kc	5 positions-1,3,10,30, and 300 kc
Power Input	115/230 volts, 50-60 cps (400 cps on special order)	115/230 volts, 50-60 cps (400 cps on special order)
Power Consumption	127 watts	95 watts
Weight	40 lbs.	37 lbs.

Table 1-1. Performance Specifications.

TUBE COMPLEMENT

Symbol	Type	Functions
CR-101	IN539	Bridge Rectifier
CR-102	IN539	Bridge Rectifier
CR-103	IN539	Bridge Rectifier
CR-104	IN539	Bridge Rectifier
CR-105	IN457	AGC Delay Diode
V-102	OA2	Voltage Regulator
V-103	OA2	Voltage Regulator
V-105	12AU7	Squelch
V-106	12AU7	1st video amplifier and tuning meter bridge
V-107	12AU7	Audio amplifier
V-108	12AU7	Video cathode follower output
V-201	416B	1st RF amplifier (used only on Model 1302 receiver)
V-202	6J4	2nd RF amplifier, Model 1302; 1st RF amplifier, Model 1301
V-203	6AK5	Mixer, 21.4 mc
V-204	6AF4A	Local Oscillator
V-301	6DC6	1st IF amplifier, 21.4 mc
V-302	6DC6	2nd IF amplifier, 21.4 mc
V-303	6CB6	3rd IF amplifier AM; 1st limiter FM, 21.4 mc
V-304	6AK5	AM detector, AM; 2nd limiter FM, 21.4 mc
V-305	6AL5	Discriminator
V-306	6AU6	Crystal-controlled 2nd conversion oscillator, 22.4 mc
V-307	6BA6	1st IF amplifier, 21.4 mc
V-308	6AK5	Mixer, 1 mc
V-309	6BA6	IF amplifier, 1 mc
V-310	6AL5	AM and AGC detector
V-311	6CB6	BFO, 1 mc
V-312	6CB6	BFO, 21.4 mc

Table 1-2. Tube Complement

SECTION 1

GENERAL DESCRIPTION

1. PURPOSE OF EQUIPMENT.

The Models 1301-A and 1302-A Special Purpose Receivers have been specifically designed to meet the requirements of a highly stable, extremely sensitive AM-FM-CW receiver for critical application in the 55 to 260 mc range.

The receivers have self-contained power supplies and are capable of operation from a power source of 115/230 volts ±10%, 50 to 60 cycles ±5%, single phase, alternating current. Selection of primary voltage is accomplished by a two-position toggle switch located on the rear of the chassis. The switch is equipped with a locking device which presents accidental switching from one voltage to the other. Receivers designed for 400 cps operation may be obtained on special order.

Among the special features of the Models 1301-A and 1302-A receivers are audio squelch with adjustable threshold, FM reception with very low distortion, AM reception with selective IF bandwidths of 10 kc or 300 kc, BFO for CW reception, and a separate high-quality 600 ohm audio output. The video output signal passes through a variable low-pass filter, allowing a greatly improved S/N ratio when the full video bandwidth is not needed. High-level, low-impedance IF output from both IF amplifiers is made available on the rear apron of the chassis.

For further details concerning the capabilities and special features of the Models 1301-A and 1302-A receivers, see table 1-1, Performance Specifications.

2. DESCRIPTION OF EQUIPMENT.

The Models 1301-A and 1302-A receivers are 8-23/32 inches high by 19 inches wide by 16-7/8 inches deep. They each occupy approximately 1.62 cubic feet. The Model 1301-A weighs approximately 37 pounds, and the Model 1302-A receiver weighs approximately 40 pounds.

Panel and chassis are of aluminum construction, and the panel is finished in smooth gray enamel. The panel is designed for standard 19 inch relay rack mounting, although the receivers are equipped with dust covers and louvered side panels, and may be used independently on a shelf or table. The IF amplifier and RF tuner are built as completely shielded subassemblies in both receivers, with most of the audio and video components mounted on a single terminal board on the underside of the main chassis.

Figure 1-1 shows a front view of the Models 1301-A and 1302-A receivers, and table 1-2 shows the tube complement. The difference in the two receivers lies primarily in the type of RF tuner employed, and the consequent mechanical and electrical differences are fully explained and illustrated in the appropriate sections of this book.

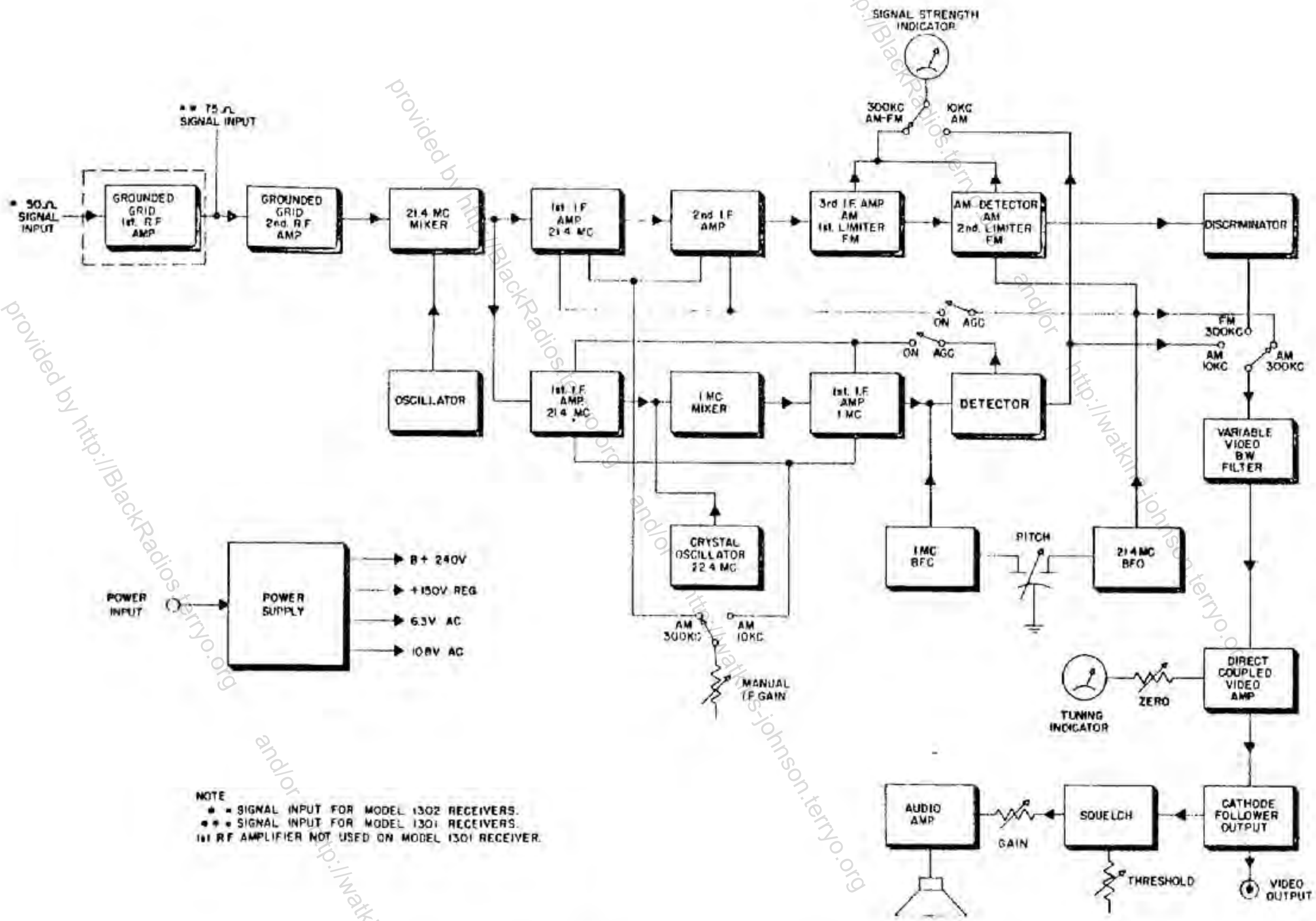

Fig. 2-1. Block Diagram, Models 1301-A and 1302-A Receivers

SECTION 2

THEORY OF OPERATION

1. ANALYSIS, MODELS 1301-A and 1302-A RECEIVERS.

a. A block diagram of the Models 1301-A and 1302-A receivers is shown in Figure 2-1. The circuit, with the function switch in the AM 300kc or FM position is a single superheterodyne with an IF of 21.4 mc. With the function switch in the AM 10kc position, a dual-conversion circuit is used, with a 21.4 mc first IF, followed by a 1 mc second IF.

The tuner is designed to produce the lowest possible noise figure consistent with the type tube used (Model 1301-A uses a 6J4 first RF amplifier, and Model 1302-A uses a 416B first RF amplifier) and a practical tuning structure capable of tuning 55 to 260 mc, with reasonably uniform performance over the band.

The IF amplifier, with the function switch in the FM position, uses two stages of amplification, cascade limiters, and a phase-shift discriminator. With the function switch in the AM 300 kc position, AGC voltage is applied to the first two stages, and the second limiter becomes the AM detector. With the function switch in the AM 10kc position, plate voltage is removed from the 21.4 mc IF amplifier and applied to the 1 mc dual conversion mixer and IF amplifier.

The output signal of the IF strips (AM 300kc, FM, or AM 10kc) is fed through a variable low-pass filter, thus providing the maximum S/N ratio when the full video bandwidth is not needed. The output of the filter drives a two-stage direct-coupled video amplifier with cathode follower output. A portion of the follower output drives a four-stage squelch-audio amplifier circuit.

2. MODEL 1301-A RECEIVER ONLY.

a. ANTENNA.— The input impedance of the receiver is approximately 75 ohms over the frequency range of 55 to 260 mc. The input signal is applied through a type "N" coaxial receptacle located on the rear apron of the chassis. This is a UG-593/U connector.

b. RF STAGE.— The input signal is applied to the cathode of the 6J4 (V-202) grounded grid amplifier. The basic tuning element is a Mallory type S-4 spiral inductuner with the input circuit broadly tuned by the first section. The RF amplifier is operated at maximum gain at all times in order to produce the optimum S/N ratio.

The plate of the 6J4 is coupled to the grid of the 6AK5 (V-203) pentode mixer by a double-tuned band-pass filter. A capacity "T" is used to provide coupling between the primary and secondary tuned circuits. The shunt element of the "T" is adjustable, thus providing a control over the interstage bandwidth. A small iron-core inductor across the shunt element of the "T" network approaches parallel resonance at 55 mc, thus increasing the coupling at the low end and providing a more uniform coupling over the tuning range of 55 to 260 mc.

c. MIXER.– A 6AK5 pentode is used as a mixer. The oscillator signal is injected into the grid circuit, developing an operating bias proportional to the amplitude of the local oscillator signal. This causes a minimum effect on the receiver operation due to variations in local oscillator amplitude. A decoupled test point (TP-201) from a tap on the mixer grid resistors provides a convenient means for observing the response of the RF circuits.

d. LOCAL OSCILLATOR.– The local oscillator utilizes a 6AF4A tube in a modified Colpitts configuration. The end inductors are made of heavy straps to insure frequency stability. The frequency stability of the oscillator is very high due to the use of a high GM tube which is loosely coupled to the high Q tank circuit.

3. MODEL 1302-A RECEIVER ONLY.

a. ANTENNA.– The input impedance of the receiver is approximately 50 ohms over the frequency range of 55 to 260 mc. The input signal is applied through a type "N" 50 ohm coaxial receptacle located in the rear apron of the chassis.

b. FIRST RF STAGE.– The input signal is applied to the cathode of the 416B low noise planar triode. To prevent loss of input signal due to cathode-to-filament capacity, the filaments are kept above RF ground with broad-band chokes.

The input resistance of the 416B is approximately equal to $\frac{2}{Gm}$ when $R_L = R_P$, and in this case is 40 ohms.

The cathode circuit is not tuned, due to the extreme bandwidth produced by the 40 ohm shunt load and the low cathode-to-ground capacity.

