

GATES' BC-1J, 1000 WATT BROADCAST TRANSMITTER

The Gates' BC-1J Broadcast transmitter is a completely self-contained 1000 watt AM unit, designed for broadcast service within the frequency range of 1600 Kc to 540 Kc.

IB-888-0382 001
June 27, 1955

Gates Radio Company
Quincy, Illinois

MODULATION TRANSFORMER INSTRUCTIONS

Please read these instructions before attempting to test the modulation transformer in this transmitter.

The modulation transformer employed in this transmitter may be of a type which will indicate unequal resistance in the primary windings. An ohmmeter check of the windings may indicate that the transformer is defective; whereas in reality, this is a normal reading and the modulation transformer is performing normally.

In order to properly check this transformer outside of the transmitter circuit, merely apply 117 volts, 60 cycle a.c. to the secondary winding. Check the voltage on each half of the primary winding. If the transformer is operating normally, then these voltages should be approximately equal.

Gates Radio Company
Quincy, Illinois

ADDENDA SHEET
BC-1J/BC-500K/BC-250L BROADCAST TRANSMITTERS

The stability of the crystals used to control the frequency of these transmitters is affected greatly by the air-gap adjustment. The air-gap should be adjusted as follows:

"The screw should be turned counter-clockwise until the top electrode rests on the crystal, causing it to stop oscillating. Then turn the screw clockwise approximately $1/8$ of a turn which will make an air gap of approximately $.003$ of an inch and the screw slot will then point to the mark on the oven".

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Quincy, Illinois

ADDENDA SHEET

INSTALLATION INSTRUCTIONS FOR REMOTE CONTROL IN GATES TRANSMITTERS BC-1J, BC-500K and BC-250L

M-4703 Rheostat

Refer to drawing B-13417 RDC-10 Remote Equipment

Refer to drawing B-13275 RCM-20 Remote Equipment

The Rheostat Assembly can be conveniently mounted on the cabinet base, right front, near the filament and plate convectors. Tapped 8-32 holes have been provided for machine screw mounting. Using Packard high voltage cable or equivalent, run the two rheostat leads upward through an available hole in the modulator deck to the modulation reactor. Disconnect from the modulation reactor high voltage lead which runs from modulation reactor terminal "B" upward to the R.F. Amplifier Deck. Connect one of the rheostat leads to the end of the lead removed, and the other rheostat lead to modulation reactor terminal "B". Set the transmitter's existing plate rheostat to maximum voltage position (minimum resistance).

Plate Voltage Extension Kit M-4719

Refer to Remote Control Instruction Book - drawing C-19233 - Figure 1.

Tapped 10-32 holes have been provided adjacent to the filter components for machine screw mounting of the M-4719 Kit. Using Packard cable or a high voltage equivalent connect the M-4719 "HV" terminal to the remote rheostat terminal furthest from the power supply. Do not connect to the rheostat terminal which goes to modulation reactor terminal "B". Connect M-4719 kit terminal "G" to a good ground point within the transmitter.

Plate Current Extension Kit M-4720

Refer to Remote Control Instruction Book - drawing C-19233 - Figure 3.

Tapped 10-32 holes have been provided on the cabinet base for mounting the M-4720 kit - right side of cabinet - near the front extremity of the cable entrance output. The kit is connected at the ground end of the P.A. cathode circuit. Remove the jumper that connects terminal #4 of P.A. overload relay, E5 to terminal #4 of relay E4. Do not remove the lead connected from #4 of E4 to ground. The "G" terminal of the two-terminal strip of kit M-4720 should be connected to a good ground point within the transmitter. Connect the other terminal to transmitter P.A. overload relay E5 terminal #4.

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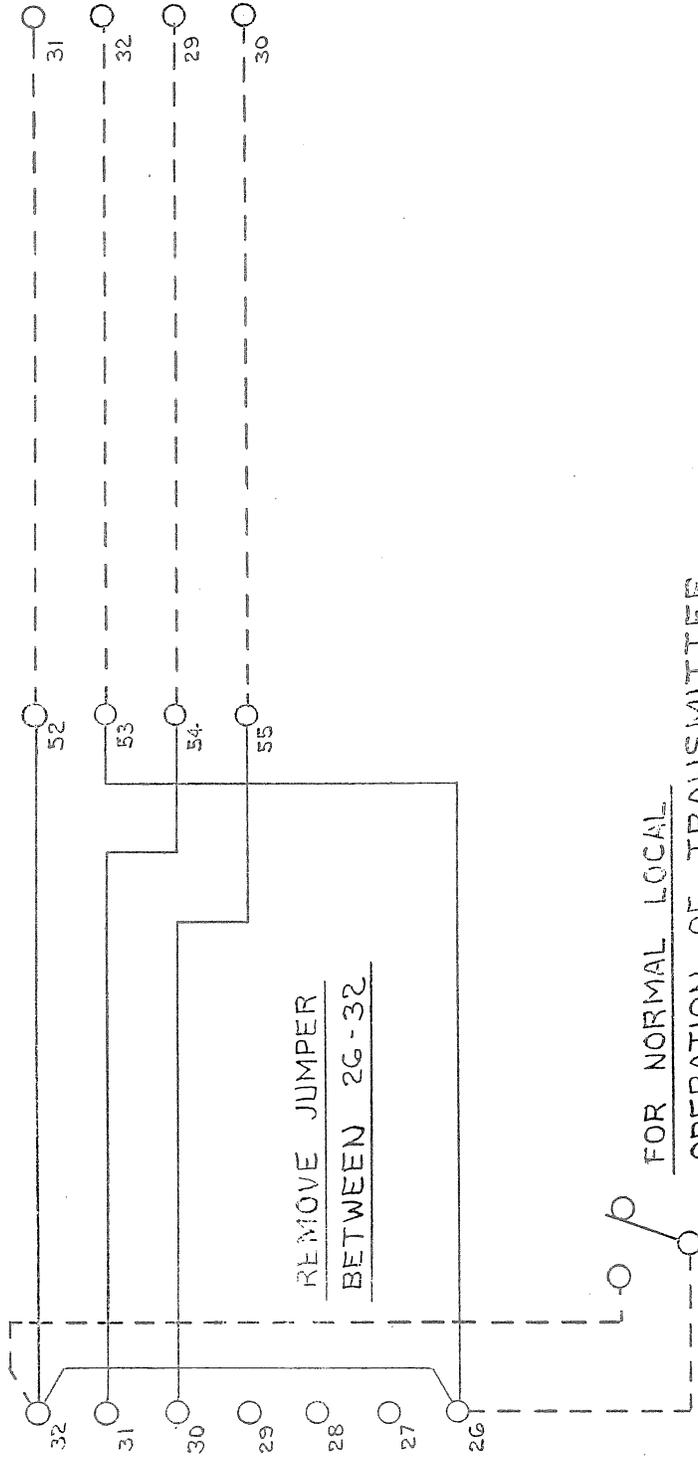
DRAWING NUMBER

A-11404

TRANSMITTER
TB-1

RCM-20
TB-2

RDC-10
TB-2



FOR NORMAL LOCAL
OPERATION OF TRANSMITTER

ADD SWITCH AS SHOWN

RMT. CONTROL INSTALLATION INSTRUCTIONS
BC1J-M4S15, BCX50L-M5147, BC500K-M5157

UNLESS OTHERWISE SPECIFIED,
ALL TOLERANCES PER GATES
SPEC 652102.

