II MODEL 51SB-B SINGLE SIDEBAND GENERATOR

A. INTRODUCTION

1. General Description

The B&W Model 51SB-B Single Sideband Generator has been designed as a companion unit for the B&W Model 5100-B Amateur Radio Transmitter. It is contained in an attractive matching cabinet measuring 10 inches wide by 11½ inches high by 14 3/4 inches deep and weighs 27 pounds (see Figure 1). The unit is bolted to the right side of the Model 5100-B to form one integral assembly. Connections between the two equipments are made through holes located on the sides that are bolted together. The terminals at the rear of the Model 51SB-B provide for making connections to the voice operated relay circuits.

A hinged cover at the top of the cabinet permits easy access to the inside for replacement of tubes. For servicing, the equipment may be removed from the cabinet and disassembled into three basic units, the RF unit, the Audio Unit, and the Main Chassis Unit (see Figure 14). The latter unit consists of the front panel and the main chassis which contains the receptacles for plugging in the other units, and terminals for making the necessary connections to the equipment. All operating controls are located on the front panel. Those controls requiring infrequent adjustments are located within the cabinet. The equipment has been designed with an eye toward ease and simplicity of operation.

2. Function of the Equipment

The B&W Model 51SB-B Single Sideband Generator is designed to connect directly to the Model 5100-B to convert it to a bandswitching single sideband suppressed carrier transmitter but still retaining all of the normal AM and CW features. Connections are made in such a way that the output of the 5100-B multiplier section feeds the RF input to the Model 51SB-B whose output, in turn, drives the final grids of the 5100-B. The 51SB-B combines its RF input with the audio input to its microphone jack to produce a single sideband suppressed carrier signal. Either the upper or the lower sideband may be selected by means of a switch on the front panel. The SSSC signal output of the Model 51SB-B drives the final amplifier of the Model 5100-B as a class AB_1 amplifier. RF connections between the two equipments are made by means of two RG-62/U cables located on the 5100-B which plug into the RF section of the 51SB-B. Filament and D.C. voltages are supplied through a cable located on the 51SB-B which plugs into receptacle J506 on the 5100-B chassis.

3. Electrical Specifications

a. Power Source
   6.3 V.A.C. 3.2 A.
   250 V.D.C. 130 MA.

   These voltages are obtained from the 5100-B.

b. Frequency Coverage
   The Model 51SB-B is completely bandswitched and is designed for operation in the following amateur radiotelephone bands:

   80 Meter Band - 3800 Kcps. to 4000 Kcps.
   40 Meter Band - 7200 Kcps. to 7300 Kcps.
   20 Meter Band -14200 Kcps. to 14300 Kcps.
   15 Meter Band -21250 Kcps. to 21450 Kcps.
   11 Meter Band -26960 Kcps. to 27230 Kcps.
   10 Meter Band -28500 Kcps. to 29700 Kcps.

c. RF Input characteristics
Frequency - same as the desired output frequency.
Input impedance - 50 ohms resistive on all bands.
Input voltage required - 1.5 to 2.0 VRMS on all bands.

d. RF Output characteristics
Frequency - same as input frequency. Peak output voltage is approximately 75 volts when driving a class AB1 stage.

e. Audio Input
Crystal or dynamic microphone, Amphenol 80-PC2F two contact connector.

f. Tube complement
(1) RF Unit
Balanced Modulator - 2 - Type 12AT7
First driver - 1 - Type 6CL6
Second driver - 1 - Type 6V6

(2) Audio Unit
Voltage amplifiers - $3\frac{1}{2}$ - Type 12AT7
Voice operated relay tube - $\frac{1}{2}$ - Type 12AT7
Rectifier - - 1 - Type 6AL5

B. INSTALLATION AND OPERATION

The B&W Model 51SB-B Single Sideband Generator is shipped, complete with tubes, in a cardboard container, properly baffled and padded to prevent damage in transit. After the equipment has been removed from its container, inspect it to ascertain if it has suffered any damage in transit. Make sure that all tubes are intact and properly seated in their respective sockets.

1. Installing and Connecting the Equipments

Remove the Model 51SB-B from its cabinet after removing the eight retaining screws, six on the front panel and two on the bottom rear of the cabinet. The equipment can now be more thoroughly inspected for damage. After disconnecting the power line, remove the two plug buttons from the right side of the 5100-B cabinet, then bolt the 51SB-B cabinet to it with the four bolts, flatwashers, and lockwashers provided. The bolts are threaded into the four tapped inserts on the right side of the 5100-B. The flatwashers are used as spacers between the two cabinets while the lockwashers are placed under the heads of the bolts. The 51SB-B may now be replaced in its cabinet and secured with the screws previously removed.

Connect the two equipments together by passing P301 of the 51SB-B through the rear opening common to the two cabinets and plugging it into J506 of the 5100-B. Pass X304 of the 5100-B through this same opening and plug it into J101 of the 51SB-B. J101 is located on the rear of the 51SB-B RF unit. Pass X305 of the 5100-B through the forward hole common to the two cabinets and plug it into J103 of the 51SB-B. J103 is located on the top front of the 51SB-B RF unit.

Remove the cover at the rear of the 51SB-B so that the terminal board TB301 is accessible. Connections to TB301 are made as follows:

Terminal No. 1 - connect to station grounding bus.
Terminals Nos. 4, 5 & 6 - these terminals are connected to SPDT contacts of the Voice Operated Relay and are utilized in such a fashion that the receiver is disabled when the VOR is energized.

Terminals Nos. 7 & 8 -- connect in series with the antenna relay circuit.
Terminals Nos. 9 & 10 - connect across the receiver speaker voice coil. This connection together with the VOR deactivating circuit in the audio unit provides for preventing the loudspeaker output from operating the VOR.

The above connections are shown in Figure 15.

2. Preliminary Adjustments

All operating controls for the 51SB-B are located on the front panel and perform the following functions:

"BAND SELECTOR" switch - Selects the desired band of operation.
"BAL. MOD. TUNING" control - Tunes the plate tank circuit of the balanced modulator stage.
"DRIVER TUNING" control - Gang tunes plate tank circuits of first and second driver stages.
"AUDIO GAIN" control - Controls overall gain of the speech amplifier or the levels of the audio signals fed to the balanced modulator and hence the SSB power output.
"BALANCE" controls - Used in balancing out the carrier from the balanced modulator stage.
"BALANCE-UNBALANCE" switch - Used for unbalancing the balanced modulator stage without necessitating disturbing the balancing controls. This is done when the equipment is being tuned.
"METER" switch - Used in conjunction with the front panel meter.
"GRID" position - Indicates the grid current of the 5100-B final amplifier tubes.
"OUTPUT" position - Indicates relative level of RF output of the 51SB-B. This indication is used when balancing out the carrier from the balanced modulator stage.
"TUNE-OPER." switch - In the "TUNE" position, this switch places a short across the normally open key jack of the 5100-B and also energizes the voice operated rel In the "OPER." position, this short is removed and the VOR is operated either by the voice output of the microphone or by the push-to-talk switch on the microphone.
"SIDEBAND" selector - the position of this switch determines whether the output of the 51SB-B is an upper or a lower sideband signal.
"MIC." jack - Terminal No. 1 is the microphone input. Terminal No. 2 provides connection for push-to-talk microphone switch. Grounding this terminal through the microphone switch causes the voice operated relay to become energized.