The plate tank circuit takes the form of a modified pi network and is used to couple the high impedance plate circuit of the 416B tube to the low input impedance of the 6J4 grounded grid second RF amplifier.

c. SECOND RF STAGE.–– The output of the pi network drives the cathode of the 6J4 grounded-grid second RF amplifier. A low-noise second stage is used so that the system noise figure (first RF, second RF, and mixer) is essentially that of the first stage.

The plate of the 6J4 is coupled to the grid of the 6AK5 pentode mixer by a double-tuned over-coupled band-pass filter. A capacity "T" is used to provide coupling between the primary and secondary tuned circuits. The shunt element of the "T" is adjustable, thus providing a control over the interstage bandwidth. A small iron-core inductor across the shunt element of the "T" network approaches parallel resonance at 55 mc, thus increasing the coupling at the low end and providing a more uniform coupling over the tuning range of 55 to 260 mc.

The single-tuned high Q plate circuit of the 416B tube is used to "fill in" the dip in the over-coupled interstage network. The overall RF response when viewed at the mixer grid test point is essentially flat over the band.

A convenient means for measuring the plate current of the 416B tube is made possible by TP-201 at the junction of R-201 and R-202, the cathode bias resistors. A VTVM at TP-201 will read the voltage drop across 100 ohms. Thus 2V equals 20 ma, 3V equals 30 ma, etc.

The filament of the 416B is operated from a 10.8 volt winding of T-101 through a total series dropping resistor of 4 ohms. This produces a self-regulating effect, which extends the tube life.

A blower motor mounted on the front end assembly is used to cool the 416B. The motor plugs into the main chassis with a 6-pin Jones plug. A jumper between pins 5 and 6 of the Jones plug removes plate voltage from the 416B when the motor is disconnected, thus protecting the tube.

Positive grid bias of 8 volts is applied from a voltage divider from the 150 volt regulated B+. This voltage is necessary to cancel the cathode self-bias voltage of 8.2 volts so that the tube will operate with approximately 0.2 volts bias. The d-c degeneration due to the large cathode resistor has a considerable stabilizing effect on the 416B tube and minimizes performance variations from one tube to the next if replacement becomes necessary.

If, for any reason, the grid bias voltage is shorted or removed, the plate current is reduced and the tube will not be damaged.

d. MIXER.– A 6AK5 pentode is used as a converter. The oscillator signal is injected into the grid circuit, developing an operating bias proportional to the amplitude of the local oscillator signal. This causes a minimum effect on the receiver operation due to variations in local oscillator amplitude. A decoupled test point (TP-202) from a tap on the mixer grid resistors provides a convenient means for observing the response of the RF circuits.

e. LOCAL OSCILLATOR.– The local oscillator utilizes a 6AF4 tube in a modified Colpitts configuration. The end inductors are made of heavy straps to insure frequency stability. The frequency stability of the oscillator is very high due to the use of a high G_m tube which is loosely coupled to the high Q tank circuit.

4. MODELS 1301-A and 1302-A RECEIVERS (continued)

a. IF AMPLIFIER FUNCTION SWITCH IN FM POSITION.– The first IF transformer, located on the IF subassembly, is connected to the mixer plate through a short length of RG62/U coaxial cable. Two high gain stages (V-301, V-302) using 6DC6 tubes are followed by a 6CB6 (V-303) first limiter and a 6AK5 (V-304) second limiter. A 6AL5 (V-305) is used in a discriminator circuit of the phase-shift type. Accurate balance is obtained by using a bifilar winding for the secondary. An automatic gain control voltage is derived from the first limiter grid circuit and applied to the first IF amplifier. The first IF amplifier and the first limiter do not have their cathode resistors bypassed, thus causing cathode degeneration which practically eliminates the detuning caused by changes in tube input capacitance resulting from a change in the bias voltage. Such circuitry is not necessary in the second limiter due to the different tube structure and smaller change in grid bias. A minimum of approximately one volt bias is on the second limiter due to grid rectification of noise signals. A self-resonant choke is connected in the output lead of the discriminator to prevent IF signals from leaving the IF subassembly. A relative signal strength meter with a logarithmic characteristic is operated from the voltage developed at the grids of the limiters.

b. IF AMPLIFIER FUNCTION SWITCH IN AM 300kc POSITION.– The first two high-gain 6DC6 remote cutoff amplifiers (V-301, V-302) receive an AGC voltage developed at the grid of the 6AK5 (V-304) AM detector. The third IF amplifier (V-303) which drives the AM detector, is not gain controlled but its signal handling capabilities have been improved by increasing the screen voltage. A self-resonant choke is connected in the AM output lead from the 6AK5 AM detector (V-304) to prevent IF signals from leaving the IF subassembly.

With the AGC switch in the manual position the AGC voltage is shorted to ground, and the IF gain control in the cathode circuit of the two 6DC6 IF amplifiers is unshorted and becomes operative. The gain-controlled stages use cathode compensation of input capacity variation with bias change. The zero center tuning meter operates only in the FM position. Correct tuning of an AM signal may be accomplished by first tuning in the signal with the selector switch in the FM position and then switching to the AM 300kc position.

The signal-strength meter, M-101, is not calibrated, though it may be used for a relative indication of signal strength. The signal-strength meter is switched between the limiters or AM detector in the 300kc wide amplifier and the AM detector in the 10 kc wide amplifier.

c. IF AMPLIFIER FUNCTION SWITCH IN AM 10KC POSITION.– Plate and screen voltage are removed from the 21.4 mc IF amplifier, and a 21.4 mc signal is capacitively coupled from T-302 to the grid of V-307, the 21.4 mc isolation amplifier preceding V-308, the 1 mc pentode mixer. The output of V-306, the 22.4 mc crystal controlled 2nd conversion oscillator, is capacitively coupled to the grid of V-308, the 1 mc mixer. Terminal "D" of T-310 provides a convenient test point for the alignment of the selective double-tuned 21.4 mc amplifier, consisting of T-309 and T-310. This selective 21.4 mc amplifier is used to increase the rejection of the second image and to further isolate the 22.4 mc crystal oscillator from the front end.

The output of the 1 mc mixer, V-308 is coupled to V-309, a 1 mc amplifier, through T-311 and T-312, which, together comprise a 1 mc double-tuned transformer. V-310, the signal detector and AGC diode, is coupled to V-309 through T-313 and T-314, which comprise the second 1 mc double-tuned IF transformer.

With the AGC switch in the manual position, the AGC voltage is shorted to ground, and R-105 is unshorted and becomes operational. (R-105 is the IF gain control in the cathode circuit of V-307 and V-309, the two 6BA6 remote cutoff IF amplifiers).

d. BEAT FREQUENCY OSCILLATORS, 21.4 MC AND 1 MC. - The two BFO's use 6CB6 type tubes in an electron-coupled Hartley circuit. The BFO's are an integral part of the IF amplifiers, with V-312 in the 21.4 mc circuit and V-311 in the 1 mc circuit. A differential capacitor is used, permitting a single front panel Pitch control to operate both the 21.4 mc and the 1 mc BFO's.

The BFO "ON-OFF" switch is interwired with the "AM 300KC-FM-AM 10KC" function switch so that the appropriate BFO is energized.

e. VIDEO.- The output of the IF strips, AM 300KC, FM 300KC, or AM10KC, is fed to the input of a 5 position lowpass filter. The cutoff frequency can be set to 300 KC, 30 KC, 10 KC, or 1 KC by a front panel selector switch. The output of this filter drives one half of a 12AU7 direct-coupled video amplifier (V-106A). A zero center scale meter (M-102) is used as a tuning indicator and is connected in a bridge circuit consisting of the video amplifier and the other half of the 12AU7 (V-106B). A partial bypass of the cathode of the first video amplifier extends the high frequency response. The output video amplifier is a 12AU7 tube (V-108) connected as a direct-coupled cathode follower. A tap on the cathode resistor of the output video amplifier provides the signal source to drive the monitor audio amplifier, V-107.

f. THE SQUELCH CIRCUIT.- The squelch circuit is best described with the aid of the simplified schematic of Fig. 2-2. V-105A acts as a gated audio amplifier stage, while V-105B serves as a d-c amplifier and gate generator. The circuit is connected in such a manner that V-105B has zero grid voltage when no signal is being received and has a negative signal applied when a carrier is being received. The audio amplifier stage, V-105A, will pass an audio signal when the d-c amplifier, V-105B, is nonconducting, and will not pass an audio signal when V-105B, is in a conducting condition. In this manner the audio circuit is disabled when no carrier is being received. The carrier strength necessary to make the audio section operative is adjusted by the threshold (squelch) control R-115. The operation of this circuit is detailed in the following paragraph.

The d-c amplifier tube, V-105B, is connected between the 150V supply and ground. The fixed bias on this stage is adjusted by R-115. The audio section, V-105A, is connected between the 250 volt supply and the 150 volt supply. The bias on this stage is the voltage drop across the cathode resistor, R-114, plus the voltage drop, if any, in the plate load resistor, R-117, in V-105B. Assuming no signal is being received, the grid of the d-c amplifier tube is zero, or at most has a very small negative voltage on it. R-115 is adjusted until the noise just disappears from the output. In this condition the d-c amplifier tube is drawing plate current, and the drop across its plate load, R-117, appears as a bias to V-105A. This voltage drop is sufficient to cut off V-105A and disable the audio signal. When a carrier is tuned in, a negative voltage is supplied from the second limiter in the IF strip through an isolation resistor, R-111, to the grid of V-105B. This voltage is sufficient to cut off V-105B, causing the voltage to drop to zero across the V-105B plate load resistor, R-117. V-105A receives only its normal cathode bias generated in its cathode bias resistor, R-114, and audio signals are passed through to the output.

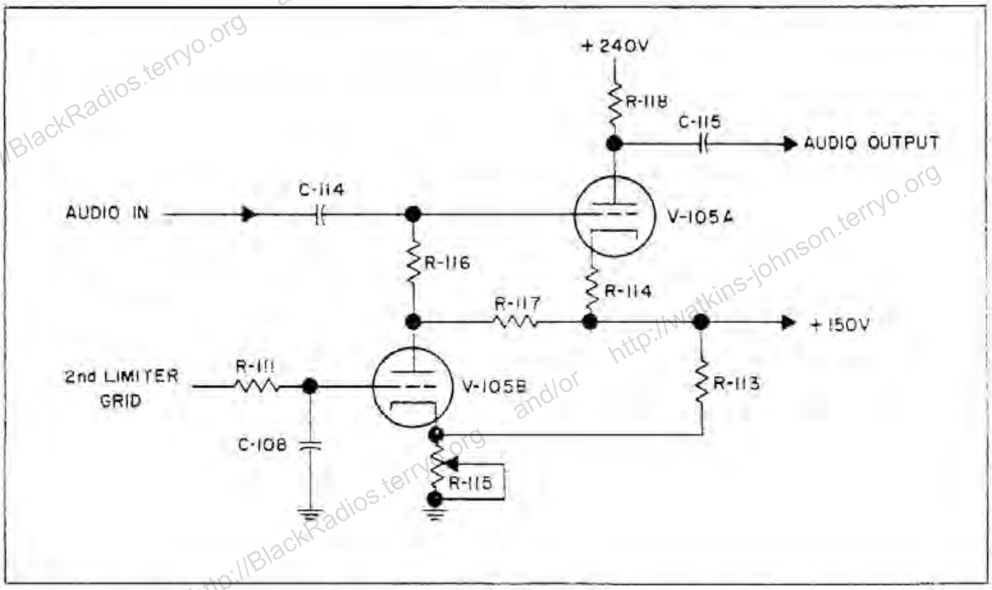

Fig. 2-2. Model 1301-A – 1302-A Receiver Squelch Circuit, Simplified Schematic.