DR. <u>W. R. B. K.</u>	CH. BY	ENG. APPR. <u>W. C. M.</u>
DATE <u>1-12-55</u>	DATE	DATE

GATES RADIO COMPANY
QUINCY, ILLINOIS

DRAWING NUMBER

A-11404

ADDENDA SHEET

ATTENTION INSTALLATION ENGINEER

The high voltage meter multiplier, R3, and its' associated mounting assembly have been removed for shipping. These parts are securely wrapped and placed in box and shipped with the Radio Frequency Deck. The installation of this meter multiplier can be easily accomplished by following the information contained on various tags tied to the connecting wires. The multiplier mounting assembly bolts to the underside of the R.F. deck near the left edge as the deck is viewed from the rear. The approximate location has been stencilled with the nomenclature "R3".

D.C. resistance measurements taken on the modulation transformer T6, Gates Drawing AM-10464E.

Center tap to one side of primary, approximately 35 ohms.

Center tap to other side of primary, approximately 100 ohms.

Secondary winding approximately 168 ohms.

Frequency Monitor Connection

On some frequencies and with certain coax lengths the tuning of the first IPA plate coil may be effected. A suitable method is to use a small mica capacitor (.0001 or .0002 mfd.) in series with the TB3-6 terminal and the center (hot) conductors of the coax. Normal first IPA tuning will result with adequate R.F. available at the frequency monitor.

July 14, 1955

Gates Radio Company
Quincy, Illinois

BC-1J/BC-500K/BC-250L ADDENDA SHEET

There has been added to the Twin Drive Audio Deck a small variable condenser (C61) located on the top of the chassis, near the input audio tube, V9. This condenser is used as a phase corrector and is very useful for minimizing high frequency distortion.

Adjusting Procedure -

The noise and distortion can be brought down to minimum readings by following this procedure during test. Set the modulator bias controls (R66 & R67) so that each modulator is drawing its correct static plate current.

BC-1J - 40 ma per tube, 80 ma total.

BC-500K - 30 ma per tube, 60 ma total.

BC-250L - 30 ma per tube, 60 ma total.

Now with 50 cycle audio input check the distortion. Adjust for minimum distortion by use of cathode balance control R41. This control is on left front corner of "Twin Drive" audio deck as transmitter is viewed from the back.

At this point modulate the transmitter with 7500 cycle audio input and check distortion. Adjust the small condenser (C61) also located on the "Twin Drive" audio deck at the front right hand corner of the deck, when transmitter is viewed from the rear, to a position which gives lowest distortion reading at this 7500 cycle audio input.

Now go back to 1000 cycles, modulate the transmitter to correct levels and measure noise. Both noise and distortion readings taken under these test conditions should be satisfactory.

September 29, 1955

Gates Radio Company
Quincy, Illinois

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SECTION I - ELECTRICAL SPECIFICATIONS

1. Power output, 1000 watts. The BC-1J can be operated at 1100 watts output, if necessary, to overcome losses in transmission lines and/or phasing equipment. On special order this transmitter can be adapted for quick change to 500 watts output.
2. Frequency range - 1600 Kc to 540 Kc.
3. Primary power - 230 volts, two wire single phase, 50/60 cycles.
4. Input power - Transmitter draws from 3200 to 4500 watts depending upon percentage of modulation.
5. Frequency stability - ± 5 cycles.
6. Type of modulation - Class "B", high level, modulation capability 100%.
7. Audio input impedance - 150/250/600 ohms.
8. Audio input level (100% modulation) ± 10 DBM, ± 2 DBM.
9. Audio response - 30 to 10,000 cycles, $\pm 1-1/2$ DB.
10. Distortion - 3% or less, 50 cycles to 7500 cycles measured at 90% modulation.
11. ~~Noise - Minus 60 DB below 100% modulation.~~
12. ~~Carrier Shift - 4% or less, 0-100% Modulation.~~
13. Output impedance - To match 50/70 ohms at all frequencies, 540-1600 Kc. Coupling unit available for other impedances.
14. Tubes Used - One 6AG7 Oscillator
One 6AG7, 1st IPA.
~~Two, 833A, Power Amplifier~~
Two 6146's, 2nd IPA
Two 6SN7, 1st Audio and Phase Inverters
Four 1622, Audio Driver Tubes
Two 833A, Modulators
Two 8008's, High Voltage Rectifiers
Two 5R4GY, Intermediate Voltage Rectifier
One 5R4GY, Low Voltage Rectifier
One 5R4GY, Bias Rectifier
One 6AQ5, Clamper Tube
One OB2, Voltage Regulator
14. All frequency determining components (except crystal and oven) are included in the R.F. section of the transmitter.

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SECTION II - MECHANICAL DESCRIPTION

1. Overall dimension - 78" high, 42" wide and 30" deep. No space required for door swing, as rear door is of slip-on type.
2. Floor space - 8.7 square feet.
3. Weight unpacked - 816 pounds.
4. For shipping, the RF deck and the Modulator deck have been removed, along with certain other components such as modulation transformer, modulation reactor, power transformer and filter chokes.

SECTION III - INSTALLATION

This instruction book affords valuable information for persons who are installing and operating the Gates' BC-1J Transmitter. The following mentioned points should be studied so that the unpacking and setting up procedure will be well in mind when doing the actual work.

1. Check all packing lists for materials.
2. Read this instruction book completely before attempting to set up the equipment.
3. Have the transmitter location clean so that the various parts can be safely placed out of harms way when they are unpacked.
4. It is preferable to have a mounting base, in place, upon which the transmitter can be set. This base can be made out of 2 x 4 lumber, preferably painted black. See Gates' Drawing A-10349, a part of this instruction book. This base should be lagged to the floor, and measures taken to make sure the top side of the frame is perfectly level. This will give a good solid, level base upon which the transmitter can set.
5. Use heavy primary wire from the switch box to the AC input terminals on the transmitter. Number four or six wire will be very suitable.
6. Be sure the power company has installed large enough service for all of the equipment, lights, water pump, etc., which will be in use at the transmitter site.
7. Do a good job of installing the equipment. Time spent in making your installation as good electrically and mechanically as possible will pay off in the future. You will have less loss of valuable air time if this idea is followed to the best of the installation engineers ability.
8. Acquaint yourself with this equipment by studying this instruction book and all of the schematics herein.