With the 51SB-B connections completed, connect the 5100-B to the A.C. line. Also connect the RF output to a ten meter antenna or a dummy load and place it into normal CW operation at 29,600 Kcps. Tune and load the final for a DC plate current of 300 ma. Note that with the 51SB-B "METER" switch in the "GRID" position, the 51SB-B panel meter reads the grid current of the 5100-B final tubes. Making sure that the "MULTIPLIER TUNING" control is properly peaked, set the 5100-B "EXC. CONTROL" for a grid current of .5 to 1.5 ma. Place the 5100-B "H.V." switch in the "OFF position and proceed as follows:

a. Place the 5100-B "NORM-SSB" switch in the "SSB position.
   Do not disturb any of the other controls.
b. Place the 51SB-B controls as follows:
   "BALANCE-UNBALANCE" switch - "UNBALANCE" position
   "AUDIO GAIN" control - complete counter-clockwise position
   "BAND SELECTOR" - 10 meter band.
   "METER" switch - "OUTPUT" position
   "TUNE-OPER." switch - "TUNE" position.
   "SIDEBAND" selector - either position

c. Place the 5100-B "HV" switch in the "ON" position. The 51SB-B panel meter should now show a reading.

d. Lift the top cover of the 5100-B and peak this meter reading by adjusting C326 with an insulated tool. C326 is located at the rear of the 5100-B R.F. section near the "NORM-SSB" switch.

e. Further peak this meter reading by the "BAL. MOD. TUNING" and the "DRIVER TUNING" controls.

f. Lift the top cover of the 51SB-B and further peak the meter reading by adjusting C122 located inside near V103. Each time C122 is adjusted, "rock" the "DRIVER TUNING" control for maximum meter reading. Repeat this until no further increase in the meter reading can be obtained. If the meter needle goes off scale, keep it on scale by backing down on the 5100-B "EXC. CONTROL". Repeat the above steps d to f, this time using the grid current as an indication. Note: C326 and C122 will require no further adjustments after this.

g. Place the 51SB "BALANCE-UNBALANCE" switch in the "BALANCE" position and balance out the carrier by means of the two balancing controls at the top of the 51SB-B panel. These controls must be adjusted alternately so that the meter reading (switch in "OUTPUT" Position) is reduced to zero. The equipment is now adjusted and ready to be put into SSB operation.

Note: If a dummy load or a 10 meter antenna is not available, the above adjustments can be performed at the high end of the 15, 20, or 40 meter bands.

3. Operation

With the 5100-B "NORM-SSB" switch in the "NORM" position, place the 5100-B into normal CW operation at the desired operating frequency and load the final to 300 ma. The appropriate antenna will, of course, have to be connected to the transmitter. With the 5100-B "HV" switch in the "OFF" position, place the "NORM-SSB" switch in the "SSB" position. Return the "HV" switch to the "ON" position and proceed as follows:

a. Place the 51SB-B controls as described in section 2b. above except for the "BAND SELECTOR" which should be set to correspond to setting of the 5100-B "BAND SELECTOR".

b. Tune the "BAL. MOD. TUNING" and the "DRIVER TUNING" controls for maximum output as indicated on the 51SB-B panel meter. A sharper indication of maximum is obtained by observing the grid current. However, it should be noted that grid current does not flow until the peak driving voltage at the grids of the 5100-B final exceeds the grid bias.

c. Set the 5100-B "EXC. CONTROL" for a grid current of .5 to 1.5 ma.

d. Place the "BALANCE-UNBALANCE" switch in the "BALANCE" position and balance out the carrier by alternately adjusting the balancing controls. These controls are adjusted until the output meter reads zero. A course indication of balance is obtained by adjusting for minimum final amplifier plate current and then using the 51SB-B output indication to reduce the carrier level to zero.
Note: Do not readjust the 5100-B "EXC. CONTROL" and the "MULTIPLIER TUNING" control after the carrier has been balanced out as this may cause a slight shift in the balance. Shifting the operating frequency by more than about 50 Kcps. may also cause the balance to shift, in which case, balance can be restored by repeaking the "MULTIPLIER TUNING" control.

e. Connect the microphone to the "MIC" jack.* Speaking into the microphone in a normal manner, advance the 51SB-B "AUDIO GAIN" control clockwise until the grid current barely "kicks up" on voice peaks. The 5100-B is now being driven to full class AB_1 output.

* B&W will have available, shortly, a microphone adaptor, Type 51 MCA. This adaptor will permit the use of one microphone with the 5100-B & 51SB-B combination without the need for switching microphones when going from AM to SSB operation.

For voice-break-in operation, place the "TUNE-OPER." switch in the "OPER." position. Speaking into the microphone in a normal manner, adjust the "VOR SENS." control (located near the front of the Audio Unit chassis) so that the voice operated relay operates positively. The hold in time for the relay is adjusted by the "VOR-DEL" control (also located on the Audio Unit chassis) Advancing this control clockwise increases the hold-in time which is set to suit the operator. *

For push-to-talk operation, turn the "VOR SENS." control completely counter clockwise. The relay is then energized, by means of the push-to-talk switch on the microphone.

When voice-break-in operation is employed, it may be desirable to use a loudspeaker on the receiver, in which case, provision is made to prevent the loudspeaker output from operating the VOR. This is done by feeding the voltage developed across the speaker voice coil to terminals 9 and 10, at the rear of the 51SB-B. With the receiver gain set at a comfortable hearing level, advance the "VOR DEACT. SENS." control clockwise, from its extreme counterclockwise position, until the speaker output ceases to operate the VOR.

Note: WHEN BREAK-IN OPERATION WITH LOUDSPEAKER IS EMPLOYED, THE RECEIVER MUST BE DISABLED DURING TRANSMISSION PERIODS. This can be accomplished by the SPDT VOR contacts that are brought out to terminals 4, 5, and 6 at the rear of the 51SB-B as shown in Figure 15.

The Audio Unit chassis has two other controls, the "BAL." control and the "PHASE ADJ." control. These are adjusted at the factory and locked in place. They should not be disturbed unless they are out of adjustment for some reason. The RF phase shift network adjustments (C101 to C106 and L101 to L106) located at the rear of the RF Unit chassis, are factory adjustments. These too will not normally require adjusting when installing. In the event that any of these controls do require adjustment, the procedures for doing so are given in the section under "Maintanance and Trouble Shooting".

C. CIRCUIT DESCRIPTION

The B&W Model 51SB-B Single Sideband Generator utilizes the phasing principle of generating a single sideband suppressed carrier radiotelephone signal. The circuits are designed so that the single sideband signal is generated at the operating frequency which obviates the necessity for hetrodyning stages. The result is an equipment that is very simple to operate and adjust.

The equipment is made up of three major subassemblies, the RF Unit, the Audio Unit, and the Main Chassis Unit. These are interconnected by means of cable and plug assemblies and can be easily disassembled for servicing.

1. Main Chassis Unit

The Main Chassis Unit consists of the front panel assembly and the chassis for mounting the RF and audio units. (See Figure 14). The front panel mounts all of the necessary operating controls as well as the meter and microphone jack. The chassis contains the necessary wiring and receptacles for interconnecting the RF and Audio Units. It also contains the cable and plug assembly for connecting the equipment to the 5100-B. This cable provides for feeding the necessary voltages to the 51SB-B, for metering the 5100-B final grid current by means of the 51SB-B panel meter, and for connecting the 5100-B keying circuit to the circuits of the 51SB-B. The terminal board on the rear apron of the chassis

* If the operator wishes to "talk himself" on frequency, he should disable the receiver muting circuit by opening the SPST switch shown in Figure 15. Then by listening to himself on the receiver headphones, he can adjust the transmitter frequency until his voice sounds natural.

provides for making connections to the voice operated relay contacts and to the speaker deactivating circuit. All of these terminals are filtered to minimize conduction of RF ıergy through external leads.

2. R.F. Unit

The R.F. Unit is contained in a separate chassis measuring 12 inches long by 3 7/8 inches wide by 3½ inches high. (see Figure 14). Referring to the schematic diagram (Figure 16) of the 51SB-B, the R.F. Unit is shown at the top. It consists simply of a 90 degree R.F. phase shift network, a double balanced modulator stage, and two Class-A R.F. voltage amplifiers. All stages are band switched for operating convenience.

The R.F. excitation voltage from the Model 5100-B Transmitter is fed to the R.F. input receptacle, J101, which is connected to the input of the 90 degree R.F. phase shift network. This network splits the R.F. voltage into two equal amplitude components that are 90 degrees out of phase with respect to each other. These two voltages are then fed to the input of the double balanced modulator stage where they are combined with equal amplitude audio voltages, also 90 degrees out of phase with respect to each other, to produce a single sideband suppressed carrier signal.