When receiving amplitude-modulated signals with a high percentage of modulation, the squelch circuit may cut off on negative modulation peaks when the envelope amplitude becomes zero. To prevent this, a filter consisting of R-111 and C-108 is placed between the limiter and the grid of the D-C amplifier. This filter has a long enough time constant to reject the lowest audio frequency likely to be received, but not long enough to noticeably delay operation of the squelch.

g. AUDIO AMPLIFIER.– The output of V-105A is used to drive a two-stage resistance coupled audio amplifier. The output amplifier drives a four-inch panel mounted speaker, a phone jack which silences the speaker when in use, and an independent 600 ohm balanced output.

h. PANORAMIC OUTPUT.– An output at the IF 21.4 mc frequency is provided for connection to a panoramic adapter. This output is obtained from the 6AK5 (V-203) mixer plate load through a capacity divider. A special panoramic adapter, type no. T-3000 CL, may be secured from Nems-Clarke Company.

i. POWER SUPPLY.— A conventional two-section capacitive input filter power supply delivers a d-c potential of 240 volts. V-102 and V-103 provide two separate 150 volt d-c regulated outputs.

A 6.3 volt winding supplies the filaments of all tubes except V-201. V-201 is supplied by a separate 12.0 volt winding in series with an external 5.1 ohm dropping resistor.

The Models 1301-A and 1302-A receivers have a toggle switch located on the rear apron, which provides for the selection of either 115 volt or 230 volt operation.

SECTION 3
OPERATION

1. INTRODUCTION.

Figure 1-1 shows the appearance and location of controls on the front panel of the Models 1301-A and 1302-A Special Purpose Receivers.

2. CONTROL SETTINGS.

a. Set line voltage selector switch, S-102, located on the rear apron of the chassis, to the appropriate position for the line voltage encountered. This switch provides for input voltages of either 115 or 230 VAC, and is equipped with a locking device which prevents accidental switching from one voltage to the other.

b. POWER.— Turn on the power switch, S-101, located on the front panel. NOTE: For the Model 1302-A receiver, a time delay relay (K-201) is used to delay the application of plate voltage to the 1st and 2nd RF amplifiers for approximately 120 seconds. Delay of plate voltage to the 416B tube (V-201) is in the interest of improved tube life. The receiver will therefore be inoperative for approximately two minutes after it is turned on.

c. MODULATION.— The modulation selector switch (S-104) has three positions: AM 300KC, FM and AM 10KC.

(1) FM.— The function switch must be in the FM position. The IF bandwidth is 300 kc. The BFO should be in the "OFF" position. The manual AGC switch (S-105) and the IF gain control are inoperative in the FM position. The zero-center tuning meter (M-102) is operative only in the FM position.

(2) AM WIDE BAND (300 kc).– The function switch must be in the AM 300 KC position. The Manual AGC switch should be in the AGC position except when the BFO is to be used. For BFO operation, the manual IF gain control (R-105) should be adjusted to produce the loudest beat note.

(3) AM NARROW BAND (10KC).– The function switch must be in the AM 10KC position. The Manual AGC switch should be in the AGC position except when the BFO is to be used. For BFO operation, the manual IF gain control (R-105) should be adjusted to produce the loudest beat note. Care must be taken when tuning in the 10KC IF position to avoid "missing" the station.

d. VIDEO BANDWIDTH.– The video bandwidth switch (S-106) has five positions: 300KC, 30KC, 10KC, 3KC, and 1KC. The position resulting in the best S/N ratio should be used.

e. SQUELCH.– The squelch circuit is inoperative with the squelch control R-115 counterclockwise against its stop. In the absence of a signal, rotate the squelch threshold control clockwise until the background noise just becomes inaudible. Any usable signal should then disable the squelch circuit.

f. AUDIO.– Adjust as needed.

SECTION 4

MAINTENANCE

1. INTRODUCTION.

The models 1301-A and the 1302-A receivers should give comparatively trouble-free performance. If, however, trouble occurs, rapid and effective trouble shooting may be accomplished by the application of a simple effect-to-cause reasoning process, along with the data given in this section. A thorough knowledge of the theory of operation, as contained in Section 2, is essential to successful effect-to-cause reasoning. As a general statement, it may be said that frequent recurrence of a trouble usually indicates that the effect and not the cause has been remedied, and further investigation should be made. In time, the blower for the 416B tube (V-201, used only on the Model 1302-A receiver) may become clogged with dust collected from the atmosphere. Since this impairment of the blower's efficiency may cause the loss of a very expensive tube, it is recommended that the blower be disassembled and cleaned whenever it is found to be sufficiently dirty to warrant such action.

The voltage chart and the overall schematic diagram contained herein will be useful in locating trouble. Such trouble as broken leads or solder joints and loose or defective tubes will not be discussed at length here, but should be suspected and searched for in all cases where the trouble is not immediately apparent. The illustrations given in this section show the location of all major components and such smaller components as cannot be readily identified from adjacent stencils on the receiver.

All illustrations of an overall nature (front, top, bottom, and rear views of the receiver) are of the Model 1302-A. With certain reservations, however, these illustrations will serve to represent the Model 1301-A receiver, since the two receivers have identical chassis and IF sub-assemblies. Where differences occur, as in the RF tuners, separate illustrations of the sub-assemblies or components for each receiver are included. Reference to the parts list (Section 5) will further clarify the identification of components for each receiver.

2. IF ALIGNMENT PROCEDURE. (Sweep Method) 300 KC IF Strip

a. General Instructions.– In order to minimize the frequency response of the detectors (including their decoupling networks) used for visual alignment, the sweep generator sweep width used should be no greater than that required to produce the desired oscilloscope pattern. The marker generator signal at 21.4 mc should be coupled in as required to produce a suitable marker pip. Check to see that the marker generator connection does not upset the response shape by disconnecting the marker generator and observing that the response shape does not change. In general, the marker signal can be introduced by connection to a turn or two of insulated wire wrapped around the sweep generator lead near the point of connection to the circuit under test, or by coupling to the sweep generator lead through a small capacitor.

In order to avoid extraneous coupling or regeneration, the sweep and the marker generator leads should be dressed out and away (toward the input end) from the stages already tuned.

A low capacity shielded cable, such as RG-62/U coaxial cable should be used for connection to the oscilloscope. The cable capacity, plus oscilloscope input capacity, should be held to a maximum of 100 $\mu\mu f$. The direct coupled (DC) vertical amplifier connection should be used on the oscilloscope.

The adjustment procedure should be carefully followed and adjustments should be made in the order given. The receiver should be allowed sufficient warm-up time to stabilize its operation.

b. Equipment Required.–

(1) Sweep Generator Type RCA 59-C.

(2) Oscilloscope, Type Dumont 304-A or equivalent.

(3) 21.4 mc center frequency crystal controlled marker, with side markers of 21.025 and 21.775 mc.

(4) One 10.0 ohm, 1/2 watt resistor.

(5) One 200 ohm, 1/2 watt resistor.

(6) Assorted leads and connectors as indicated in text.

c. Control Settings.– During the entire alignment procedure the receiver controls must be set as follows unless otherwise indicated:

(1) Squelch Control . . . . Maximum CCW.
(2) BFO Pitch Control . . . . Aligned at reference mark.
(3) Line Selector S-102 . . . . 115 V AC position.
(4) BFO . . . . OFF
(5) Video Bandwidth . . . . 300 kc position.
(6) Audio Gain . . . . Set maximum CCW.
(7) AM-FM Control . . . . Place in FM position.
(8) MAN-AGC Control . . . . Place in MAN position.
(9) IF GAIN Control . . . . Set maximum CCW.

Turn on power. Set receiver tuning dial to lowest frequency and remove local oscillator tube V-204.

d. Second Limiter, Adjustment of T-307.– Remove second IF amplifier V-302 from its socket. Connect the scope to TP-302 (see Fig. 4-8). Connect the sweep generator between pin #1 of V-303 and ground on the tube socket mounting strap nut. Set the sweep generator output to maximum. Adjust T-307 for a symmetrical response centered around the center frequency marker at 21.4 mc.

e. Discriminator, Adjustment of T-308.– Remove the first limiter V-303 from its socket. Connect the sweep generator between pin #1 of V-304 and ground on the tube socket mounting strap nut. Set the sweep generator output to maximum. Adjust the discriminator transformer T-308 for a symmetrical S-shaped discriminator curve, centered around 21.4 mc. The discriminator peak-to-peak separation should be 750 kc, plus or minus 30 kc. The adjustments for equal amplitude of the two peaks should be made with the marker disconnected to prevent base-line shift.

f. First Limiter, Adjustment of T-305, and T-306.– Replace V-302, and V-303. Remove V-301. Connect the scope to TP-301 (see Figure 4-8). Connect the sweep generator between pin #1 of the second IF amplifier V-302 and ground on the tube socket mounting strap nut. Set the sweep generator to produce a peak scope deflection of 0.25 volts. Adjust T-305 (primary) and T-306 (secondary) for a symmetrical response curve centered around 21.4 mc. The shape of the response curve should be flat-topped or slightly double-peaked.

g. Second IF amplifier, adjustment of T-303, and T-304.– Replace V-301. Disconnect the cable connected to J-202 on the RF chassis. See Figure 4-1. Connect the scope to TP-301, see Fig. 4-8. Solder a 10 ohm resistor between pin #1 of V-301 and ground of the tube socket mounting strap nut. Solder a 200 ohm resistor to pin #1. Connect the sweep generator between the 200 ohm resistor and ground on the grounded lead of the 10 ohm resistor. Set the sweep generator output as required to produce a peak scope deflection of 0.25 volts. Adjust T-303 (primary) and T-304 (secondary) for a symmetrical response curve centered around 21.4 mc. The response shape should be flat-topped or slightly double-peaked. After the adjustment is completed, remove the 10 and the 200 ohm resistors.

h. First IF Amplifier, Adjustment of T-301, and T-302.— Reconnect the cable to J-202. See Fig. 4-1. Install the IF bottom cover and tighten all the mounting screws. Connect the scope to TP-301. See Fig. 4-8. Connect the sweep generator to TP-202 (on the RF chassis) and ground on one of the trimmer capacitor studs. Set the sweep generator output as required to produce 0.25 volts peak scope deflection. Adjust T-301 (primary) and T-302 (secondary) for a symmetrical response centered around 21.4 mc. The response shape should be very nearly flat-topped.

i. 21.4 mc BFO Alignment.— Leave the scope and sweep generator connected as in step h. above. Turn the BFO switch to the "ON" position. Set the BFO pitch control to line up with the panel reference line. Adjust T-316 until the BFO marker appears on the middle of the IF response. Rotate the BFO pitch control, the BFO marker should move across the entire top of the IF response.

3. IF ALIGNMENT PROCEDURE, (SWEEP METHOD), 10 KC IF STRIP.

a. 21.4 mc Isolation Stage, V-307. Adjustment of T-309 and T-310.— Set the function switch to AM 10 kc. Connect the sweep generator between pin #1 of V-307 and ground on the tube socket mounting strap nut. Connect the scope to terminal D on T-310. Adjust T-309 and T-310 for maximum gain centered around the 21.4 mc marker. The 22.4 mc pip, generated by the second local oscillator V-306, as seen on the scope must appear on the high frequency side of the response curve. This pip may be identified by removing the 22.4 mc oscillator and observing the pip disappear.

b. 1.0 mc IF Amplifier.— Connect a 21.4 mc marker to pin #1 of V-307 and tune T-311, T-312, T-313, and T-314 for a maximum indication of the Signal Strength meter, M-101, on the front panel. Readjust T-309 and T-310 for a maximum indication on the signal strength meter, M-101, on the front panel.

c. 1.0 mc BFO Adjustment.— Insert 21.4 mc marker into the grid, pin #1, of the Isolation Stage V-307. Turn BFO to "ON" position. Set BFO pitch control to coincide with the marker on the panel. Increase audio gain control and adjust T-315 for zero beat as heard in the panel mounted monitor speaker. Turn BFO control both clockwise and counter-clockwise and note that the BFO note goes to inaudability in both directions.

4. LOCAL OSCILLATOR ADJUSTMENTS.

a. Local Oscillator Adjustment, Model 1302-A only. The only adjustment necessary in the local oscillator is to make the tuning dial read properly. This section may be disregarded if the dial is reading correctly. If a tube has been replaced and an error is noted, it may be corrected by adjustment of C-229. This adjustment should be made with a signal generator of high accuracy at 60 mc.