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SECTION IV - BC-1J TRANSMITTER DETAILS

For shipping purposes, the following has been removed from the transmitter.

1. The Radio Frequency Deck
2. The Modulator Deck. Taken off this deck has been the modulation transformer, T6, and modulation reactor, L21.
3. Main High Voltage Power Transformer, T11.
4. Input Swinging Choke, L22.
5. Output Smoothing Choke, L23.
6. All Tubes and Crystals if supplied.
7. Output Feedthru Insulator.
8. Time Delay Relays, E7 and E8.

The removed items have been separately boxed to help insure safe delivery of the transmitter. Be sure to check the packing lists for any discrepancies. The various parts are all marked with their schematic symbol and replacement within the cabinet should be easily accomplished by checking with the various photographs that are provided as a part of this instruction book.

The output feedthru insulator that has been removed for packing, can easily be replaced in the top of the cabinet. The coil, L15 (Modulation monitor pickup) and the two parasitic suppressor assemblies have also been removed and packed in a carton secured to the R.F. Deck. The copper tubing connection between coils L13 and L14 has been removed and secured to the R.F. deck.

The following information on the Gates' BC-1J transmitter pertains to the general construction and operation of the unit. It is highly desirable to study the transmitter through its' various sections in order to completely understand and comprehend its operation.

The oscillator is an independent unit mounted on the Radio Frequency deck at the rear (right side as transmitter is viewed from the rear). This oscillator circuit is the so-called grid-plate and the oscillator output circuit is electron coupled to the grid circuit. This gives good isolation to the crystal and makes for very stable operation. The output of the 6AG7 oscillator tube drives the grid of the first IPA stage, another 6AG7. This stage is tuned. Provision is made for padding this stage for low frequency operation, the condenser terminals are close to the second 6AG7. No padding is required from 1600 Kc to approximately 850 Kc., from this frequency to 540 Kc a 270 mmfd. mica condenser is used. This condenser is furnished as a part of the transmitter and will be found in a bag tied to the ground connection on the oscillator unit. The oscillator cathode current, the 6AG7, 1st IPA cathode current and the grid current to the parallel 6146's, are measured by the first three positions on the multi-meter switch, located on the front control panel. These positions are marked

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Osc. plate; 1st IPA plate and 2nd IPA grid. For typical readings obtained in these circuits refer to Gates Drawing A-10859, which is a part of this instruction book.

The crystal ovens operate on 6.3 volts AC. This voltage is supplied by a small step-down transformer, T1. The crystal holders supplied are of the variable gap type. Be sure to read the directions supplied with each holder. Follow these directions to adjust the air gap which governs the frequency of operation. For very slight changes in frequency, the variable condensers, C3 and C4, can be used. These condensers are in shunt with the crystals and can vary the frequency from 5 to 10 cycles depending on fundamental frequency. Also, at the rear of the oscillator unit is a variable control (R13) which varies the screen voltage of the 1st IPA, 6AG7. This controls the output of this stage. For normal operation, the grid current to the parallel 6146's should be from 2 to 4 ma. This figure can be obtained by adjustment of screen control, R13.

Provision has been made in the 1st IPA stage (6AG7) to supply voltage to operate any standard Frequency Monitor, such as the Gates' MO-2890. This output voltage is available at terminal #6 on TB3. A ground is conveniently located at terminal #7. By connecting a suitable length of Co-ax cable to these terminals and the Frequency Monitor, the installation of the monitor is easily completed.

The oscillator unit is supplied with 550 volts from the Intermediate Voltage Power Supply, located on the Modulator Deck. This supply uses a pair of 5R4GY rectifiers (V19 and V20).

The second IPA stage uses two 6146's operating in parallel. These tubes have approximately 550/600 volts applied to their plates. Full protection is afforded these tubes by use of a screen clamper tube, the 6AQ5 (V6). The cathode current of the two 6146's will run between 150 and 200 ma. depending upon frequency and loading. This current is indicated by the multi-meter, when the selector switch is set to "2nd IPA plate". The 6146 driver stage is tuned from the front panel by control Knob designated "2nd IPA tune". This stage will tune with no padding from 1600 Kc. to approximately 800 Kc. From 800 Kc. to 540Kc. ~~Padding condenser, C23, a 500-ufd. mica must be paralleled across the~~ tuning condenser, C24. This padding condenser is supplied as standard equipment on all transmitters. If the frequency of operation is such that C23 is not used, remove both jumpers from the variable condenser, C24. Also, take the jumpers off of C23, doing this will preclude any possibility of accidental shorts.

The 6146 RF driver will supply adequate drive to the parallel 833A tubes. The normal grid current, as indicated on the multi-meter, when selected, will run between 100 and 140 ma.

Neutralization of the power amplifier is accomplished by the "Rice" method, the out of phase voltage being obtained from the 6146 tank coil. There are several taps around the mid point on this coil (L9), these taps allow neutralization adjustment.

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One plate of the neutralizing condenser, C26, has mounting slots provided which will enable the operator to slightly adjust this plate to change the spacing of the condenser. This condenser is normally adjusted at the factory and should require no further attention. Neutralization can be further varied by means of the five taps mentioned above.

The power amplifier uses two 833A operating in parallel. The output circuit is a combination "pi" and "T", a circuit proved over the years as one which is flexible and also very effective in attenuation of undesirable harmonics. The coil and capacitor values as supplied in the transmitter are effective in loading this transmitter into a 50/70 ohm load.

The output circuit of the transmitter includes a pick-up coil (L15) which supplies sufficient RF voltage to operate a modulation monitor, such as the Gates' MO-2639. This voltage is available at a terminal board located in the top of the cabinet.

This amplifier is rather novel, in that no variable, air dielectric condensers are used for tuning. The tank circuit is tuned by a rolling contact inductor, L12. This method of tuning is helpful in preventing arcs or flash-overs that may occur in variable condensers, especially if there is dust accumulation.

The P.A. tank circuit includes two 250 mmfd. mica condensers, C31 and C32, connected in parallel. These condensers are used for frequencies of 1600 to approximately 850 Kc.

For lower frequencies, 850 Kc to 540 Kc, another mica condenser, C33, 500 mmfd. must be paralleled with C31 and C32. This is shown on Gates' schematic, E-25385, which is a part of this instruction book, and tuning chart A-10860.