The double balanced modulator consists of two single balanced modulators with separate input circuits and a common output circuit. If we consider the single balanced modulator, V101, we see that the plates are connected in push-pull through the tank circuit, L111 and C116. (C115 is connected in parallel with L111 and C116 for all bands except 10 and 11 meters). The grids are connected in parallel for the R.F. signal through C107 and C108, and in push-pull for the audio signal through L107 and L108. R108 is the carrier balancing control which varies the gain of V101-A and V101-B differentially. Thus, in the absence of an audio signal and with equal in-phase R.F. voltages on the grids, R108 is djusted so that the output of V101-A is just equal to that of V101-B. Since these two grid voltages are equal and in phase, there is no net output voltage at the link of L111, and hence the carrier is balanced out.

If we now apply a push-pull audio tone to the grids of V101 through L107 and L108, they are alternately biased negative and positive with respect to ground. Thus when grid No. 2 is positive with respect to ground, grid No. 7 is negative with respect to ground, and vice-versa. We then have each triode conducting more heavily than the other on alternate half cycles of the applied audio tone. The net output at the link of L111 is then as shown in Figure 17a. This is a double sideband suppressed carrier signal. These two side frequencies are of equal amplitudes, spaced twice the audio frequency, and are centered about the carrier frequency.

If now, we apply the same R.F. and audio voltages but each shifted in phase by 90 degrees, to the grids of V102, the output at the link of L111 due to V102 is also as shown in Figure 17a, but with one important difference, one side frequency is exactly 180 degrees out of phase with the corresponding side frequency output of V101, the other two side frequencies being exactly in phase. The out-of-phase components cancel each other in the common output circuit while the in-phase components add together and the result is a single sideband signal.

In the above example, let us assume that the two upper side frequencies cancel each other producing a lower single sideband signal. If now, we reverse the phase of one of the audio signals, the two lower side frequencies become exactly 180 degrees out of phase, resulting in an upper single sideband signal. In this particular case, phase reversal of one of the audio signals is accomplished by S301.

If the audio signal is a single audio tone, the output of the double balanced modulator is a single R.F. signal whose frequency is displaced from the suppressed carrier by an amount equal to the audio frequency. Since it is impossible to obtain complete carrier and unwanted sideband suppression, this R.F. signal will appear to have a small amount of amplitude modulation as shown in Figure 17b. This waveform represents a good single tone, single sideband signal. Lack of a small amount of modulation on the R.F. envelope is an indication of excessive audio or R.F. drive causing a stage to be overdriven. When the audio signal is speech, the R.F. envelope is of the form of Figure 17c.

The output of the balanced modulator is link coupled to the grid of V103. This is a conventional Class-A, R.F. voltage amplifier utilizing a type 6CL6 pentode. Its output drives V104, a 6V6 which is also operated as a Class-A voltage amplifier. Both of these amplifier stages have identical plate tank circuits so that they may be readily ganged tuned. The trimmer capacitor C122 is adjusted so that the total shunt capacity across the first driver plate circuit is equal to that across the second driver plate circuit when the latter is connected to the grids of the 5100-B final.

C129 couples a small portion of the 6V6 output to the germanium crystal rectifier circuit. The d.c. output current of this circuit is indicated on the panel meter M301. This indication is used when balancing out the carrier.

The output of the 6V6 is coupled to the 6146 grids through C128, a short length of RG-62/U cable, and S302-C of the 5100-B, when S302 is in the "SSB " position. Also, with S302 in the "SSB" position, the output of the 5100-B multiplier section (arm of S302-A) is coupled through S302-A, C326, C327 and a short length of RG-62/U cable to the R.F. input of the 51SB-B. Here, C326 and C327, together with the 51SB-B input circuit, provide for lowering the multiplier output voltage to the level required at the input of the 51SB-B.

. Audio Unit

The Audio Unit is contained in a chassis measuring 12 inches long by 3 1/8 inches wide by 2 inches high. (See Figure 14). The schematic diagram for the unit is shown at the bottom left of the 51SB-B schematic of Figure 16. The microphone output connects to terminal No. 1 of J302 and is amplified by V201-A and V201-B. The output of V201-B is fed to R208, the "AUDIO GAIN" control which controls the voltage level at the grid of V202-A. The audio signal is further amplified by V202-A whose output is transformer coupled to the low-pass filter composed of L201, C204, and C205. This filter has a cutoff frequency of approximately 3500 cps. and is provided to attenuate those audio frequencies lying above 3000 cps. This is done since these frequencies are beyond the operating range of the B&W Model 350, Type 2Q4, 90 Degree Audio Phase Shift Network.

The output of the low-pass filter feeds the parallel combination of R210 and Z201. R210 is adjusted so that at 1000 cps., the two output voltages of Z201 (pins 2 and 6) are equal and exactly 90 degrees out of phase with respect to each other. This phase angle is then maintained to within 1.5 degrees of 90 degrees as the frequency is varied from 300 to 3000 cps., and the relative amplitudes are held constant.

The two output voltages of Z201 are then separately amplified by V203-A and V203-B. The "AUDIO BALANCE CONT."provides for varying the gains of these two stages differentially to compensate for slight differences in tube characteristics so that the two output voltages are exactly equal. The outputs of V203-A and V203-B are then transformer coupled to the grids of V101 and V102 respectively.

Connected in parallel with the "AUDIO GAIN" control is the "VOR SENSITIVITY CONTROL", R219. This controls the audio signal level at the grid of V205-A. The signal is then

amplified by V205-A, and rectified by V204-B. The positive d.c. voltage thereby developed across the series combination of R224 and R225 in parallel with C209 is applied to the grid V205-B. This tube is normally cut off by the positive voltage applied to its cathode through R226. The relay, K201, in the plate circuit is therefore normally denergized. Application of sufficient positive voltage to the grid causes V205-B to conduct and thereby energize K201. The sensitivity control, R219, is set so that the relay operates readily when one speaks into the microphone in a normal manner.

The setting of the "VOR DELAY CONTROL", R225, determines how long the relay remains energized after the operator stops talking. With R225 shorted out completely, K201 operates at a syllabic rate. However, when R225 is set at the other extreme, K201 remains energized for more than five seconds or so after the operator stops talking. This control, is of course, set to suit the operator.

Relay K201 can also be energized by placing R228 in parallel with R227. This reduces the positive bias on the cathode of V205-B sufficiently to allow enough plate current to flow to energize K201. R228 can be placed in parallel with R227 by the push-to-talk switch on the microphone or by the "TUNE-OPERATE" switch, S303.

Contacts 2 and 3 of K201 are utilized for the antenna relay circuit. As indicated previously, these are placed in series with the antenna relay coil and the antenna change-over terminals, of the 5100-B. Contacts 4, 5 and 6 are brought out to the rear terminal strip for use as desired. Contacts 8 and 9 are utilized for keying the buffer stage of the 5100-B. When these contacts are closed, blocking bias is removed from V201 and V202 of the 5100-B Crystal Oscillator and Buffer Unit. Thus, R.F. excitation is applied to the R.F. input of the 51SB-B only when K201 is energized or when the key is closed.

When voice-break-in with loudspeaker operation is desired, the VOR deactivating circuit is provided to prevent the speaker output from actuating K201. This is accomplished by feeding the signal developed across the speaker voice coil to the input of T201. This signal is amplified by V202-B and then rectified by V204-A which develops a negative voltage across the parallel combination of R218 and C207. This negative voltage is used to bias the diode V204-B through R223, and it is this bias that prevents the microphone output due to the speaker output from developing sufficient positive bias across C209 to energize K201. With the loudspeaker output set at a comfortable hearing level, the "VOR DEACT SENS." control is advanced clockwise until the speaker output ceases to actuate the VOR.

D. MAINTENANCE AND TROUBLE SHOOTING

1. General

The Model 51SB-B Single Sideband Generator has been designed so as to require a minimum of servicing. It will be found that faulty operation of the equipment can usually be attributed to a faulty tube. For this reason, it will be good practice to maintain spare tubes on hand, one of each type used in the equipment. Once having established that all tubes are in satisfactory condition, one can proceed to localize the trouble to a particular stage.