The high-frequency end of the dial is controlled by the location of C-230 on the end inductor L-210. The correct adjustment is made at the factory and should not require readjustment in the field.

b. Local Oscillator Adjustment, Model 1301-A only.— The only adjustment necessary in the local oscillator is to make the tuning dial read properly. This section may be disregarded if the dial is reading correctly. If a tube has been replaced and an error is noted, it may be corrected by adjustment of C-233. This adjustment should be made with a signal generator of high accuracy at 55 mc.

The high-frequency end of the dial is controlled by the location of C-231 on the end inductor. The correct adjustment is made at the factory and should not require readjustment in the field.

c. Mechanical Adjustments.— Normally the tuning dial will not need any adjustment in the field, however, if the above procedure fails to restore normal operation, refer to the following.

(1) Loosen both stops.

(2) Rotate dial to the extreme low-frequency end until the dial is stopped by the inductuner stop. Hairline should align with triangle on dial.

(3) Back up just off the inductuner stop and tighten the set screws in the dial drive low-frequency stop.

(4) Rotate dial to the extreme high-frequency end until the dial is stopped by the inductuner stop. Hairline should align with triangle on dial, if not, loosen screws on inductuner shaft and align triangle.

(5) Back up just off the inductuner stop and tighten the set screws in the dial-drive high-frequency stop. This completes the dial adjustments.

5. RF AMPLIFIER ALIGNMENT.

a. RF Amplifier Alignment, Model 1302-A only.— The RF circuits are wide band compared with the IF selectivity and are designed around the highly stable Mallory S-4 spiral inductuner. The end inductors are also very stable, and therefore the unit should not require realignment. If realignment is found necessary:

(1) Unsolder C-248 from the inductuner lug and solder to the BNC test connector.

(2) Connect a sweep generator with a 50-ohm source impedance to the BNC test jack.

(3) Connect oscilloscope to front-end test point TP-202.

(4) Set the dial to 70 mc.

(5) Adjust C-217 and C-222 for a double-tuned symmetrical response centered at 70 mc. Use 70-mc marker.

(6) Adjust C-220 for a 15% dip in the response.

(7) Repeat (5) above.

(8) Set dial to 250 mc and bend end inductors L-207 and L-209 to produce a symmetrical response centered at 250 mc. Use 250 mc marker.

(9) Unsolder C-248 from the BNC test connector and resolder to the inductuner.

(10) Connect sweep generator to the antenna jack J-101 or J-201. NOTE: An accurate 50-ohm source can be achieved by using a 6- or 10-db ohm pad between the sweep generator output and the receiver input.

(11) Set the dial to 70 mc.

(12) Adjust C-243 for a symmetrical response.

(13) Set the dial to 250 mc and move the position of C-244 along the end portion of end inductor L-204 to produce a symmetrical round-nose response.

b. RF Amplifier Alignment, Model 1301-A only.— The RF circuits are wide band compared with the IF selectivity and are designed around the highly stable Mallory S-4 spiral inductuner. The end inductors are also very stable, and therefore the unit should not require realignment. If realignment is found necessary, proceed in accordance with the following outline;

(1) Connect a sweep generator with a 750 ohm source impedance to J-101 or J-102.

(2) Connect oscilloscope to front-end test point TP-201.

(3) Set the tuning dial to 55 mc.

(4) Adjust C-222 and C-226 for a double-tuned symmetrical response centered at 60 mc. Use 60-mc marker.

(5) Adjust C-224 for a 3% dip.

(6) Repeat (4) above.

NOTE: The RF response at the high-frequency end is controlled by rigid fixed end inductors and should not be adjusted in the field.

6. IF ALIGNMENT.— (CW Method)

a. Introduction.— In the event that it should become necessary to align the IF strip, and a suitable sweep generator and oscilloscope are not readily available, the following CW alignment procedure is included. It is to be noted that alignment by the sweep method is more efficient and effective than the CW method that follows, and, alignment by the sweep method is more easily adaptable to trouble-shooting should the necessity arise. Therefore, if suitable equipment is available, the sweep method of alignment should be used.

b. Second Limiter Alignment.— (CW Method)

(1) Remove V-302.

(2) Set the signal generator to 21.4 mc and connect its output to pin #1 of V-303.

(3) Connect a high-resistance voltmeter (VTVM) to the second limiter grid return (TP-302).

(4) Set the signal generator output to produce approximately 2.0 volts on the VTVM.

(5) Detune the primary slug of T-307 counterclockwise against the stop.

(6) Increase the signal generator output to produce approximately the same value on the VTVM as in (4) above.

(7) Adjust the secondary slug of T-307 for a maximum reading on the VTVM.

(8) Adjust the primary slug of T-307 for a maximum reading, keeping the signal generator output adjusted for the same value on the VTVM as in (4) above. DO NOT readjust the secondary for a maximum as this will result in improper alignment.

The second limiter transformer, T-307, has a 3.0 db bandwidth of approximately 2.5 mc. The low circuit Q's and heavy coupling make visual alignment of this transformer desirable but not essential. The procedure outlined above will produce less than 1.0 db tilt in the response of this transformer. Thus the slope is negligible over the narrow 300 kc IF bandwidth.

c. Discriminator Alignment (CW Method).– In preparation for alignment of the discriminator transformer, T-308, remove the 6AK5 (second limiter) tube, V-304, and note the reading of the center frequency meter M-102. If it is off center, it should be centered by means of the potentiometer, R-127, located on the rear apron of the chassis. Difficulty in readily securing an exact center reading is indicative of a defective 6AL5 tube (V-305), a defective 12AU7 tube (V-106), or their associated components, and must be corrected before proceeding further. After this adjustment, replace V-308 and proceed as follows:

(1) Remove V-302.

(2) Set the signal generator to 21.4 mc and connect to pin 1 of V-303.

(3) Connect a high-resistance d-c voltmeter (VTVM) to the second limiter grid return (TP-302).

(4) Set the signal generator output to produce 2 volts on the VTVM.

(5) Connect the VTVM to the discriminator output lead, (TP-303).

(6) Tune the secondary of T-308 to zero output, then counterclockwise until the VTVM shows a reading of 0.5 volt.

(7) Tune the primary of T-308 to give a maximum reading on the VTVM.

(8) Retune the secondary to produce a zero (balance) reading on the VTVM.

(9) Detune the signal generator above and below 21.4 mc to produce a maximum positive and negative output. These voltages should be equal and have a magnitude of approximately ± 8 volts, D.C. Minor adjustment of the primary of T-308 will cause the two peak voltages to become exactly equal.

d. IF Amplifiers (CW Method).–

(1) The characteristics of cascaded, critically coupled amplifier stages are such as to make alignment difficult; however, the advantages of response stability, gain, and adjacent-channel selectivity make this type of coupling most desirable. Alignment has been kept as simple as possible by designing the three capacitively coupled double-tuned IF transformers, comprising T-301, T-302, T-303, T-304, T-305,

and T-306, to have almost identical characteristics. The primary and secondary Q's have been kept high, and therefore the mutual coupling is low for the required bandwidth. These factors suggest a rather simple alignment procedure with a minimum of equipment. The resonant frequency of the primary or the secondary in the absence of the other (no couplings) is very nearly the proper tuning when the circuits are coupled. If the primary circuit is detuned, the secondary adjusted for maximum output, and the primary then returned to maximum, the overall response will be approximately correct. This procedure is as follows:

(2) Remove the oscillator tube (V-204) to prevent mixing at the signal generator harmonic frequencies.

(3) Set the receiver dial to approximately 60 mc.

(4) Set the generator to 21.4 mc and connect to pin 1 of V-203.

(5) Connect a high-resistance d-c voltmeter (VTVM) to the second limiter grid return (TP-302).

(6) Set the generator output level to produce approximately 2 v on the VTVM.

(7) If the IF amplifier is known to be considerably out of adjustment, it will be necessary to peak T-301, T-302, T-303, T-304, T-305 and T-306, to provide adequate gain.

(8) Detune the primary (T-305) counterclockwise against the stop.

(9) Increase the signal generator output to produce 2 v on the VTVM.

(10) Adjust the secondary (T-306) for maximum reading on the VTVM.

(11) Adjust the primary (T-305) for maximum reading, keeping the signal generator output adjusted to maintain 2 v on the VTVM. DO NOT readjust the secondary (T-306) for a maximum as this will result in improper adjustment.

(12) Repeat steps 7 through 10 for T-302, T-303, and T-304. NOTE: It is not necessary to follow this sequence, as any transformer may be adjusted without affecting the others.

e. 10 kc IF Alignment (CW Method).– Function switch in AM 10 kc position, BFO off, AGC off, IF gain control maximum clockwise.

(1) Connect an accurate 21.4 mc CW generator to pin 1 of V-307.

(2) Remove local oscillator, V-204.

(3) Connect VTVM to terminal "D" of T-310.

(4) Adjust T-309 and T-310 for maximum indication on meter.

(5) Connect VTVM to TP-304.

(6) Peak T-311, T-312, T-313, and T-314 for maximum indication on meter.

(7) Turn BFO on and with pitch control on reference line, adjust T-315 for zero beat.

TUBE	TYPE	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
MODEL 1302-A, FRONT END										
V-201	416B	Cathode	+6.95V	Filaments	6.0VAC	Plate +	195V	Grid Ring	+6.9V	
V-202	6J4	Gnd	1.1	Gnd	6.3AC	Gnd	Gnd	130		
V-203	6AK5	-2.0	Gnd	6.3AC	Gnd	145	59	Gnd		
V-204	6AF4A	*53	Do not measure	Gnd	6.3AC	2.5	do not measure	*53		
MODEL 1301-A, FRONT END										
V-202	6J4	Gnd	1.2	Gnd	6.3AC	Gnd	Gnd	156		
V-203	6AK5	-1.4	Gnd	Gnd	6.3AC	146	55	Gnd		
V-204	6AF4A	*53	Do not measure	Gnd	6.3AC	2.5	Do not measure	*53		
MODELS 1301-A & 1302-A, MAIN CHASSIS										
V-102	OA2	147	NC	NC	NC	147	NC	Gnd		
V-103	OA2	148	NC	NC	NC	148	NC	Gnd		
V-105	12AU7	145	-.27	24	Gnd	Gnd	210	133	150	6.2AC
V-106	12AU7	135	Gnd	6.7	Gnd	Gnd	137	-.1	6.8	6.2AC
V-107	12AU7	98	0	5.7	Gnd	Gnd	230	0	8	6.2AC
V-108	12AU7	235	138	141	Gnd	Gnd	235	138	141	6.2AC
MODELS 1301-A & 1302-A, IF AMPLIFIER; FUNCTION SWITCH IN FM POSITION										
V-301	6DC6	-.33	.7	5.9AC	Gnd	134	76	Gnd		
V-302	6DC6	-.32	.82	5.9AC	Gnd	133	69	Gnd		
V-303	6CB6	-.31	.12	6.0AC	Gnd	135	34	Gnd		
V-304	6AK5	-6.6	Gnd	6.0AC	Gnd	37	83	Gnd		
V-305	6AL5	-.22	-7.0	4.8AC	Gnd	Gnd	Gnd	-12.4		
MODELS 1301-A & 1302-A, IF AMPLIFIER; FUNCTION SWITCH IN AM 300KC POS.										
V-301	6DC6	-1.2	.68	5.9AC	Gnd	130	76	Gnd		
V-302	6DC6	-.37	.81	5.9AC	Gnd	130	71	Gnd		
V-303	6CB6	-.18	.31	6.0AC	Gnd	131	58	Gnd		
V-304	6AK5	-3.8	Gnd	6.0AC	Gnd	35	85	Gnd		
V-305	6AL5	-.13	-7.2	4.8AC	Gnd	Gnd	Gnd	-12.		