The power amplifier plate current is read on P.A. plate meter, M4, a 0-1 ampere meter. This current will generally run from 525 ma. to 600 ma. depending upon the efficiency and the applied plate voltage. The normal plate voltage as read on Plate Voltmeter, M5, will be around 2500 volts. As mentioned previously, the P.A. Grid Current is indicated on the multimeter will be 100 ma. to 140 ma. depending upon frequency, tuning, etc.

Two P.A. tuning controls are located on the R.F. deck front panel, toward the top. The Veeder Counter Control on the right tunes the power amplifier plate coil, the counter control on the left adjusts the loading coil, L14.

The modulator deck contains the complete audio system, the bias power supply, 380 volt power supply and 600 volt power supply.

The complete audio driver unit comprised of the audio input transformer, the first audio stage and phase inverters (6SN7's) and audio driver tubes (4 - 1622/5881) and the audio driver transformers is built up as a complete unit. This chassis is so mounted, that by disconnecting

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the input wiring from TB6, TB7, and TB9 it can be removed for servicing, if needed.

The output of this audio driver is connected to the grids of a pair of 833A modulators, V15 and V16. Also, on this modulator deck is the modulation transformer, T6, modulation reactor, L21, and coupling capacitor, C58.

The first audio stage makes use of two 6SN7 tubes (V9 and V10) serving a dual purpose, first as a push-pull audio stage and also as phase inverters to drive the push-pull "Twin Drive" audio driver tubes, V11, V12, V13 and V14.

A balance control, R41 is located on the left front top of the audio driver chassis as viewed from the back. This control is in the cathode circuit of the two tubes in the input circuit. It is suggested that this control be used to adjust for lowest distortion at 7500 cycles. If this is done, the balance will hold over the audio range.

The filaments of these tubes are all energized from a 6.3 volt winding on Filament Transformer, T10. This Transformer supplies the two 833A modulator tubes, as well as the 6SN7's and 1622 tubes.

There are two separate feedback loops in the audio system. One makes use of separate tertiary windings on the driver transformers, T4 and T5, producing about 25 DB of feedback around the audio drivers. The second feedback loop is taken from the plates of the modulators back to the input audio stage. This loop develops approximately 6 DB of feedback. By the use of this feedback the distortion is kept at a low figure. The amount of internal feedback varies as the modulator drive varies. The above figures are based on average modulation of approximately 75%.

The modulators of the BC-1J Transmitter are a pair of 833A, tubes operating as class "B" audio amplifiers. These tubes are driven by the "Twin Drive" audio drivers, the four 1622/5881 tubes. The modulators are biased by a separate power supply, the bias voltage is adjustable from the front of the modulator deck panel. These controls are R66 and R67. These controls are adequately marked on the front panel. The static plate current of the modulators will run approximately 60-80 ma. as read on meter M2. The plate current will rise to approximately 375-500 ma. depending on the percentage of modulation. The modulators are protected by overload relay, E4, located on the relay panel in the base of the transmitter. This relay has its throw out point raised or lowered by a shunt resistor across the relay coil. Normally this relay is adjusted to kick out at about 650 ma. This will allow unavoidable over modulation peaks to occasionally go through and not cut off the transmitter.

The relay panel is located on the right side of the transmitter base, when viewed from the rear. On this relay panel are mounted the following relays:

- (a) Relay E1, filament contactor.
- (b) Relay E2, plate contactor.

- (c) -- Relay E3, master relay
- (d) Relay E4, modulator overload
- (e) Relay E5, P.A. overload
- (f) Relay E6, P.A. Grid undercurrent
- (g) Relay E7, Time delay relay

Relay E1, the filament contactor, when energized by depressing the filament start switch located on the front panel, causes all of the filaments in the transmitter to be heated. Also, at the same time the modulator and audio driver bias supply has become operative, putting correct operating bias on these tubes. At this same time, the time delay relay, E7, is also heating and at the end of its' heat cycle, its Normally Open Contacts are closed. Simultaneously the intermediate voltage time delay relay, E8, is heating and after its operating cycle of from 5 to 10 seconds has passed, 380 volts D.C. is applied to the four audio driver tubes and approximately 550/600 volts is applied to the pair of 6L46 RF driver tubes. This intermediate voltage supply is adequately protected by a door interlock S8 which operates in the primary of the intermediate plate transformer, T7. If the back door is off, door interlocks, S6 and S8 mentioned above, will make it impossible to apply high DC voltage of any sort to the transmitter (remember that approximately 100 volts of bias is on and in operation within the transmitter whenever the filaments are lighted). If door interlock switch, S6, is closed it will be possible to apply high voltage to the transmitter. This is accomplished by depressing the plate start switch, located on the front control panel. When this plate start switch is depressed, the coil of relay, E2, the plate relay, is energized applying primary power to high voltage plate transformer, T11, in the transmitter.

Also, on the relay panel are two overload relays, modulator overload E4 and P.A. overload, E5. These relays are in the filament center tap return. By means of shunt resistance across the coils of these relays their tripping point is adjusted for satisfactory operation. Both relays, E4 and E5, are set at the factory to kick out at about 650 ma. This gives satisfactory protection to the modulator and P.A. stage. These relays can be re-adjusted by the station engineer to suit his requirements, as desired.

Of interest also, is relay, E6, the P.A. grid undercurrent relay. This relay closes when rectified grid current flows through it, as long as there is sufficient drive the relay will be closed. If for any reason, the grid excitation fails, this relay will de-energize and cause the plate relay, E2, to open up, thus removing high voltage plate power from the transmitter.

The Gates' BC-1J incorporates four D.C. power supplies. The 380 volt supply, using one 5R4GY rectifier (V18) supplies plate and screen voltage to the audio input stage and audio driver stage. This supply becomes operative when the fil. start button is depressed. After the time delay relay E8 has closed and if the door interlock S8 is also closed. This supply has its high voltage winding as a part of T7, its filament voltage is derived from a winding on transformer, T8.

The filter system for this low-voltage supply is made up of choke, L19, and filter condenser, C56.

The 600 volt supply uses two 5R4GY tubes (with paralleled plates) in a full wave rectifier, V19 and V20. This supply furnishes plate and screen power for the oscillator, first IPA and two 6146 R.F. driver tubes. This supply also becomes operative when the fil. start button on the control panel of the transmitter is depressed. Assuming that time delay relay, E8 and door interlock S8 are closed. This supply has its high voltage winding as a part of T7, the filaments of the two 5R4GY rectifiers are energized by filament transformer, T8. The filter system for this intermediate plate supply is made up of choke, L20, and filter condenser, C57.

The main high voltage power supply delivers 2500 volts for plate potential on the P.A. tubes, V7 and V8, and modulator tubes, V15 and V16. This supply uses a pair of 8008 rectifier tubes (V21 and V22) energized by a large plate transformer, T11. The filaments of the 8008 tubes are heated by rectifier filament transformer, T12. The filter is made up of input swinging choke, L22, output smoothing choke, L23, and filter condensers, C59 and C60.