Any program of equipment maintenance should include a program of preventive maintenance. This includes a periodic check on the functioning of mechanical parts and keeping the equipment free of dust and other foreign matter. A periodic inspection and cleaning of switch wafers will also go a long way in preventing troubles from developing. Such cleaning should be done with a small soft bristled brush and a clean solution of carbon tetrachloride. Under no circumstances should an attempt be made to clean the plastic supported

coils with acetone or other plastic solvent. This may result in deforming the coil causing short-circuiting of adjacent turns.

In the course of servicing, it may be necessary to remove the equipment from the cabinet. This will require the removal of eight retaining screws, six on the front panel and two on the bottom rear of the cabinet. Before removing the equipment, however, pull out plugs P301 of the 51SB-B and X304 and X305 of the 5100-B. Before disassembling any further, a complete visual inspection of the front panel and main chassis wiring may reveal the source of trouble. If no trouble is apparent visually, check to make sure that the R.F. and Audio Units are receiving filament and d.c. voltages. These may be measured at the tube sockets referring to the schematic wiring diagram. If the proper voltages are present, the next step is to localize the trouble to either the R.F. Unit or the Audio Unit, then to a particular stage of the unit.

The R.F. Unit may be removed from the Main Chassis by removing the three front panel control knobs, and the #6-32 self-tapping screws on the underside of the Main Chassis. The R.F. Unit can then be pulled out toward the rear. The R.F. Unit wiring should then be thoroughly visually inspected. If this does not reveal the cause of the trouble, proceed to make resistance measurements of the unit in accordance with Table 1. The inside of the R.F. Unit can be made more accessible by removing the two side cover plates.

If it is apparent that the trouble is in the Audio Unit, it can be removed by taking off the single front-panel control knob, unsoldering the microphone input connection at the junction of L301 and C301 and removing the #6-32 self-tapping screws on the underside of the Main Chassis. Then removing P201 from its receptacle, the Audio Unit can be pulled out toward the rear. The Audio Unit should then be thoroughly visually inspected, removing the two side cover plates if necessary. If found necessary, make resistance measurements as indicated in Table II.

When the trouble has been traced to a faulty component, it should be removed and replaced with one known to be good. In doing this, however, care should be exercised so as not to disturb other parts of the circuit. In time, the operator will find that he can usually localize most troubles without removing the equipment from the cabinet. The ability to do this, of course, comes from a thorough working knowledge of the circuits and their operation.

2. Alignment

Under normal conditions of use and operation, the Model 51SB-B will not require alignment. However, in the event that those circuits affecting sideband suppression are out of alignment for some reason, they must be readjusted if the equipment is to provide the maximum performance for which it was designed. These circuits include the 90 degree R.F. phase shift network, and the 90 degree audio phase shift circuit. These adjustments will require a 1000 cps. low distortion (less than 1%) audio signal source and an oscilloscope for observing the R.F. output of the 5100-B Transmitter.

The R.F. phase shift network has a different L-C combination for each band. Each of these combinations must be adjusted at the center frequency of the corresponding amateur radiotelephone band. These frequencies are as follows:

Band	Center Frequency	L	C
80	3900 Kcps.	L106	C106
40	7250 Kcps.	L105	C105
20	14250 Kcps.	L104	C104

Band	Center Frequency	L	C
15	21350 Kcps.	L103	C103
11	27095 Kcps.	L102	C102
10	29100 Kcps.	L101	C101

The "AUDIO PHASE ADJ." control, R210, and the "AUDIO BALANCE CONT." R212, need be adjusted at only one of the above frequencies. The adjustment is then good for all other bands.

Proceed as follows for aligning the 51SB-B:

a. With the 5100-B Transmitter set up for SSB operation, tune the equipment to one of the above frequencies following the procedure given in the section on operation. The 5100-B should, of course, be connected to an antenna or a dummy load.

b. Make up an R.F. pick-up assembly as shown in Figure 18, and couple the loop lightly to the output tank coil of the 5100 Transmitter. The inductance of the coil L, is made to series resonate with the capacity C. The coupling should be such as to produce a vertical deflection of about one inch or so on the oscilloscope. Adjust the horizontal sweep speed to about 200 cps.

c. With the carrier balanced out, apply the 1000 cps. signal to the microphone input terminal of J302. The level of this signal should be about .003 to .03 volts R.M.S. This voltage should not exceed .05 volts R.M.S. since this may cause the audio input stages to be overdriven and distort the signal. Under these conditions it will be impossible to properly adjust the equipment.

d. Advance the "AUDIO GAIN" control clockwise until the final plate current meter reads about 100 ma. If the equipment is properly adjusted, the oscilloscope presentation will be as shown in Figure 17b. The presence of more modulation on the signal indicates that adjustments will be required.

e. Adjust L and C of the R.F. phase shift network corresponding to the band of operation for minimum ripple on the signal. The capacitors are made available for adjusting by removing the cover plate on the rear side of the 51SB-B.

f. Adjust the "AUDIO PHASE ADJ." and the "AUDIO BALANCE" controls of the Audio Unit for minimum ripple on the signal. Try to minimize the ripple further by again adjusting the L and C of the R.F. Phase Shift Network. Each time an adjustment is made, turn the "AUDIO GAIN" control completely counter-clockwise, then check to make sure that the carrier is properly balanced out.

g. Next, place the sideband selector switch in its other position, and note whether or not the amount of ripple is the same for both positions. If it is not, adjust the "AUDIO PHASE ADJ." control slightly until the ripple is the same for either upper or lower sideband operation.

h. With the adjustments complete, lock the "AUDIO PHASE ADJ." and the "AUDIO BALANCE" controls in position. Make sure that the adjustments

are not disturbed when locking. These controls will not require further adjusting when aligning the equipment on the other bands.

i. The equipment may now be aligned on the other bands as was done above. Keep in mind that no further adjustments on the Audio Unit will be required.

Note: If either balanced modulator tube V101 or V102 is replaced, it may be necessary to readjust the RF Phase Shift Network for each band; however, if a number of 12AT7 tubes are available, it may be possible to select one that will not require these readjustments.

3. Trouble Symptoms, Possible Causes and Remedies

The following is a list of trouble symptoms that may be encountered, together with their possible causes and remedies. However, before attempting to localize the trouble in the 51SB-B, check the operation of the 5100-B as an AM or CW transmitter to make sure that the fault does not lie there.

a. Equipment tunes properly, but delivers no output when microphone is driven: This indicates no output from the Audio Unit. If the VOR operates normally, check tubes V202-A and V203. If tubes are good, check for bad component in these stages.

b. If in addition to the above, the VOR is inoperative, check V201. If V201 is satisfactory, check the components associated with this tube.

c. VOR Inoperative:
Check V204-B and V205. If VOR operates by means of push-to-talk or "TUNE-OPERATE" switches, check stages preceding V205-B.

d. VOR Deactivating Circuit Inoperative:
Check V202-B and V204-A. If tubes check ok, check components in circuit.

e. Impossible to balance out carrier:
Check V101 and V102. Check connections to P102 and components in balanced modulator stage. Check DC supply voltage. High hum level output from the power supply will cause hum signal to be fed to balanced modulator stage.

f. No R.F. Drive to 51SB:
Faulty VOR operation. Close 5100-B Keying Circuit. If this restores R.F. drive, check operation of VOR contacts.

g. Insufficient R.F. drive to 5100-B from the 51SB-B:
Check V103 and V104 and components associated with same. Check d.c. supply voltage.

h. Transmitting a double sideband signal:
One half of V203 defective - check and replace if necessary. V101 or V102 defective - check and replace if necessary. Check T202 or T203. Check balanced modulator grid resistors.