Table 4-1. Voltage Measurements, Models 1301-A & 1302-A

TUBE	TYPE	PIN #1	PIN #2	PIN #3	PIN #4	PIN #5	PIN #6	PIN #7	PIN #8	PIN #9
BFO SWITCH ON										
V-312	6CB6	-9.7	0	5.9AC	Gnd	145	126	Gnd		
MODELS 1301-A & 1302-A, IF AMPLIFIER; FUNCTION SWITCH IN AM 10KC POS.										
V-306	6AU6	-7.4	Gnd	Gnd	5.9AC	149	83	0		
V-307	6BA6	-.22	Gnd	5.9AC	Gnd	143	58	.6		
V-308	6AK5	-1.17	Gnd	5.9AC	Gnd	148	71	Gnd		
V-309	6BA6	-.22	Gnd	5.9AC	Gnd	148	61	.65		
V-310	6AL5	0	-.1	5.9AC	Gnd	5.6	Gnd	-1.25		
BFO SWITCH ON										
V-311	6CB6	-27	0	5.9AC	Gnd	149	104	Gnd		

Table 4-1. Voltage Measurements, Model 1301-A & 1302-A (Continued)

Notes: Line voltage 115VAC, 60 cps; S-102 set to 115V; dial tuned to 220 mc; no signal input; squelch control and audio gain control full CCW; AGC on; BFO off except for measurements on V-311 & V-312, R-127 discriminator tuning meter balance set in accordance with procedure shown in section 4; filament voltages measured between tube pin and chassis except V-201; DC voltages taken with an 11-megohm VTVM; all voltages measured with respect to Gnd.

*Use 1-meg isolating resistor between tube pin and meter probe.

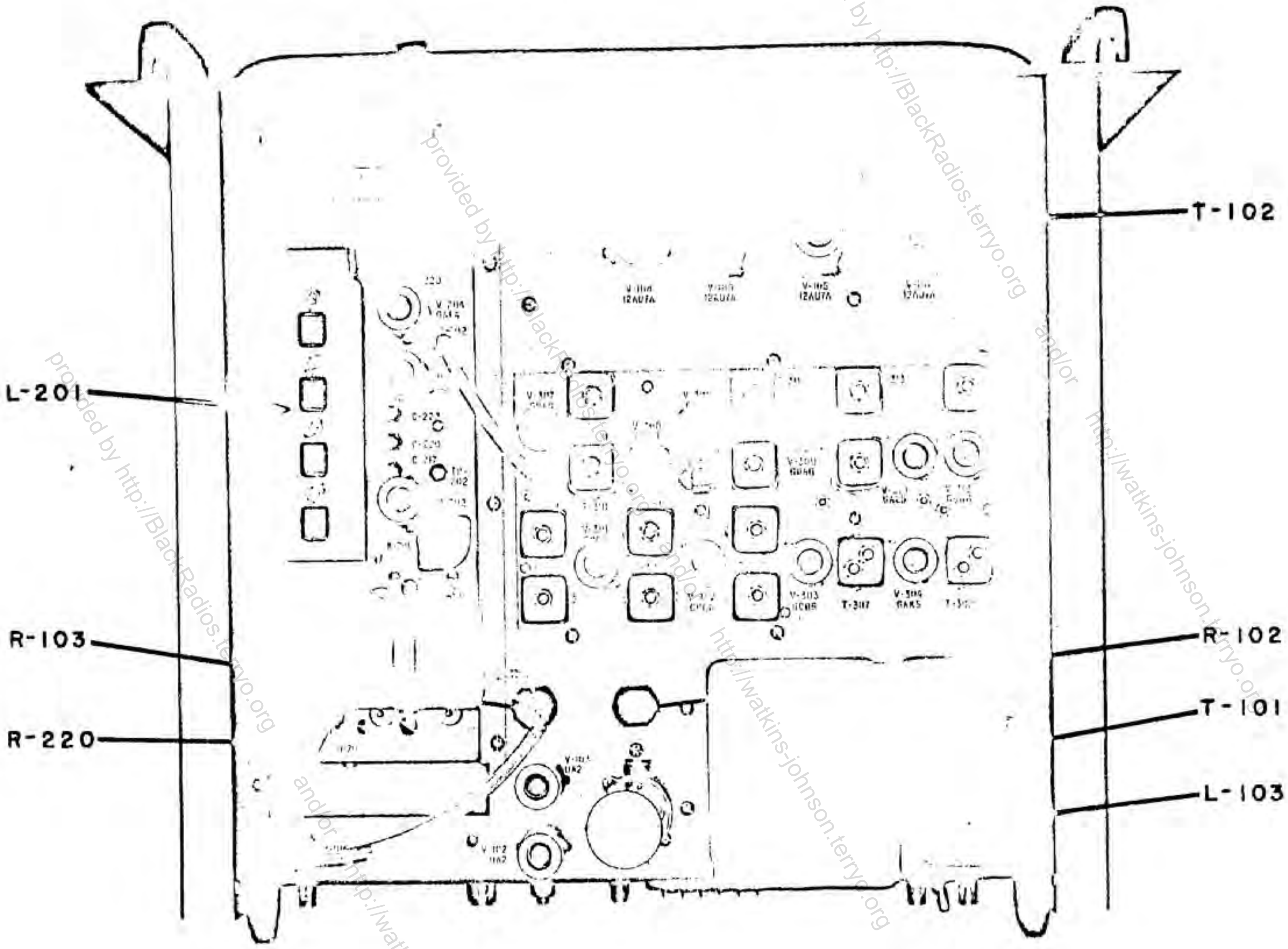

Fig. 4-1. Model 1302-A Receiver, Top View, (Dust Cover Removed).

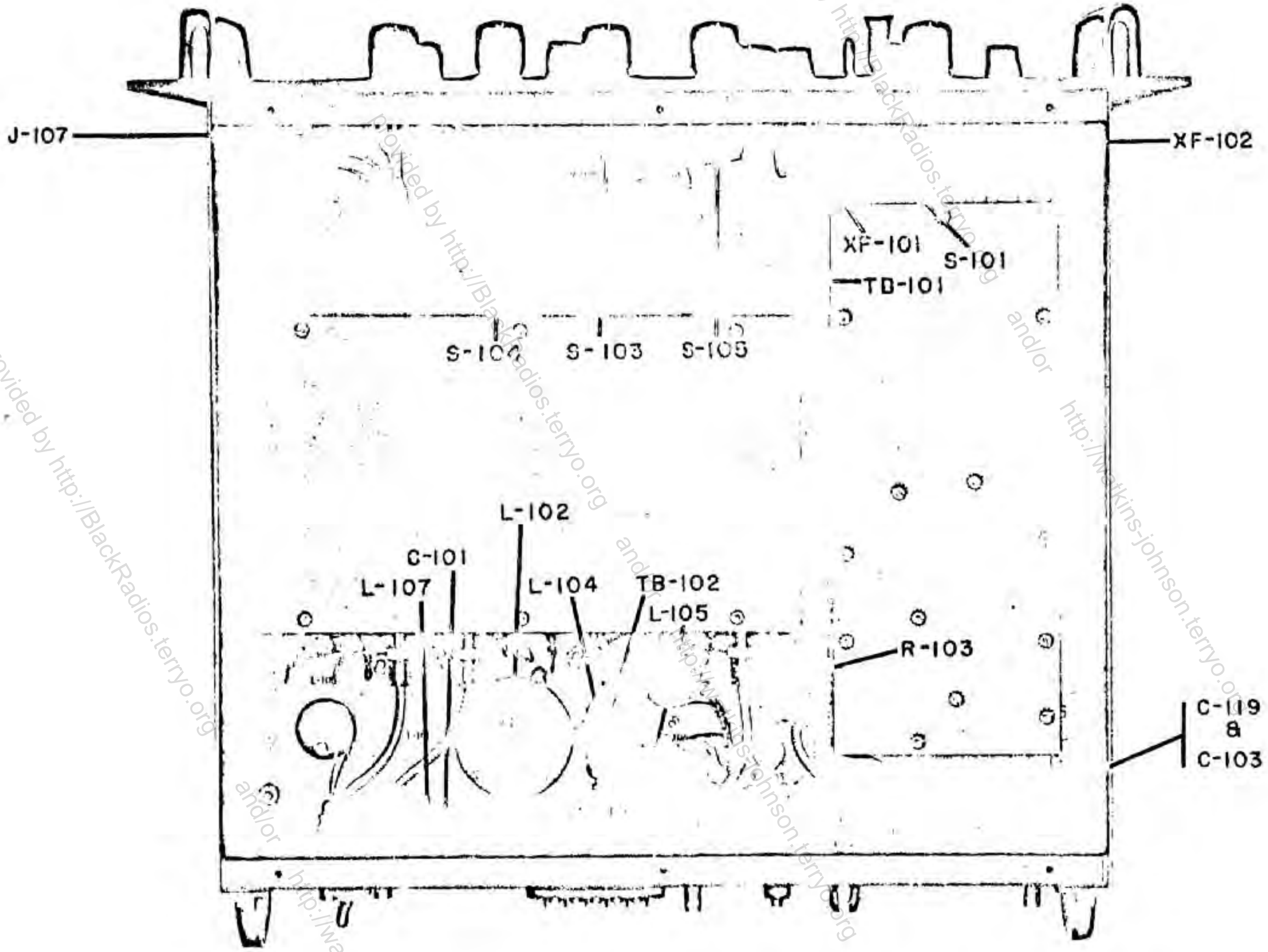

Fig. 4-2. Model 1302-A Receiver, Bottom View, (Dust Cover Removed).

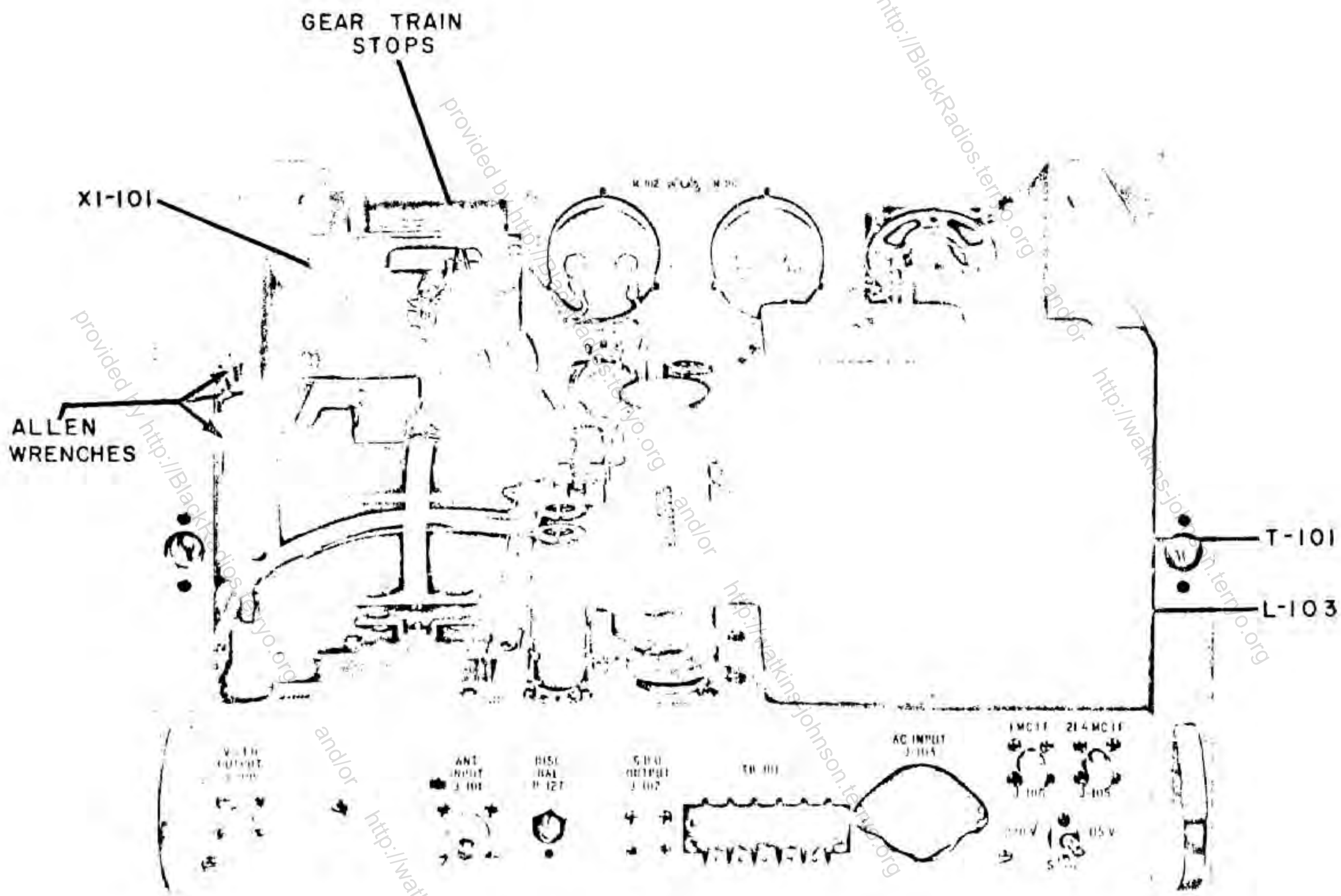

Fig. 4-3. Model 1302-A Receiver, Rear View, (Dust Cover Removed).