The BC-1J Transmitter makes use of a top-of-cabinet ventilation fan. This fan operates whenever the P.A. plate contactor is energized and power is being applied to the transmitter.

GENERAL INFORMATION

For shipping purposes, the Radio Frequency Deck and the Audio Modulator Deck have been removed, as have several of the large transformers and chokes. The units and their location can quickly be recognized by referring to the various photographs that are a part of this Instruction Book. Check these items against your packing list. If all have not been received, first note if the packing list shows a back order. If not, then note to see if the shipping waybill shows a shortage. Each shipment is carefully checked against the packing list. In case of a shortage, notify both Gates Radio Company and the delivering carrier at once. Remove all wooden supports that are used to brace cabinet during shipment.

When installing the P.A. deck and the Modulator deck, be sure to use the hardware supplied to bolt these decks securely to the cabinet supports. There are four mounting holes, one at each corner, in the bottom flanges of the decks. There are also mounting holes in the top of each panel, bolts should be used to hold these panels to the cabinet flange. These fastenings make for cabinet rigidity and also ground the two decks. Suitable hardware is supplied to mount the decks and other components securely within the cabinet. This hardware will be found in a bag securely tied within the Transmitter cabinet.

Check all relays for correct free movement. Be sure the cord and packing that was used to hold the relays while in shipment has been removed. The removed units can be quickly replaced by looking at the photographs. The external connections are few and these are easily made to the BC-1J Transmitter. The 230 volt, 50/60 cycle, A.C. enters the base of the cabinet through a slotted opening located in front of the relay panel assembly. The two primary wires connect to terminals 24 and 25 on relay panel. The modulation monitor connects to a terminal board located in right top of cabinet as viewed from back. The frequency monitor is connected to terminals 6 and 7 on TB3, 6 being hot terminal and 7 ground.

The RF output terminal of the transmitter is located at the top of the transmitter toward the left front as viewed from the front. A ground stud is provided close to the output insulator for grounding the transmission line. This ground also carries on down to the R.F. section. At the base of the cabinet near the cut-out, is a stud to be used to ground the cabinet to the ground system of the station. The station ground system should be as good as can be made, all connections solid and preferably brazed together. It is wise to bond all electrical conduits, metal frame work of buildings, etc. to the common ground system. Less trouble will be had in years to come if this suggestion is followed, as aging of the ground system will cause no trouble, if it is installed well.

SECTION V - INITIAL TUNE-UP OF GATES' BC-1J

Before proceeding with the initial tune-up of this transmitter, let us recheck the necessary things to be done, before any voltage is applied to the transmitter. Briefly check the following list.

- (a) Proper line voltage to terminals 24 and 25 on relay panel. This should be 230 volts, 50/60 cycles.
- (b) Proper location of all tubes in sockets. These tube locations can be checked by reference to the stencilling on the unit and to this instruction book.
- (c) Check to see that all tie-down twine and other shipping material has been removed from the various components, especially the relays.
- (d) Recheck on all components that were installed. Be sure they are connected correctly. The parts have been tagged to help in the correct installation.
- (e) Go over the complete transmitter, checking the tightness of all nuts and bolts, terminal board connections, etc.
- (f) Give all soldered connections a brief looking over. The equipment has passed several rigid inspections during its course of manufacture, but something could have been overlooked that might give trouble in the future.
- (g) Make certain the transmitter and associated equipment is well grounded.
- (h) It is suggested that all audio input wiring be shielded and placed in conduit or wiring troughs, away from a.c. wiring.
- (i) Be sure the crystal and oven assemblies are in their sockets, they should be heating as soon as the main primary wires are connected to the relay panel. The ovens should be warm to the touch, if not, check fuse F3 for continuity.
- (j) All tubes should be in their correct sockets, all relays free.

It is suggested at this point, that the transformer leads to the plates of the high voltage rectifiers, 8008's, V21 and V22, be removed from these tubes. This will insure no high voltage D.C. being applied to the transmitter.

Let us tune this transmitter to 1400 Kc. The crystals should be for 1400 Kc operation, the ovens should be heating. Remove plate caps from high voltage rectifiers, V21 and V22. Short out door interlocks, S6 and S8.

Depress filament start button on front control panel. This will cause filament relay, E1, to energize which lights all filaments and causes the bias supply to produce bias voltage. This bias voltage should be approximately 100 volts and can be measured as follows. Turn the bias controls, R66 and R67, fully counter-clockwise. This puts maximum bias voltage on the 833A modulators. By use of a good D.C. voltmeter this voltage can be measured from grid of modulator tube V15 to ground. This will be approximately 100 volts. At this time, the fixed bias on the four 1622/5881 audio driver tubes can be checked. Measuring from terminal 3 on TB6 to ground, a voltage of approximately 21 volts should be found. The voltage will be negative on the grids of the modulators and on the terminal board. Adjust 1st IPA screen control on rear of oscillator unit to maximum clockwise rotation. When the filament button was depressed and all filaments energized, the intermediate voltage time delay relay, E8, also becomes actuated and after a short interval of time (5 to 10 seconds) the intermediate voltages were applied to the audio input and driver tubes and the oscillator, 1st IPA and 2nd IPA stages.

Move around in front of the transmitter and tune up. First set Multimeter switch on oscillator plate, multimeter should read approximately 6 to 8 ma oscillator cathode current, change multimeter switch to 1st IPA plate, then adjust 1st IPA control for minimum reading (resonance) on multimeter this will be approximately 8 to 20 ma depending upon setting of screen control, R13. Note that on frequency of 1400 Kc no padder condenser is required at C17. See tuning chart A-10860. Now set multimeter switch to 2nd IPA plate.

Adjust 2nd IPA tuning control to show minimum plate current on multimeter. Note that on frequency of 1400 Kc no padder condenser is required at C23. See tuning chart A-10860. This current will read somewhere between 150 and 200 ma depending upon frequency of operation load, etc. Now set multimeter switch to P.A. Grid, the multimeter should indicate between 100 and 140 ma. grid current to the power amplifier. At this time, go back over the complete five settings of the multimeter switch to check the tuning. These readings are typical

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"Oscillator Plate" - 6 to 8 ma.

"1st IPA Plate" - 8 to 20 ma depends on adjustment of screen control R13

"2nd IPA Grid" - 2 to 4 ma (if this reading is too high, it can be reduced by adjusting the screen control R13, of the 1st IPA Amplifier)

"2nd IPA Plate" - 150 to 200 ma.

"P.A. Grid" - 100 to 140 ma.

At this time the filament voltage should be checked, the meter, M1, should read 10V. This actually measures the filament voltage of the Power Amplifier Tubes, V7 and V8. All filament primaries are controlled by filament rheostat, R2. When the voltage is adjusted to 10 volts on the PA tubes, it is also adjusted simultaneously on all of the other filaments within the transmitter.