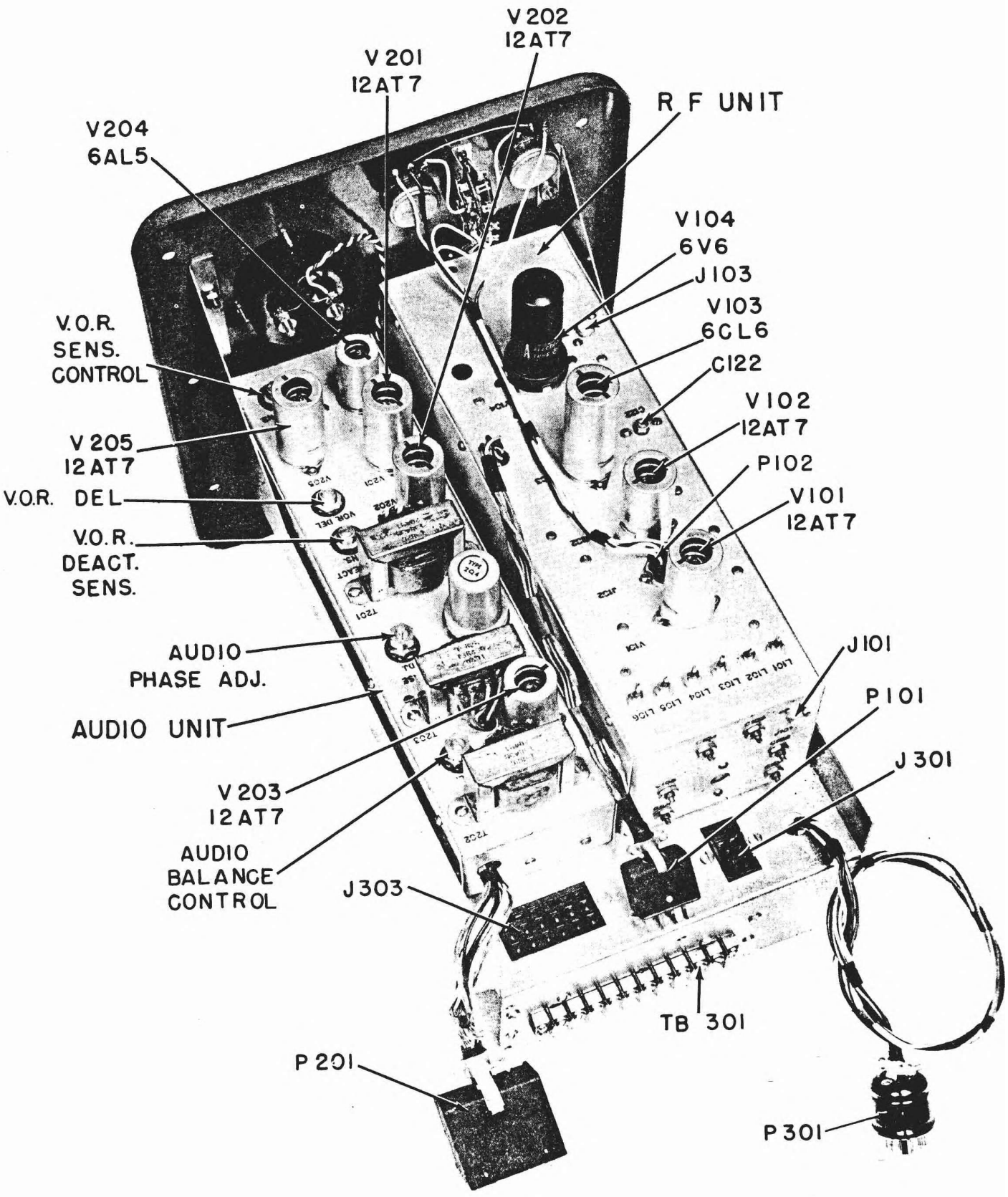
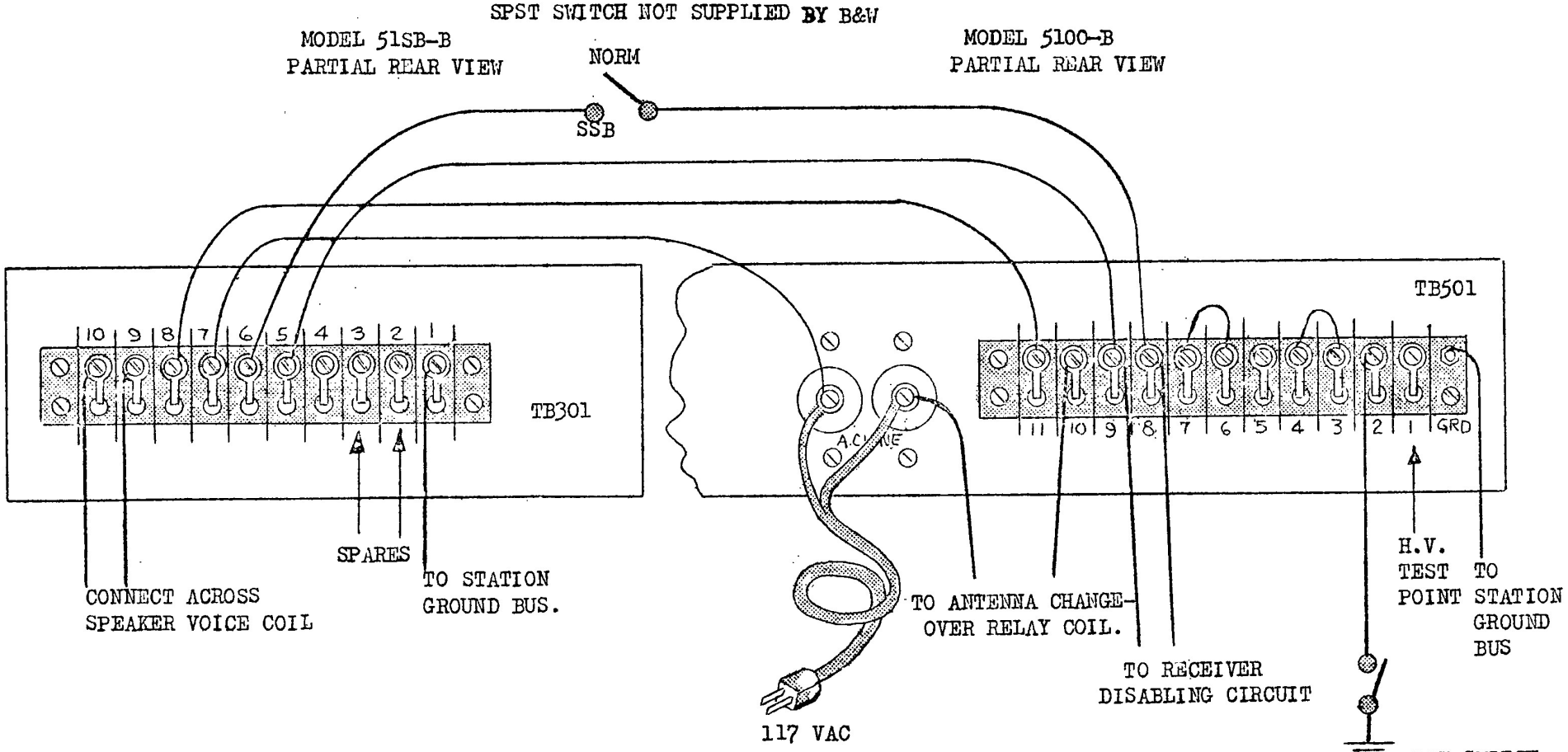


FIGURE 14. MODEL 51SB-B (WITH CABINET REMOVED)



IGURE 15 - REAR VIEW OF MODELS 5100-B and 51SB-B SHOWING CONNECTIONS.

TABLES OF D. C. RESISTANCE MEASUREMENTS

The measurements indicated below are in ohms and are taken between ground and the point indicated. All measurements are taken with all unit plugs and tubes removed from their sockets.