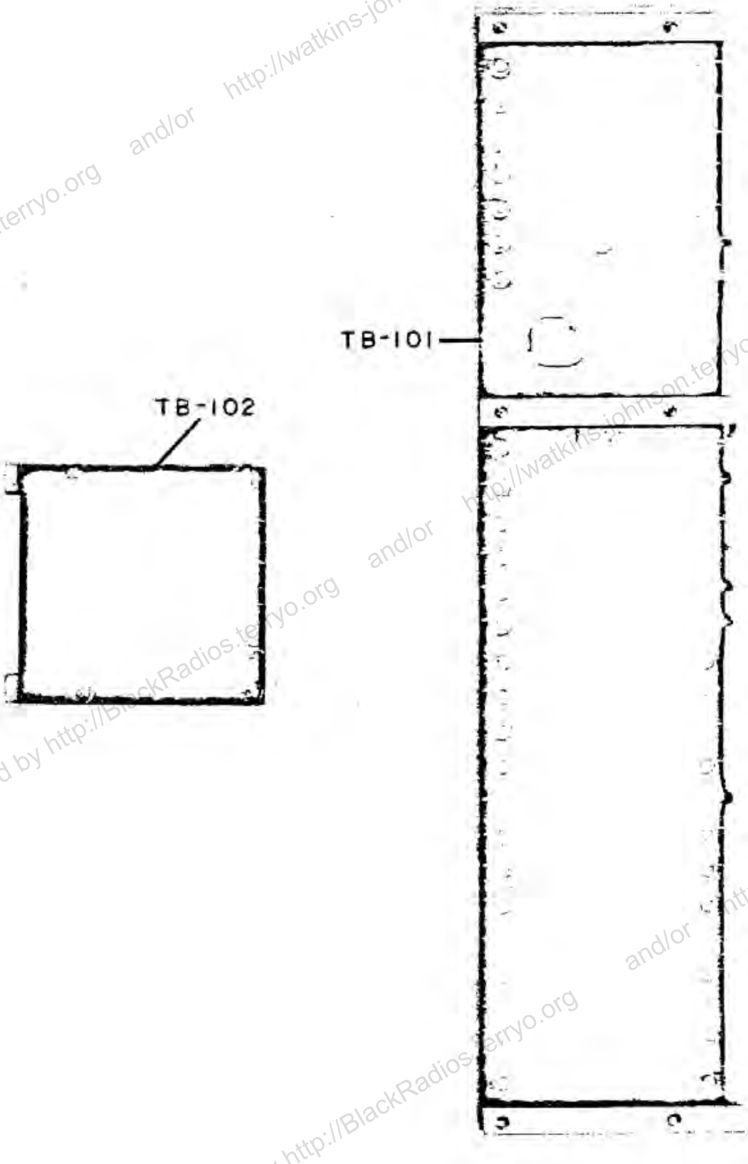

Fig. 4-4. Resistor Board(s) Used in Models 1301-A and 1302-A Receivers.

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provided by http://BlackRadios.terryo.org and/or http://watkins-johnson.terryo.org

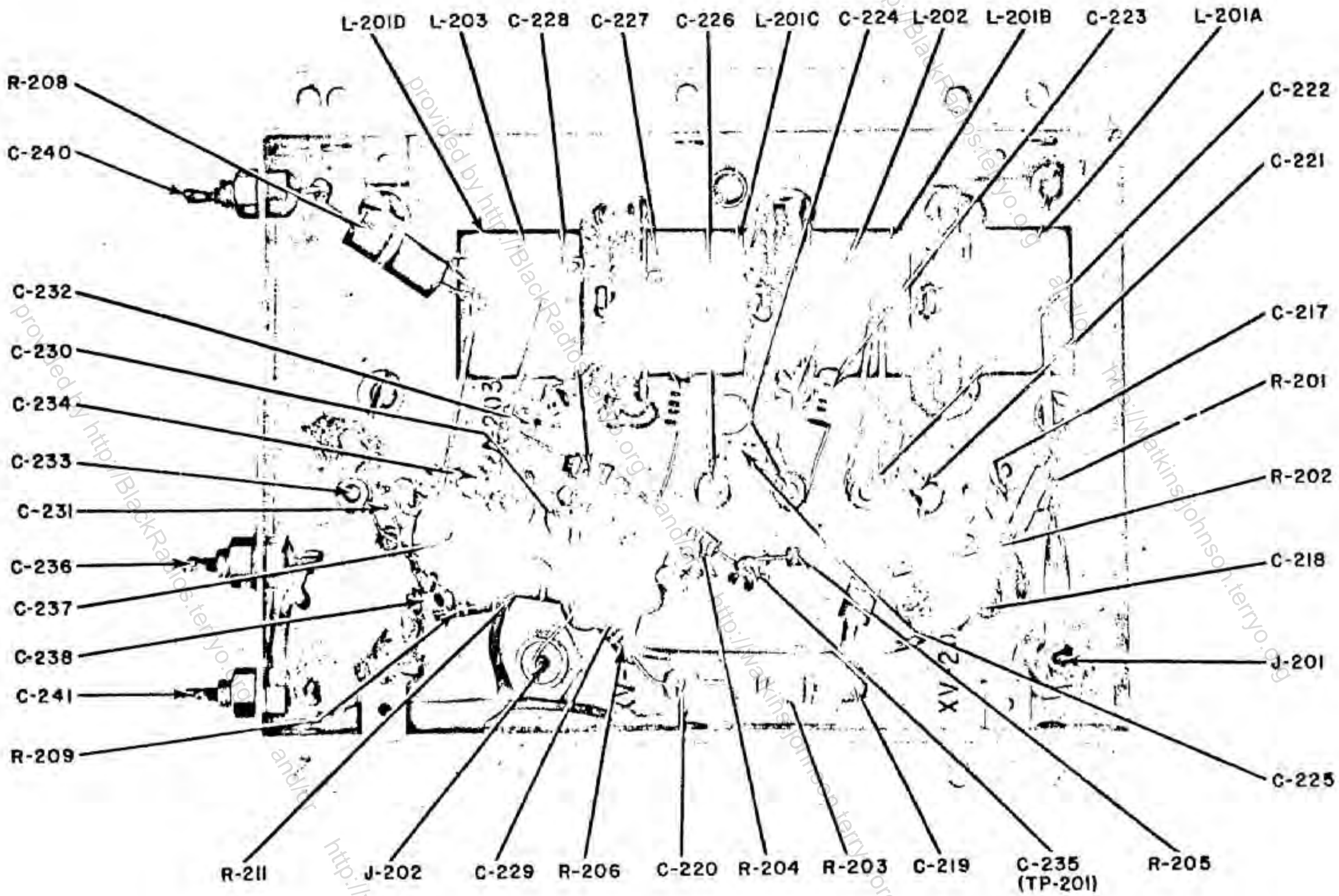


Fig. 4-5. RF Tuner, Model 1301-A Receiver, Bottom View, (Dust Cover Removed).

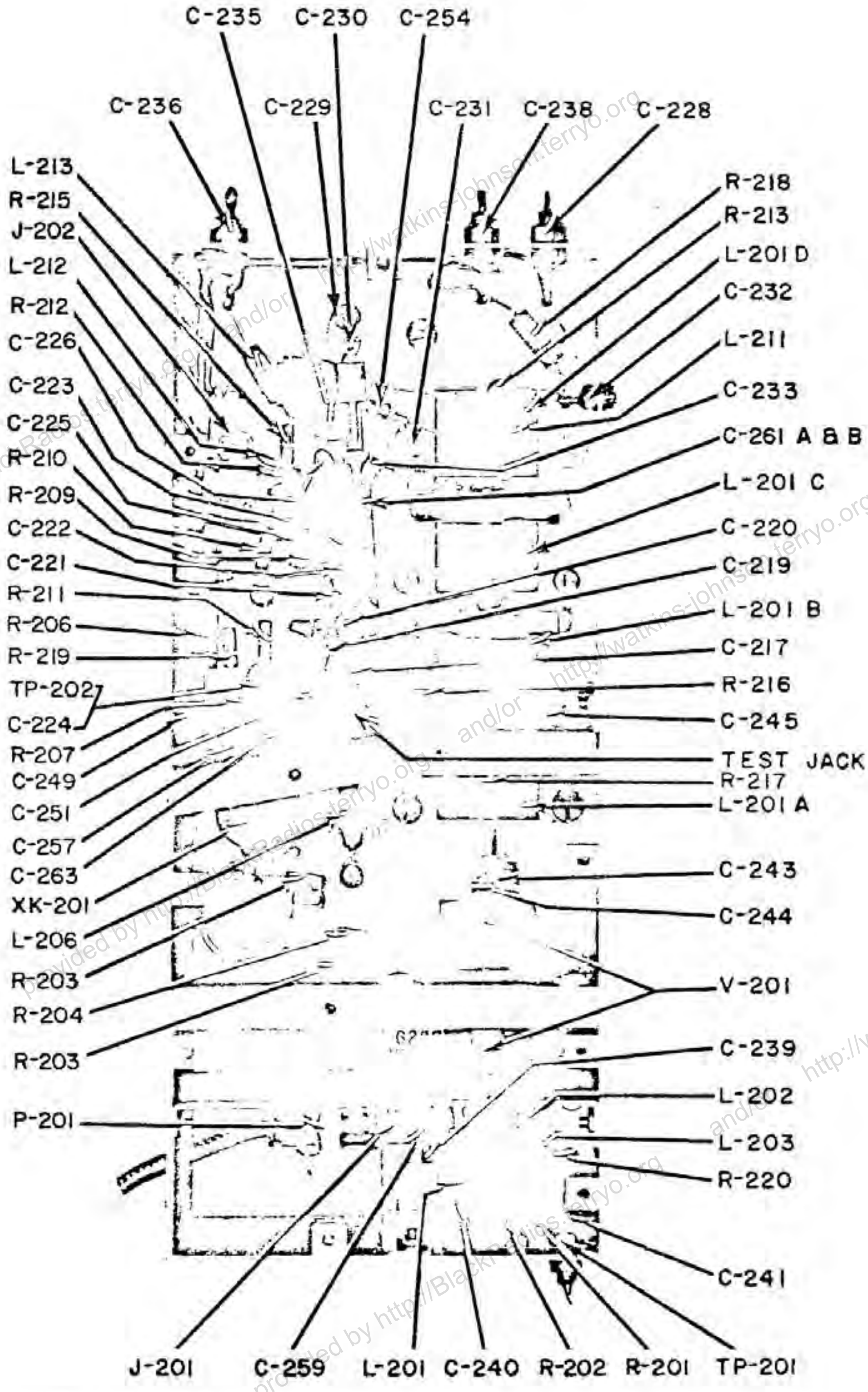


Fig. 4-6. RF Tuner, Model 1302-A Receiver, Bottom View, (Dust Cover Removed).