Shut down the Transmitter.

Now we are ready to check neutralization of the final power amplifier. Disconnect the transmission line from the transmitter. Perhaps this can be done easier by taking the lead from coil L15 off of variable output coil L14. From the Frequency Tuning Chart we notice that the power amplifier will use the two 250 mmfd. mica condensers in parallel. (The 500 mmfd. mica condenser supplied with the transmitter is not used on this frequency). Also, note from the chart that L12 should have approximately 19 turns for frequency of 1400 Kc.

Connect the correct loading condensers C34 and C36 into the output circuit as shown on the tuning chart for frequency of 1400 Kc. For 1400 Kc, C34 a .003 mica is used, as is C36 another .003 mica. C34 is input load condenser and C36 is output load capacitor. C35 and C37 are not used on this frequency. Some sort of RF indicator must be coupled up to the power amplifier tuning coil. This can be a neon bulb mounted on a long rod of bakelite, or a flash lamp connected to a 2 or 3 loop of wire. Either of these make a satisfactory RF indicator. If the amplifier is neutralized, no RF will be indicated in the main tank coil when the variable coil is tuned through resonance. If an indication is shown when amplifier is tuned to resonance, the amplifier is out of neutralization. The amplifier is neutralized by the so-called "Rice" method, that of feeding out-of-phase voltage back to the plate from the input grid circuit. This

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neutralizing voltage can be varied by adjusting the center tap on the RF driver plate coil L9. There are several taps on this coil adjacent to the electrical center and neutralization can be accomplished by the use of one. If not, de-energize the transmitter, then put the lead on the center tap of coil L9 and adjust the right hand (as viewed from rear) plate of the neutralizing condenser, C26. This plate has its mounting flange slotted, making possible a slight adjustment of the spacing of C26. Some setting of this plate will be found which causes the power amplifier to become neutralized when one of the 5 taps on L9 is used. When the resonance tuning point of the power amplifier can be passed through without an indication on the neon bulb or lamp, you can assume the P.A. is satisfactorily neutralized. Another good check is to set the multimeter switch on P.A. grid, then watch this grid current while tuning L12 through resonance. If the P.A. grid current remains steady while the amplifier is tuned through resonance it is satisfactorily neutralized. Remove any neutralization indicators. Take short off of door interlock switches 86 and 88.

Be sure the plate voltages are off.

Now place one high voltage lead on one 8008 rectifier. Also replace the output wire from L15 back on output coil L14. Now apply high voltage by depressing Plate Start Button. Tune the Power Amplifier to resonance. Adjust the loading until the plate current meter, M4, reads approximately 200 ma. and the plate voltmeter reads about 900 volts. With loading adjusted so that these figures are obtained, shut down the transmitter, be sure it is off. Place the other cap on the second 8008 rectifier. Again start up the transmitter by applying plate voltage. Rapidly retune to resonance. When properly tuned the plate current will run approximately 500 to 550 ma. at 2500 volts. With this input the output should be 1000 watts. Efficiency of the BC-1J Transmitter will approximate 72 to 75%. The R.F. end of the transmitter should be operating satisfactorily now.

It will be remembered that previously we had turned the modulator bias controls completely counter-clockwise. This applied maximum bias to the two 833A modulator tubes. We will now adjust the modulators. With the transmitter operating and producing power into the load, adjust one bias control until its associated modulator tube draws approximately 30 ma, as indicated on Modulator meter (M2). Now adjust the second bias control until the modulator plate current as indicated on M2 reads 60 ma. This is the normal operating condition.

The meter readings on the transmitter should be somewhat close to those shown on "Typical Meter Readings", a chart in this instruction book. Readings within 10% can be tolerated. The operator is given a slight control over the high voltage applied to the Power Amplifier tubes by adding or decreasing resistance in the high voltage lead to the power amplifier. This is done by varying the P.A. plate rheostat, R1, located on the front control panel. The P.A. voltage can be varied approximately 200 volts in this manner.

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SECTION VI -- GENERAL OPERATING PROCEDURE

(a) The crystal ovens should have been heating for approximately four hours before final frequency adjustments are to be made.

The ovens of the crystal holders should be warm to the touch. The ovens are heated by 6.3 volts as obtained from the secondary of oven heater transformer, T1. The primary of this transformer is connected permanently to the transmitter side of primary fuses, F1 and F2. There is a secondary fuse, F3, also. This gives adequate protection to the oven heater power circuits.

After the heaters have been heating for about four hours, the crystal frequencies should be adjusted to exact operating point. Normally this procedure is as follows.

If the adjustments are being done at a completely new station, there will be no accurate way of adjusting the transmitter frequency. The transmitter will be checked for correct operating frequency by an external monitoring source. By this method one crystal can be brought to exact frequency. The first adjustment can be made by operation of the air gap. It is possible to set the frequency very close to zero cycles deviation by this adjustment. Then any slight adjustment can be accomplished by varying the crystal shunt condensers, C3 and C4. After the number one crystal has been adjusted to zero deviation from the assigned frequency, then it would be wise to adjust the stations' frequency monitor to coincide with the checked #1 crystal. (Of course the frequency monitor should be in operation in so far as oven temperature is concerned, preferably at least 48 hours). Once the stations frequency monitor has been calibrated and is working satisfactorily, the station engineer has a reliable source of frequency measurement and can from this point go ahead and adjust the second crystal to frequency by observing the frequency meter while making adjustments of the air gap of the number two crystal.

For the station that has been on the air and has a calibrated frequency monitor in operation, the station engineer can simply adjust the two new crystals to frequency by observing the already operating frequency monitor.

(b) Modulation Monitor connections. The BC-1J transmitter has a small pick-up coil (L15) connected between output loading coil, L14, and the ceramic feedthru insulator to be used for excitation of a modulation monitor. The connections are made to a small barrier strip terminal board located in the top of the cabinet. The modulation monitor should be connected to this terminal board with a suitable length of co-ax cable, similar to RG-62U.

(c) Frequency monitor connections. The frequency monitor R.F. connections are made to terminals 6 and 7 on TB3. Number 6 is the hot side, number 7 the ground. The frequency monitor can be connected to this terminal board by means of a suitable length of co-ax cable, such as RG-62U. A word of caution at this point. Be sure to terminate the co-ax on the frequency monitor, otherwise the open circuited co-ax could cause a loading effect on the 1st IPA stage which could cause this stage not to tune.

SECTION VII, TYPICAL VOLTAGE CHARTS

GATES' BC-1J, BC-250L & BC-500K

(No signal in, measured with Simpson #260 Volt-ohmmeter)

First Audio (1/2 6SN7) V9, V10

Plate volts - 110
Cathode volts - 3
Filament volts - 6.3 A.C.