T A B L E - I

R.F. UNIT

PIN NO'S.	1	2	3	4	5	6	7	8	9
CONNECTOR									
V101	∞	15K	∞	0	0	∞	15K	∞	∞
V102	∞	15K	∞	0	0	∞	15K	∞	∞
V103	82	0	∞	∞	0	∞	82	∞	0
V104	—	0	∞	∞	3.3K	—	∞	270	—
P101	15K	15K	15K	15K	0	∞	∞	2K	—
J102	∞	∞	∞	∞	0	—	—	—	—

T A B L E II

AUDIO UNIT

PIN NO'S.	1	2	3	4	5	6	7	8	9	14	10 To 13 15 To 18
CONNECTOR											
V201	163K	100K	1K	0	0	163K	470K	1K	∞	—	—
V202	48.5K	0-50K	680	0	0	148.5K	0-25K	1K	∞	—	—
V203	48.5K	770K	500	0	0	48.5K	198K	500	∞	—	—
V204	100K	1.3M	0	∞	1-11M	—	1.2M	—	—	—	—
V205	148.5K	2.2M	1K	0	0	58.5K	1-11M	1500	∞	—	—
P201	∞	∞	0	∞	—	2K	∞	∞	∞	48.5K	∞

MODEL 515B-B PARTS LIST -1

Circuit Symbol	Description	B & W Part No.	Unit
C101	Cap., Mica, Compression Trimmer; 65-320 MMF	T-802	R.F. Unit
C102	Cap., Mica, Compression Trimmer; 65-320 MMF	T-802	R.F. Unit
C103	Cap., Mica, Compression Trimmer; 100-500 MMF	T-803	R.F. Unit
C104	Cap., Mica, Compression Trimmer; 180-690 MMF	T-804	R.F. Unit
C105	Cap., Mica, Compression Trimmer; 265-880 MMF	T-805	R.F. Unit
C106	Cap., Mica, Compression Trimmer; 340-1070 MMF	T-806	R.F. Unit
C107	Cap., Fixed, Silver Mica; 100 MMF ± 5% 500 V.D.C.W. - CM15E101J	T-833	R.F. Unit
C108	Cap., Fixed, Silver Mica; 100 MMF ± 5% 500 V.D.C.W. - CM15E101J	T-833	R.F. Unit
C109	Cap., Fixed Silver Mica; 100 MMF ± 5% 500 V.D.C.W. - CM15E101J	T-833	R.F. Unit
C110	Cap., Fixed, Silver Mica; 100 MMF ± 5% 500 V.D.C.W. - CM15E101J	T-833	R.F. Unit
C111	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C112	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C113	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C114	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C115	Cap., Fixed, Silver Mica; 18 MMF, ± 5% 500 V.D.C.W. - CM15C180J	T-832	R.F. Unit
C116	Cap., Vari., Air Dual Section 50 MMF Per Section	T-807	R.F. Unit
C117	Cap., Fixed, Ceramic Disc., .001 MF. 500 V.D.C.W.	T-509	R.F. Unit
C118	Cap., Fixed, Ceramic Disc. .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C119	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C120	Cap., Vari., Air, Single Section; 36 MMF Max.	T-808	R.F. Unit
C121	Cap., Fixed, Ceramic Disc., .001 MF. 500 V.D.C.W.	T-509	R.F. Unit
C122	Cap., Ceramic Trimmer 20 to 125 MMF	T-809	R.F. Unit
C123	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C124	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit

Circuit Symbol	Description	RAN Part No.	Unit
C125	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C126	Cap., Vari., Air, Single Section, 36 MMF Max.	T-808	R.F. Unit
C127	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C128	Cap., Fixed, Silver Mica; 150 MMF, 10%, 500 V.D.C.W. - CM20B151K	T-834	R.F. Unit
C129	Cap., Fixed, Silver Mica; 3 MMF ± 20%, 500 V.D.C.W. - CM15C030M	T-810	R.F. Unit
C130	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	R.F. Unit
C201	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	Audio Unit
C202	Cap., Ceramic Disc., .01 MF, 500 V.D.C.W.	T-820	Audio Unit
C203	Cap., Tubular Electrolytic, 20 MF, 450 V.D.C.W.	T-821	Audio Unit
C204	Cap., Metallized Paper; .1 MF, 200 V.D.C.W.	T-822	Audio Unit
C205	Cap., Metallized Paper; .1 MF, 200 V.D.C.W.	T-822	Audio Unit
C206	Cap., Ceramic Disc., MF, 500 V.D.C.W.	T-820	Audio Unit
C207	Cap., Metallized Paper, .1 MF, 200 V.D.C.W.	T-822	Audio Unit
C208	Cap., Ceramic Disc., .01 MF, 500 V.D.C.W.	T-820	Audio Unit
C209	Cap., Metallized Paper, .1 MF, 200 V.D.C.W.	T-822	Audio Unit
C301	Cap., Ceramic Disc., Fixed, .001 MF 500 V.D.C.W.	T-509	Main Chassis
C304	Cap., Fixed, Ceramic Disc., 001 MF, 500 V.D.C.W.	T-509	Main Chassis
C305	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	Main Chassis
C306	Cap., Fixed, Ceramic Disc., 001 MF. 500 V.D.C.W.	T-509	Main Chassis
C307	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	Main Chassis
C308	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	Main Chassis
C309	Cap., Fixed Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	Main Chassis
C310	Cap., Fixed, Ceramic Disc., .001 MF, 500 V.D.C.W.	T-509	Main Chassis
CR-101	Diode Germanium Type 1N34	T-243	R.F. Unit
CR-102	Diode Germanium Type 1N34	T-243	R.F. Unit

Circuit Symbol	Description	RAW Part No.	Unit
J101	Jack, RF Input	T-288	R.F. Unit
J102	Conn., Female, 5 Contacts	T-811	R.F. Unit
J103	Jack, RF Output	T-288	R.F. Unit
J301	Receptacle, 8 Conts., Jones	T-847	Main Chassis
J302	Conn., Microphone, 2 Conts.	T-611	Main Chassis
J303	Receptacle, 18 Conts.,Jones	T-848	Main Chassis
J304	Receptacle, 2 Conts., Jones	T-559	Main Chassis
K201	Relay, D.C. Conts., 3 PDT 1 Amp. Coil 10,000 Ohms D.C. Resistance, Pull in at 3 MA. D.C., Drop Out at 1.5 Ma. D.C.; Max. Current - 10 MA. D.C.	T-823	Audio Unit
L101	Inductor, Slug Tuned	T-799-5	R.F. Unit
L102	Inductor, Slug Tuned	T-799-5	R.F. Unit
L103	Inductor, Slug Tuned	T-799-4	R.F. Unit
L104	Inductor, Slug Tuned	T-799-3	R.F Unit
L105	Inductor, Slug Tuned	T-799-2	R.F. Unit
L106	Inductor, Slug Tuned	T-799-1	R.F. Unit
L107	R.F. Choke, 500 Microhenries	T-711	R.F. Unit
	R.F. Choke, 500 Microhenries	T-711	R.F. Unit
	R.F. Choke, 500 Microhenries	T-711	R.F. Unit
	R.F. Choke, 500 Microhenries	T-711	R.F. Unit
L111	Inductor, Bal. Mod., Plate	T-797	R.F. Unit
L112	Inductor, High Freq., Plate Coil, for 1st and 2nd Drivers	T-880	R.F. Unit
L113	Inductor, Low Freq., Plate Coil, for 1st and 2nd Drivers	T-798	R.F. Unit
L114	Inductor, High Freq., Plate Coil, for 1st and 2nd Drivers	T-880	R.F. Unit
	Inductor, Low Freq., Plate Coil, for 1st and 2nd Drivers	T-798	R.F. Unit
	R.F. Choke, 500 Microhenries	T-711	R.F. Unit
	Inductor, 35 ± 3.0 Millihenries	T-876	Audio Unit
L301	R.F. Choke	T-359	Main Chassis
L302	R.F. Choke	T-359	Main Chassis
L303	R.F. Choke	T-359	Main Chassis
L304	R.F. Choke	T-359	Main Chassis
L305	R.F. Choke	T-359	Main Chassis
L306	R.F. Choke	T-359	Main Chassis
L307	R.F. Choke	T-359	Main Chassis
L308	R.F. Choke	T-359	Main Chassis
L309	R.F. Choke	T-359	Main Chassis
M301	Meter, Panel Instrument 0-1 MA. D.C. 50 ohms ± 10% D.C. Resistance, Special Scale Calibrated 0-5 MA. D.C.	T-1072	Main Chassis