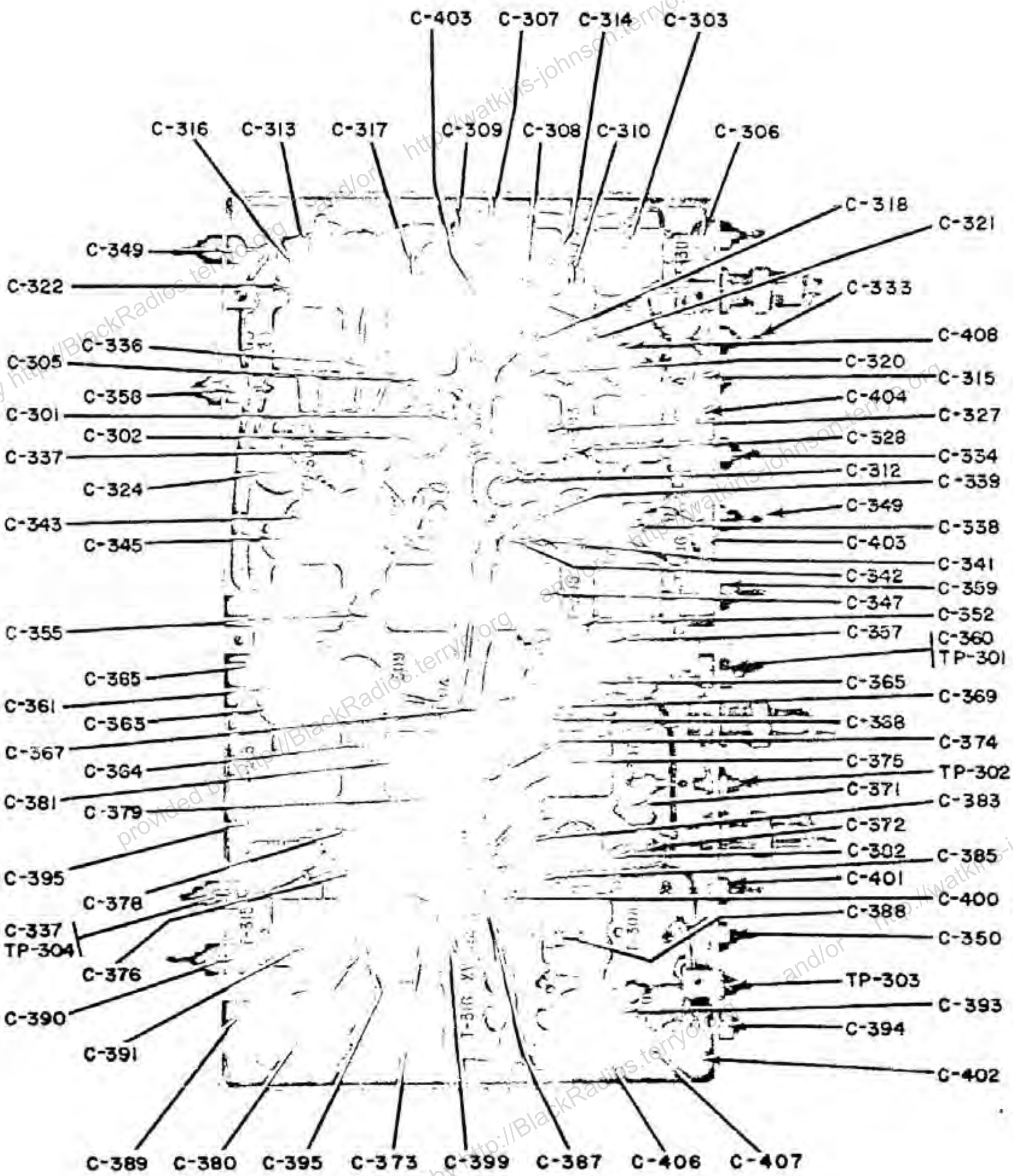


Fig. 4-7. IF Strip, Models 1301-A and 1302-A Receivers, Bottom View, Location of Capacitors and Test Points

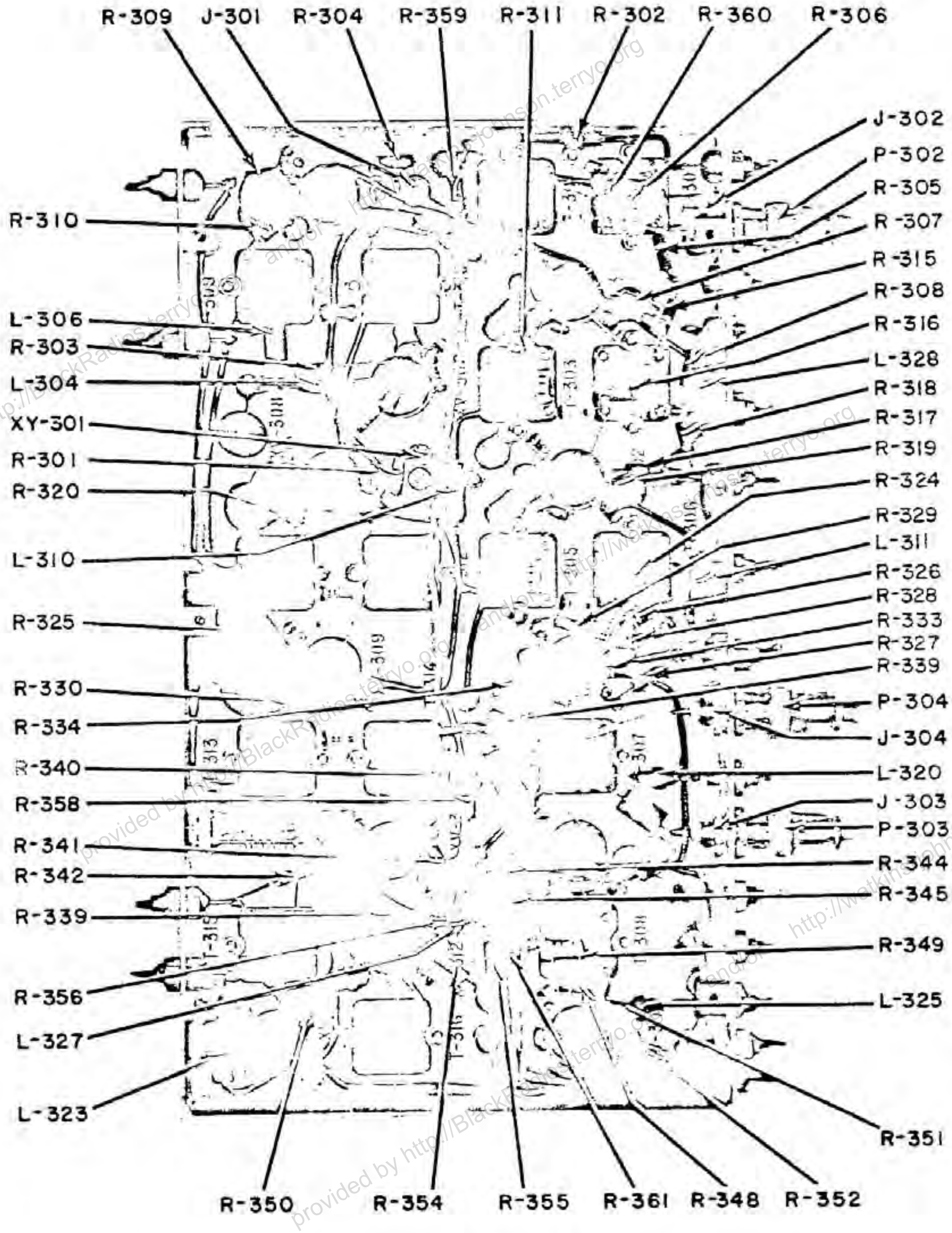
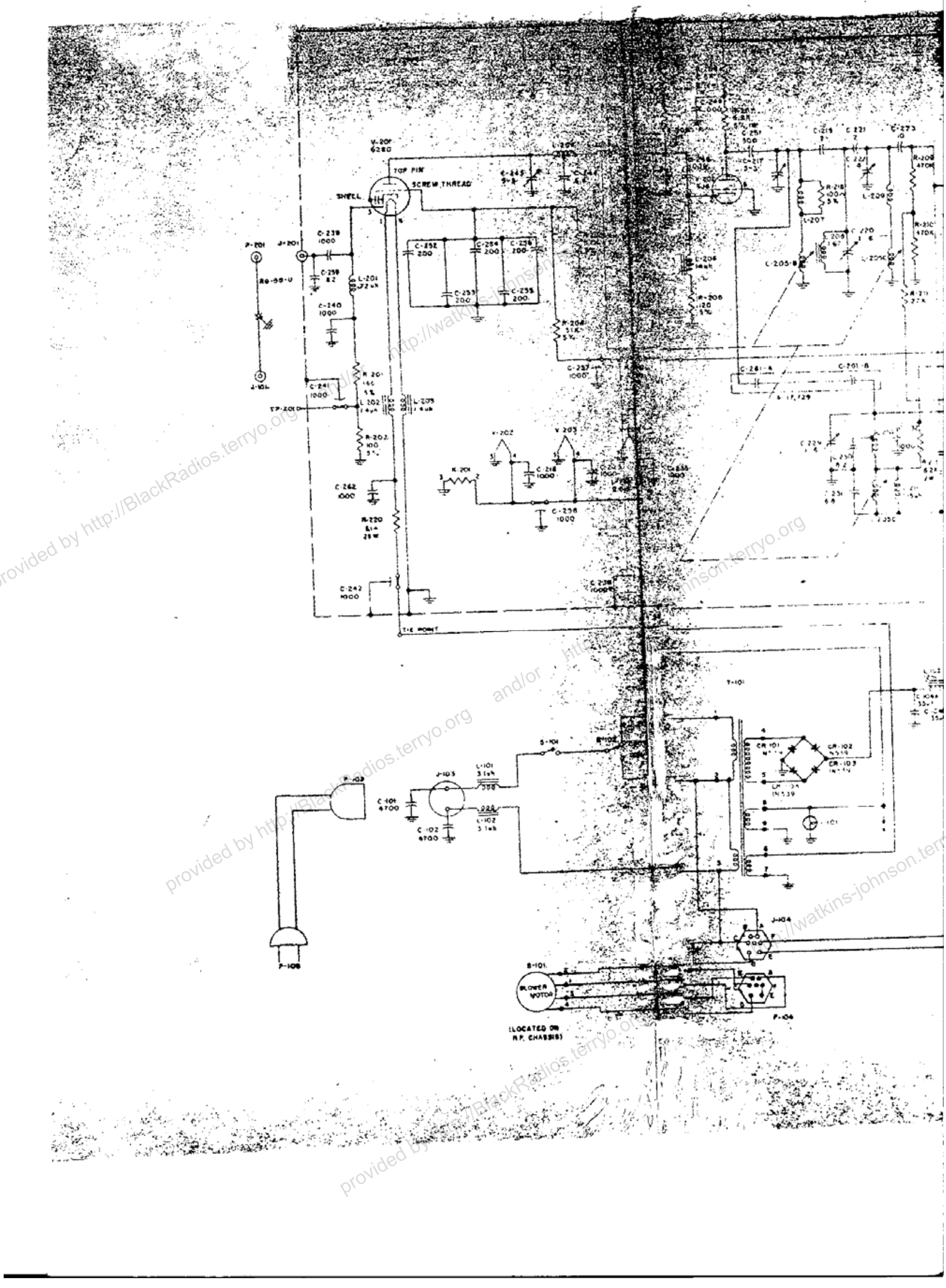


Fig. 4-8. IF Strip, Models 1301-A and 1302-A Receiver, Bottom View, Location of Resistors and Miscellaneous Items


V-201
6280
TOP PIN
SCREW THREAD
SHELL
P-201
J-201
C-239
1000
L-201
C-240
1000
R-201
C-241
1000
L-202
TP-201
R-202
100
5%
C-262
1000
R-220
C-242
1000
C-252
200
C-254
200
C-253
200
C-255
200
R-204
V-202
V-203
K-201
C-238
1000
C-237
1000
TIE POINT
C-261-A
C-261-B
R-218
L-207
L-209
T-101
CR-101
CR-102
CR-103
S-101
J-103
L-101
L-102
C-101
4700
C-102
4700
P-103
P-108
J-104
P-104
B-101
BLOWER MOTOR
(LOCATED ON R.F. CHASSIS)