Phase Inverter (1/2 6SN7) V9, V10

Plate volts - 110
Cathode volts - 3.5
Filament volts - 6.3 A.C.

Audio Drivers, V11, V12, V13, V14

Plate volts - 360
Screen volts - 270
Grid volts - 20
Filament volts - 6.3 A.C.

833A Modulators (BC-1J)

Plate volts - 2600 V. DC
Plate current (Static) per tube - 30 ma.
Bias volts - approximately 65 negative
Filament volts - 10 A.C.

833A Modulators (BC-500K)

Plate volts - 2050 V. DC
Plate Current (Static) per tube, 20 ma.
Bias volts - approximately 70 V. negative
Filament volts - 10 V. A.C.

810's Modulators (BC-250L)

Plate volts - 1400 V. DC
Plate Current (Static) per tube - 25 ma.
Bias volts - approximately 32 negative
Filament volts - 10 V. A.C.

6AG7 Oscillator

Plate volts - 125 (Checked at bottom of choke, L2)
Screen volts - 75
Filament volts - 6.3 A.C.

6AG7, 1st IPA

Plate volts - 400
Screen volts - 115 V. (Variable by means of R13)
Filament volts - 6.3 A.C.

6146's, 2nd IPA

Plate volts - 550/600
Screen volts - 125
Filament volts - 6.3 A.C.

833A Power Amplifiers (Two Tubes) BC-1J

Plate volts - 2500
Plate Current - 500/550 ma.
Bias volts - Grid leak, 300
Filament Volts - 10 A.C.

833A Power Amplifier (One Tube) BC-500K

Plate volts - 2000 V. D.C.
Plate current - 320/350 ma.
Bias volts - Grid leak, 250 V.
Filament volts - 10 V. A.C.

810's Power Amplifier (Two Tubes) BC-250L

Plate volts - 1300-1350 DC
Plate current - 250 ma, approximately
Bias volts - grid leak, 250 V.
Filament volts - 10 V. A.C.

High voltage rectifier output of filter - 2600 for BC-1J

Approximately 1400 volts for BC-250L

2000 V. for BC-500K

Intermediate voltage rectifier output of filter 550/600 V.

Low voltage rectifier, output of filter, 380 V.

Bias rectifier, output of filter, 100 V. negative

Crystal heater voltage, 6.3 V. A.C.

(d) The Gates' BC-1J Transmitter is cooled by means of a top-of-cabinet ventilating fan which draws the heated air out of the cabinet. The transmitter has a large decorative open type grill in the front, at the bottom, through which cool air is drawn in, then is pulled up through the perforated audio and R.F. decks and out the top. The heated air also rises, so by convection the cabinet air is also changed.

SECTION VIII - SUMMARY

A radio broadcast transmitter, regardless of its size, cannot be fully described, and/or all the operating problems that arise cannot be fully anticipated and information given in any Instruction Book. Information has been given in this book that will cover most installations. There has been provided in this book, schematics of all pertinent circuits of the Gates' BC-1J; photographs with symbols that tie into the various schematics and a complete electrical parts list.

In preparing the instruction book it has been recognized that the installation engineer undoubtedly is very familiar with general broadcast installation and operation procedures, and that many of the things referred to are well known to him. It is suggested therefore that the installation engineer, and likewise, the personnel who will operate the transmitter, not only familiarize themselves with the Instruction Book, as provided, but more important, with the Transmitting equipment itself.

The Gates Radio Company, in designing the BC-1J Transmitter, has done everything possible to provide for you, the finest equipment. It is not possible for us to provide the location, the ground system and in some instances the other accessories that will be used with this equipment. Because of this, certain things must be left for the installing engineer to do, and certain analysis of problems must be made. In every instance the use of good engineering practices and sound fundamental reasoning will develop the desired high quality result possible from this equipment.

It is repeated again, make a good installation, eliminate hasty methods, in doing so, you will keep future outages to a minimum. Also remember that cleanliness and good maintenance of your broadcast equipment will pay big dividends. Set aside a certain period of time each week for cleaning the inside and outside of the equipment, for testing tubes, making sure all connections are tight and the many other things that can be titled "Good Maintenance". In case of problems that arise in the use of this equipment, please feel free to contact the Engineering Department of Gates Radio Company, who will gladly co-operate with you in every way to obtain the most satisfactory operation of your Gates equipment for the present and in the future.

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SECTION IX—QUESTIONS AND ANSWERS

It is realized by the Gates Radio Company that when installing a new transmitter and especially a completely new radio station, that certain problems arise that at times become perplexing. As the radio transmitter is the only device that can indicate trouble, often times troubles in transmission lines, tower tune-up, etc., will be incorrectly attributed to the transmitter. The following questions are a digest of those most often heard and corrected for our customers. They may help you if you have one or more similar problems.

1. My transmitter arrived with a broken part. How do I handle this?

Ans.— Your equipment has been shipped in approved shipping boxes and by recognized transportation carriers. Call the delivering carrier at once. He will inspect and note your bill of lading as to the damage. You may then order the needed part and bill the delivering carrier for it when you receive the Gates' invoice.

2. Is breakage covered by the guarantee?

Ans.— Only when breakage results from actual operating conditions. Breakage in transportation is the transportation company's liability.

3. The equipment works well but the voltage regulation of the power supply exceeds the 5% allowed by F.C.C. Is this a faulty power supply?

Ans.— No indeed. We suggest placing an A.C. voltmeter across the main power lines. Check the voltage with no modulation. Then recheck with 90% (sine wave) modulation. You will find a lower line voltage under modulation than with no modulation which simply indicates the power source to the transmitter is the offender. This may mean too small wires, too small a pole transformer supplied by the utilities company, or in rare instances, both. Poor regulation can be caused by other things too. Improper tuning of the antenna load is one. Improper neutralization another.

4. I have an intermittent in the transmitter at times it will act normal, other times output power will drop off, plate current will go high and cause transmitter to kick off?

Ans.— The process of elimination is important here. Check all connections to terminal boards. Make sure all tubes are O.K. Watch the PA grid current. If it fails, the transmitter will automatically go off due to operation of under-

current grid relay, E6. This would indicate trouble in the oscillator, 1st IPA or 2nd IPA. Is crystal working satisfactory?

5. The power amplifier cannot be tuned to resonance.

Ans.- The power amplifier tank padding condenser, C31, C32 and C33, are mica and very infrequently partially open or short due to their inner construction. The condenser capacity could change in such a way as to make the P.A. untunable, with the original amount of inductance.

The load has changed considerably making it impossible to find P.A. resonance.

The rolling contact on L12, main P.A. inductor, is defective.