Circuit Symbol	Description	B&W Part No.	Unit
P101	Plug, 8 Contacts, Jones	T-753-1	R.F. Unit
P102	Plug, 5 Contacts	T-812	R.F. Unit
P201	Plug, 10 Contacts	T-825	Audio Unit
R101	Res., Precision Deposited Carbon, 50 ohms, ± 1%, ½W.	R-110	R.F. Unit
R102	Res., Precision Deposited Carbon. 50 ohms, ± 1%, ½W.	R-110	R.F. Unit
R103	Res., Precision Deposited Carbon, 15,000 ohms, ± 1% ½W.	R-133	R.F. Unit
R104	Res., Precision Deposited Carbon, 15,000 ohms, ± 1% ½W.	R-133	R.F. Unit
R105	Res., Precision Deposited Carbon, 15,000 ohms, ± 1% ½W.	R-133	R.F. Unit
R106	Res., Precision Deposited Carbon, 15,000 ohms ± 1% ½W.	R-133	R.F. Unit
R107	Res., Vari., Composition 1000 ohms, ± 10%, 2W.	R-145	R.F. Unit
R108	Res., Vari., Composition 1000 ohms, ± 10%, 2W.	R-145	R.F. Unit
R109	Res., Fixed, Composition, 6800 ohms, ± 10%, 1W.	R-130	R.F. Unit
R110	Res., Fixed, Composition, 220 ohms, ± 10%, ½W.	R-131	R.F. Unit
R111	Res., Fixed, Composition 82 ohms, ± 10%, 1W.	R-112	R.F. Unit
R112	Res., Fixed, Composition 47K ohms, ± 10%, 1W.	R-56	R.F. Unit
R113	Res., Fixed, Composition, 270 ohms, ± 10%, 2W.	R-114	R.F. Unit
R114	Res., Fixed, Composition, 3300 ohms, ± 10%, 1W.	R-115	R.F. Unit
R115	Res., Fixed, Composition, 270 ohms. ± 10%, 2W.	R-114	R.F. Unit
R116	Res., Fixed, Composition, 330 ohms, ± 10%, 1W.	R-137	R.F. Unit
R117	Res., Fixed, Composition, 3300 ohms, ± 10%, 1W.	R-115	R.F. Unit
R118	Res., Fixed, Composition, 270 ohms, ± 10%, 2W.	R-114	R.F. Unit
R119	Res., Fixed, Composition, 1500 ohms, ± 10%, ½W.	R-132	R.F. Unit
R120	Res., Fixed, Composition, 820 ohms, ± 10%, 1W.	R-142	R.F. Unit
R201	Res., Fixed, Composition, 470,000 ohms, ± 10%, ½W.	R-66	Audio Unit
R202	Res., Fixed, Composition, 1000 ohms. ± 10%. ½W.	R-65	Audio Unit

Circuit Symbol	Description	RAM Part No.	Unit
R203	Res., Fixed, Composition 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
R204	Res., Fixed, Composition, 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
	Res., Fixd, Composition 1000 ohms, ± 10%, ½W.	R-65	Audio Unit
R206	Res., Fixed, Composition 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
	Res., Fixed, Composition, 15,000 ohms, ± 10%, ½W.	R-154	Audio Unit
R208	Res., Vari., Composition, 100,000 ohms, ± 10%, ½W., C-Taper	R-117	Audio Unit
	Res., Fixed, Composition, 680 ohms, ± 10%, ½W.	R-118	Audio Unit
R210	Res., Vari., Composition, 500 ohms, ± 10%, ½W., A-Taper	R-119	Audio Unit
R211	Res., Fixed, Composition 270 ohms, ± 10%, ½W.	R-153	Audio Unit
R212	Res., Vari., Composition 500 ohms, ± 10%, 2W.	R-119	Audio Unit
R213	Res., Fixed, Composition, 270 ohms, ± 10%, ½W.	R-153	Audio Unit
R-214	Res., Vari. Composition, 100,000 ohms, ± 10%, ½W., A-Taper	R-126	Audio Unit
R-215	Res., Fixed, Composition 1000 ohms, ± 10%, ½W.	R-65	Audio Unit
R216	Res., Fixed, Composition 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
R-217	Res., Fixed, Composition, 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
R-218	Res., Fixed, Composition, 1.2 Megohms, ± 10%, ½W.	R-127	Audio Unit
R219	Res., Vari., Composition 100,000 ohms, ± 10%, ½W., A-Taper	R-126	Audio Unit
	Res., Fixed, Composition, 2.2 Megohms, ± 10%, ½W.	T-641	Audio Unit
	Res., Fixed, Composition, 1000 ohms, ± 10%, ½W.	R-65	Audio Unit
R222	Res., Fixed, Composition 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
R223	Res., Fixed, Composition, 100,000 ohms, ± 10%, ½W.	R-116	Audio Unit
R224	Res., Fixed, Composition, 1.2 Megohms, ± 10%, ½W.	R-127	Audio Unit
	Res., Vari., Composition, 10 Megohms, ± 10%, ½W., A-Taper	R-122	Audio Unit

Circuit Symbol	Description	B&W Part No.	Unit
R226	Res., Fixed, Composition, 47,000 ohms, ± 10%, 2W.	R-123	Audio Unit
	Res., Fixed, Composition, 1500 ohms, ± 10%, ½W.	R-152	Audio Unit
	Res., Fixed, Composition, 270 ohms, ± 10%, ½W.	R-153	Audio Unit
	Res., Precision Boron Carbon, 12.5 ohms, ± 1%, ½W.	R-169	Main Chassis
S101-A&B	Switch, Single Miniature Ceramic Wafer, 2 Pole -6 Position	T-813	R.F. Unit
S101-C&D	Switch, Single Miniature Ceramic Wafer, 2 Pole -6 Position	T-814	R.F. Unit
S101-E	Switch, Single Miniature Ceramic Wafer, 1 Pole -6 Position	T-815	R.F. Unit
S101-F	Switch, Single Miniature Ceramic Wafer, 1 Pole -6 Position	T-816	R.F. Unit
S101-G	Switch, Single Miniature Ceramic Wafer, 1 Pole -6 Position	T-816	R.F. Unit
S102	Switch, lever; DPST.	T-949	R.F. Unit
S301	Switch, Bat Handle Toggle, D.P.D.T.,6A., 125V.	T-987	Main Chassis
S302	Switch, Bat Handle Toggle, D.P.D.T.,6A., 125V.	T-987	Main Chassis
	Switch, Bat Handle Toggle D.P.S.T., 6A., 125V.	T-1071	Main Chassis
	Transf., Audio; Primary 20,000 ohms Single Plate 10Ma. D.C., Sec. 500 ohms Line No D.C.	T-826	Audio Unit
	Transf., Audio; Primary 20,000 ohms. Single Plate 10 MA. D.C., Sec. 500 ohms Line No D.C.	T-826	Audio Unit
T203	Transf., Audio; Primary 20,000 ohms Single Plate 10 MA. D.C., Sec. 500 ohms Line No D.C.	T-826	Audio Unit
T204	Transf., Audio; Primary 20,000 ohms Single Plate 10 MA. D.C., Sec. 500 ohms Line No D.C.	T-826	Audio Unit
TB-301	Term.Board, 10 Terminals with Thru Lugs	T-866	Main Chassis
TB-302	Line Fuse; Bakelite Board	T-604	Main Chassis
V101	Electron Tube, Type 12A7	T-817	R.F. Unit
V102	Electron Tube, Type 12A7	T-817	R.F. Unit
V103	Electron Tube, Type 6CL6	T-818	R.F. Unit

Circuit Symbol	Description	RAW Part No.	Unit
V104	Electron Tube, Type 6V6	T-819	R.F. Unit
V201	Electron Tube, Type 12AT7	T-817	Audio Unit
V202	Electron Tube, Type 12AT7	T-817	Audio Unit
V203	Electron Tube, Type 12AT7	T-817	Audio Unit
V204	Electron Tube, Type 6AL5	T-827	Audio Unit
V205	Electron Tube, Type 12AT7	T-817	Audio Unit
Z201	90° Audio Phase Shift Network	Model 350 Type 294	Audio Unit