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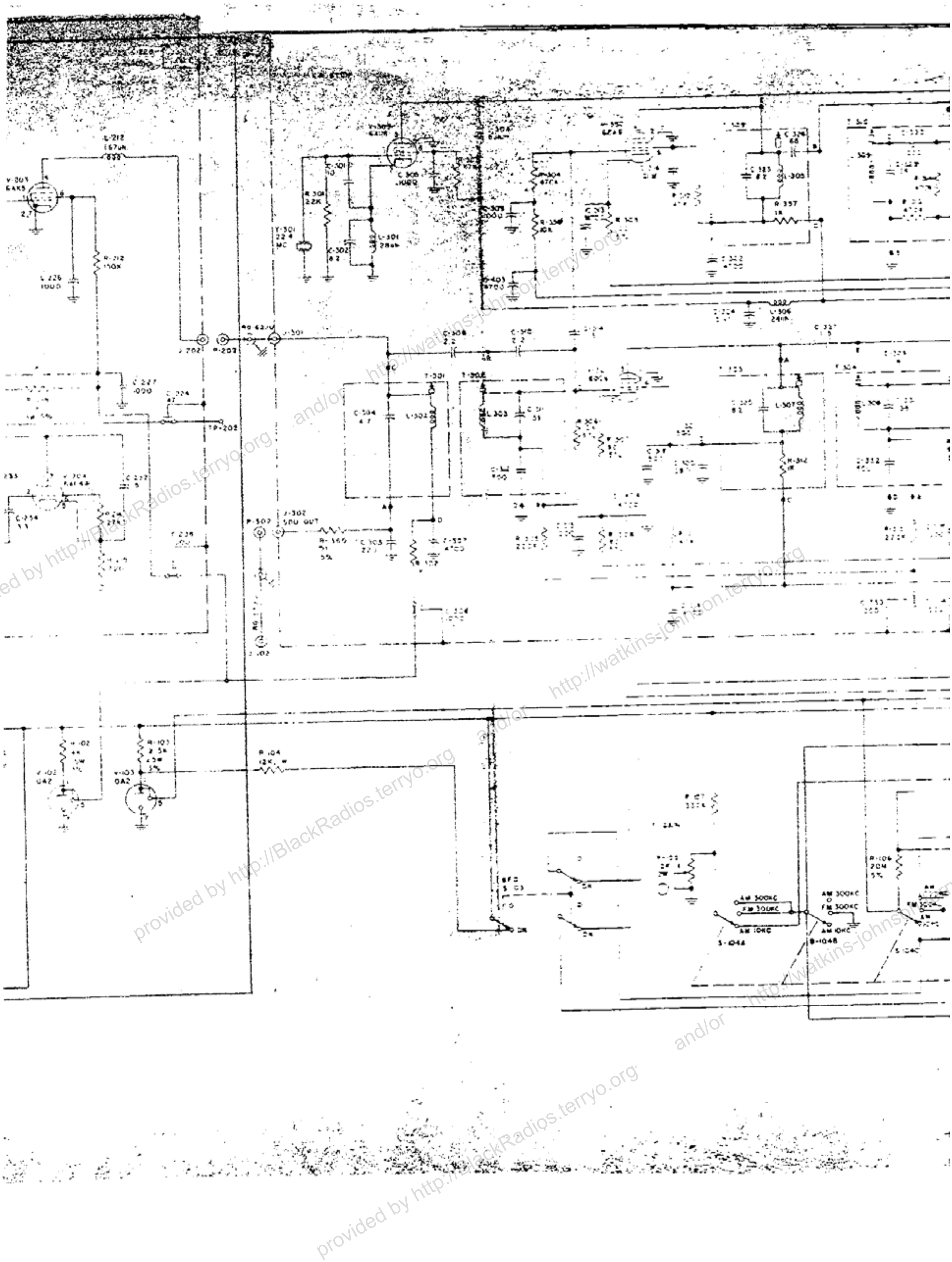
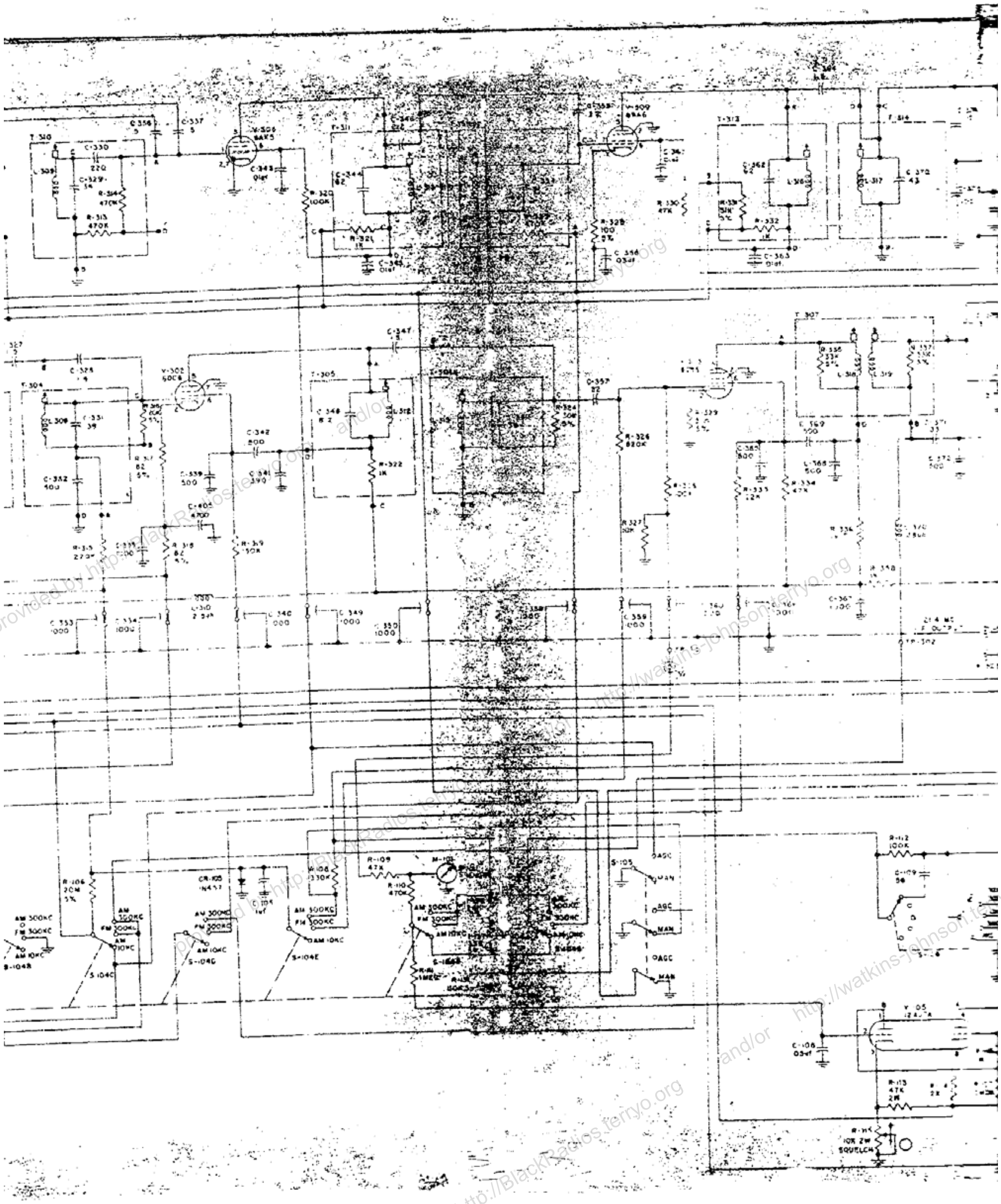
provided by http://BlackRadios.terryo.org and/or http://watkins-johnson.terryo.org


AM 300KC
FM 300KC
AM 10KC
S-104A
S-104B
BFO
R-104
12K
J-202
P-202
J-301
J-302
SDU OUT
P-302
T-301
T-302
L-302
L-303
L-307



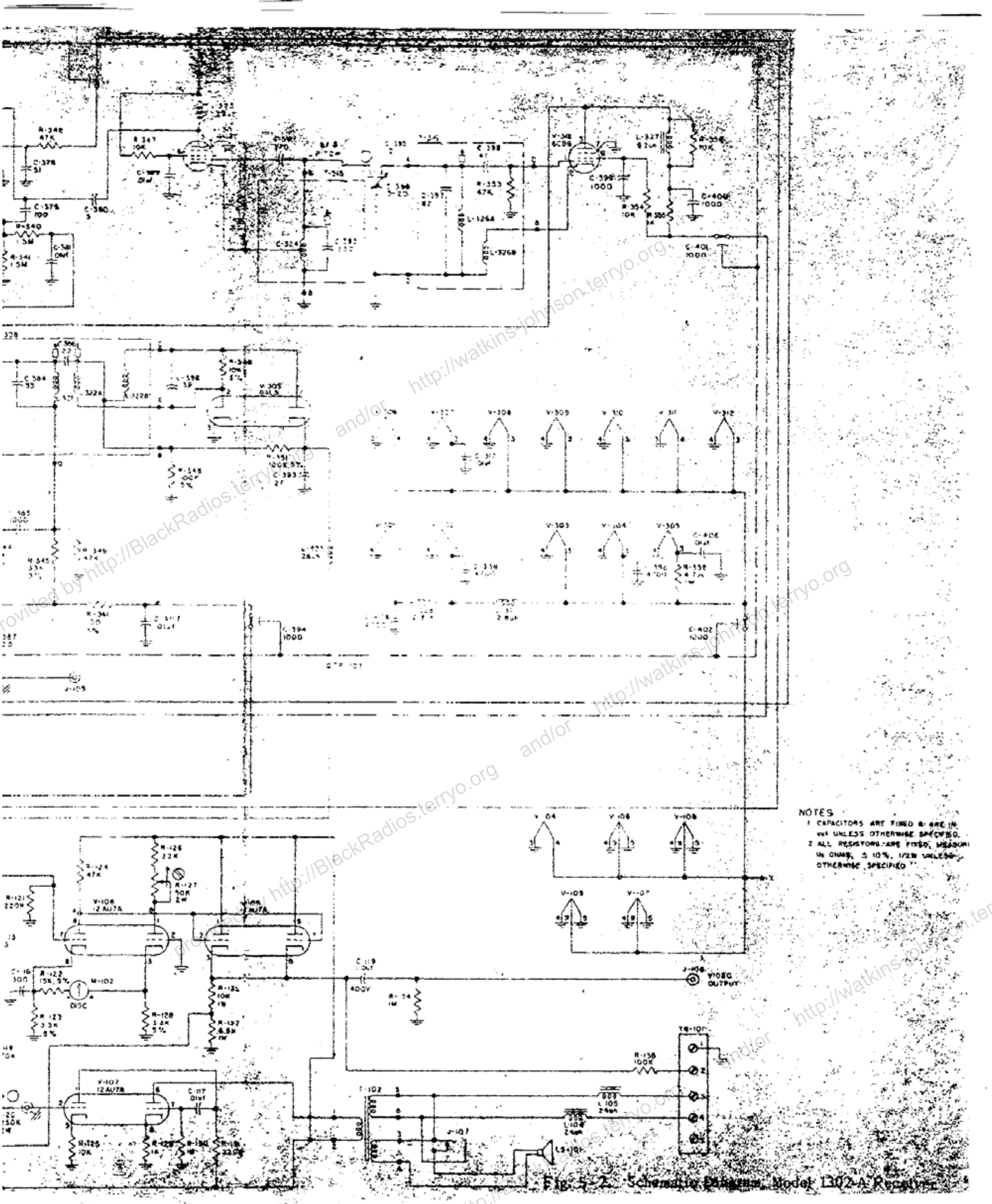


Fig. 5-2. Schematic Diagram, Model 1302-A Receiver