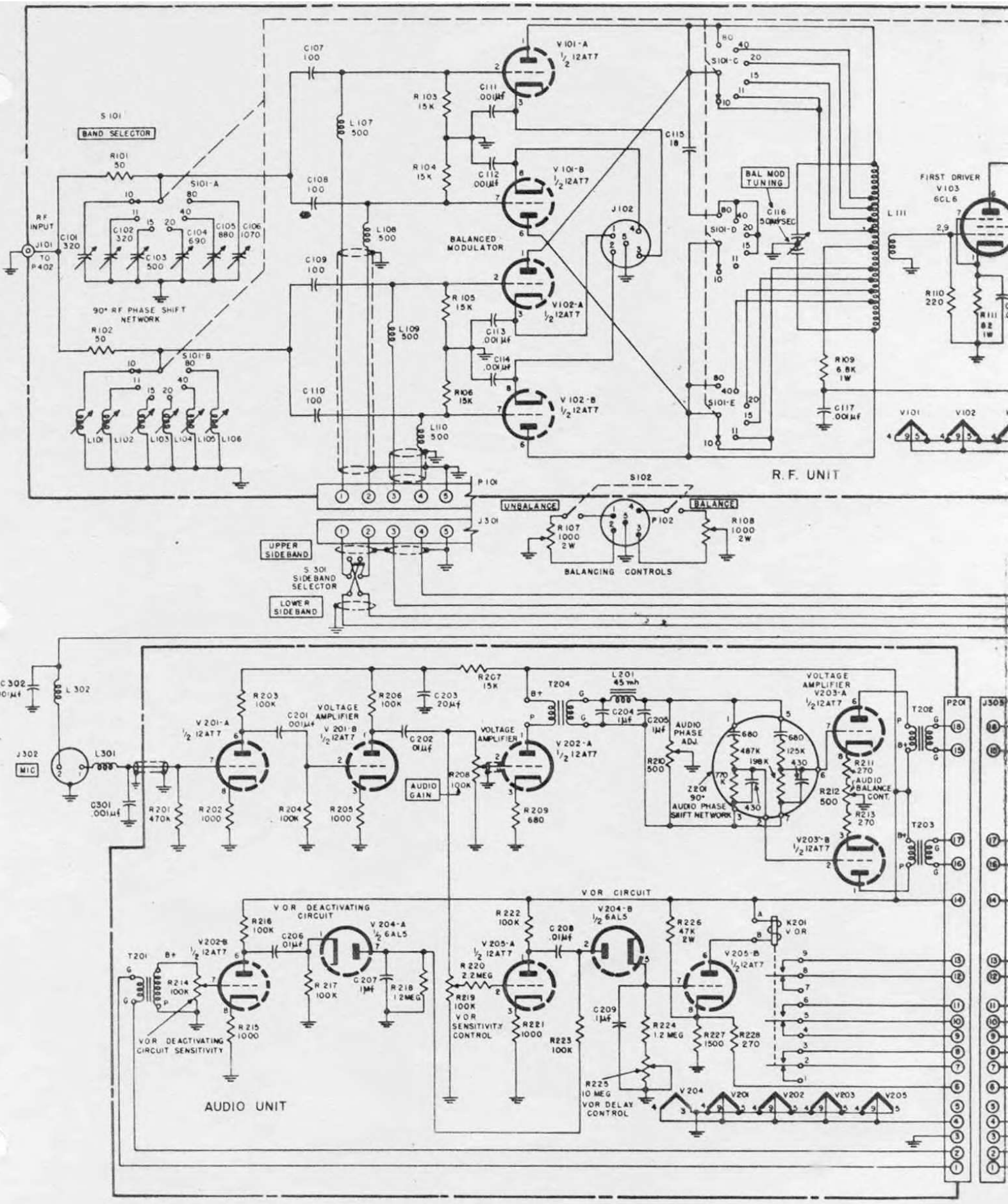
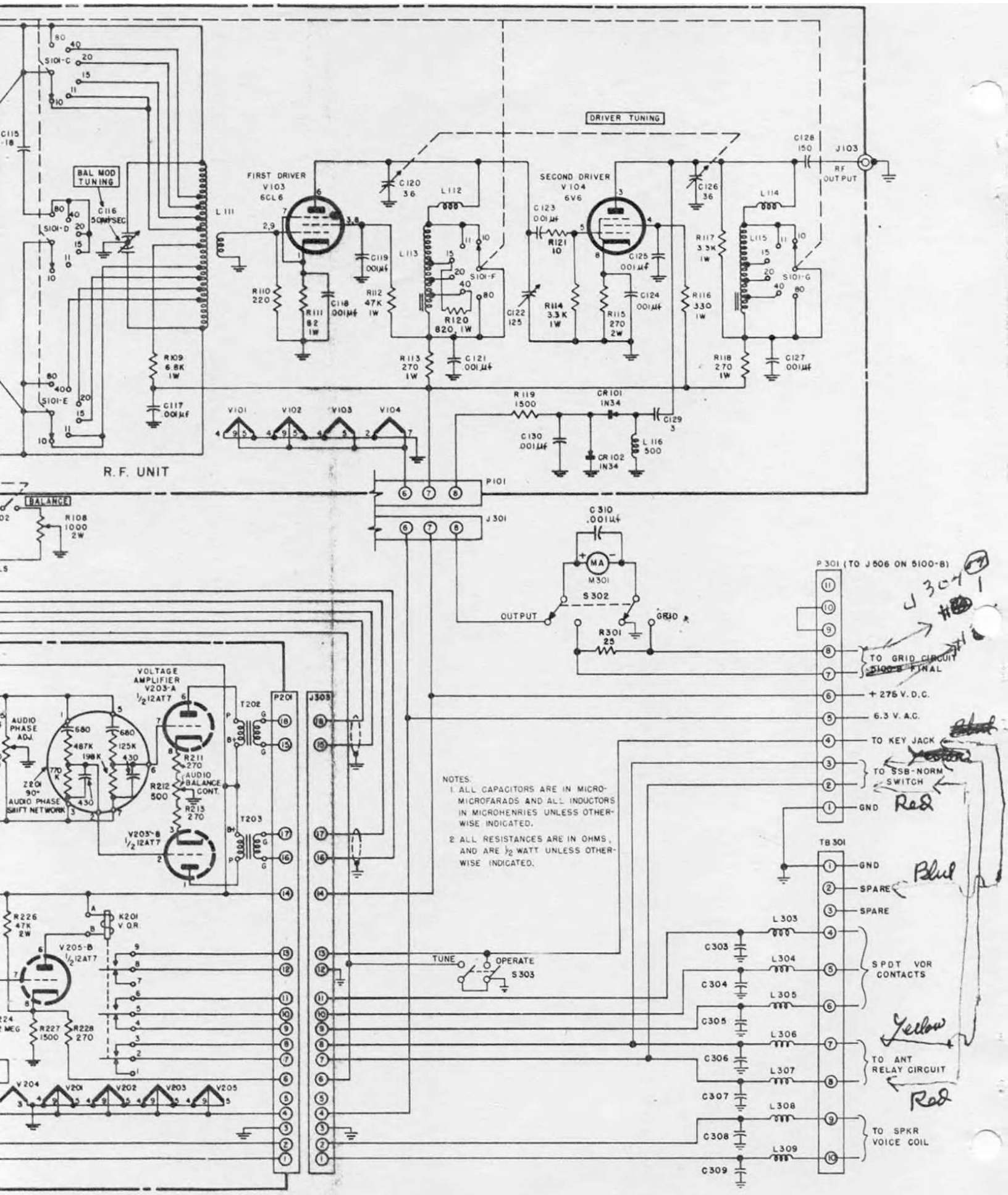


FIGURE 16, MODEL 51SB-B, SINGLE SIDEBAND GE



MODEL 51SB-B, SINGLE SIDEBAND GENERATOR - SCHEMATIC DIAGRAM