6. Plate contactor, E2, closes, but no high voltage to P.A. or modulators.

Ans.- Bad contacts on E2, plate relay. Check for burned, or misaligned contacts. If bad, they should be replaced.

Check connections to power transformer, T11. Should show approximately 230V.

Check main rectifier, filaments should be lighted and plate caps on. If bad, replace.

Open filter choke.

7. Everytime the plate start button is depressed, a main fuse will blow.

Ans.- Fuse rating too small, use 30 amp.

Arc-back in 8008 rectifier tubes. Best solution, replace tubes.

Look for frayed wires.

Shorted power component, or filter unit. All chokes and condensers should be checked, chokes for shorts to ground, condenser for shorts. Replace defective unit.

8. Transmission is not up to standard, sounds bad.

Ans.- This can be caused by many things.

Over-modulation is a cause of poor quality. Watch the levels. Be sure modulation monitor is adjusted correctly.

Defective tubes, showing up particularly in the audio section.

Improper voltages in the audio system, caused either by defective component or bad rectifier tubes.

Power amplifier out of neutralization.

Bad audio signal being fed into transmitter.

One side of push-pull audio system becoming in-operative through any cause.

Feedback resistor opening up.

R.F. getting into the audio system.

Loss of filter, causing A.C. hum to rise.

9. The transmitter plate relay will not hold in.

Ans.- The plate relay, E2, coil is in series with the door interlock switch, S6, the master relay, E3, time delay relay, E7, and the bias undercurrent relay, E6. If any of these relays are not properly closed, it will be impossible to energize this plate relay.

If the contactor can be energized but drops out immediately, this indicates an overload, possibly in the modulator or power amplifier. If such is the case, the overload relay involved will energize causing the master relay to operate, which opens the holding contacts of the plate start relay.

~~10. Have extremely high plate voltage from the main rectifier.~~

Ans.- Check the D.C. resistance of the input swinging choke, L22. This will measure in the neighborhood of 30 ohms. If this choke is shorted, terminal to terminal, the filter system would have condenser input and voltage would be extremely high.

11. The modulator overload relay, E4, energizes each time the plate start button is depressed.

Ans.- This would indicate trouble in the modulator or in its bias supply.

Check bias voltage on each grid of 833A modulator. This should read approximately 65 volts negative. If no voltage, check bias rectifier tube, V17.

Check 833A modulator tubes for possible short.

Check bias adjustment resistors R66 and R67 for open arm.

12. The efficiency of the transmitter is low.

Ans. - The normal efficiency of the Gates BC-1J runs from 72% to 75%. If the apparent efficiency is low, first check the indicating plate meters. They can be reading high. The antenna meter can be reading low. Check by substitution.

If the efficiency is actually low, possibly the antenna resistance has gone up. This happens slowly over a period of time. A recheck of the antenna resistance is suggested.

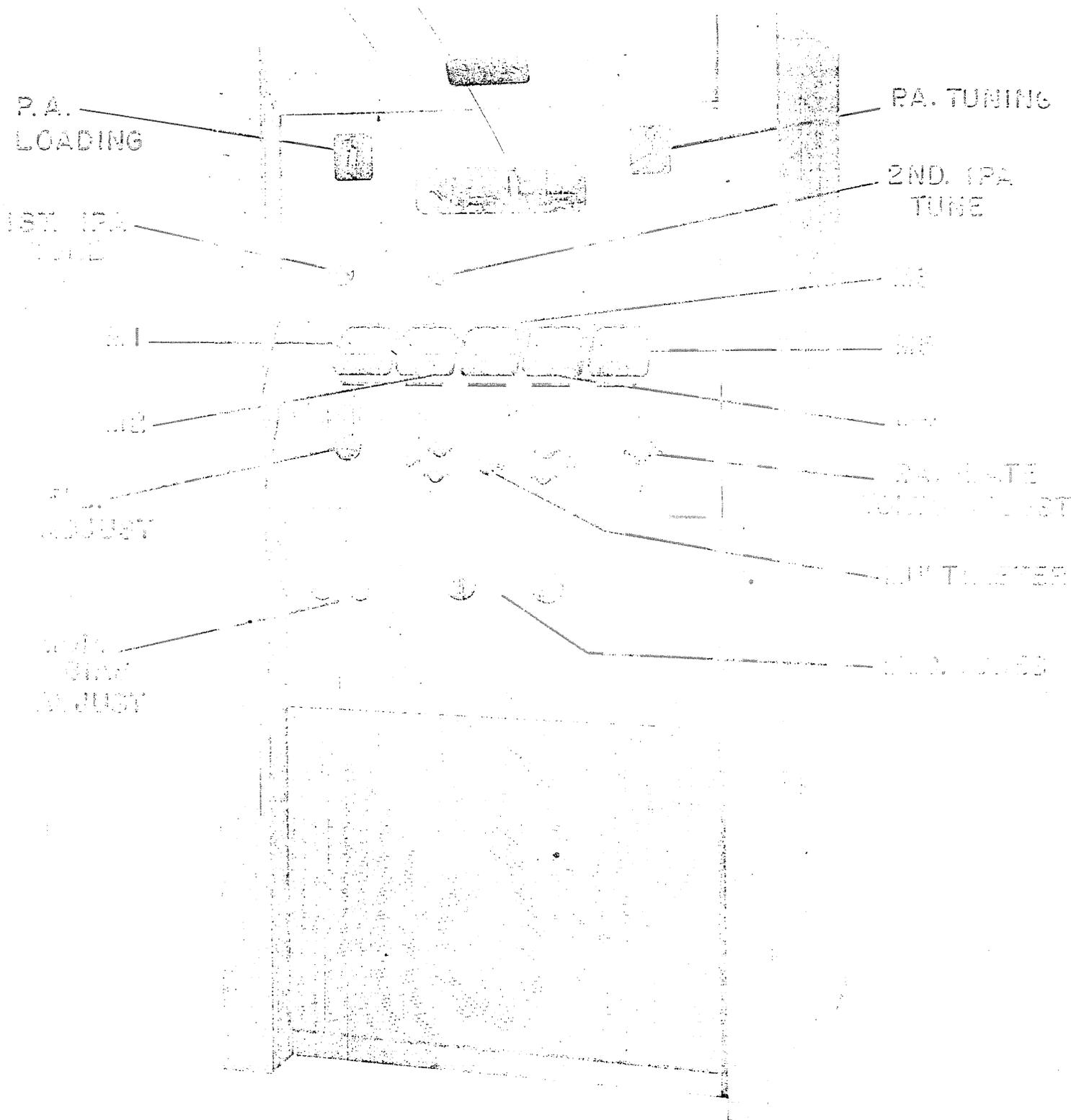
Check grid drive - should be between 100 and 140 mA.

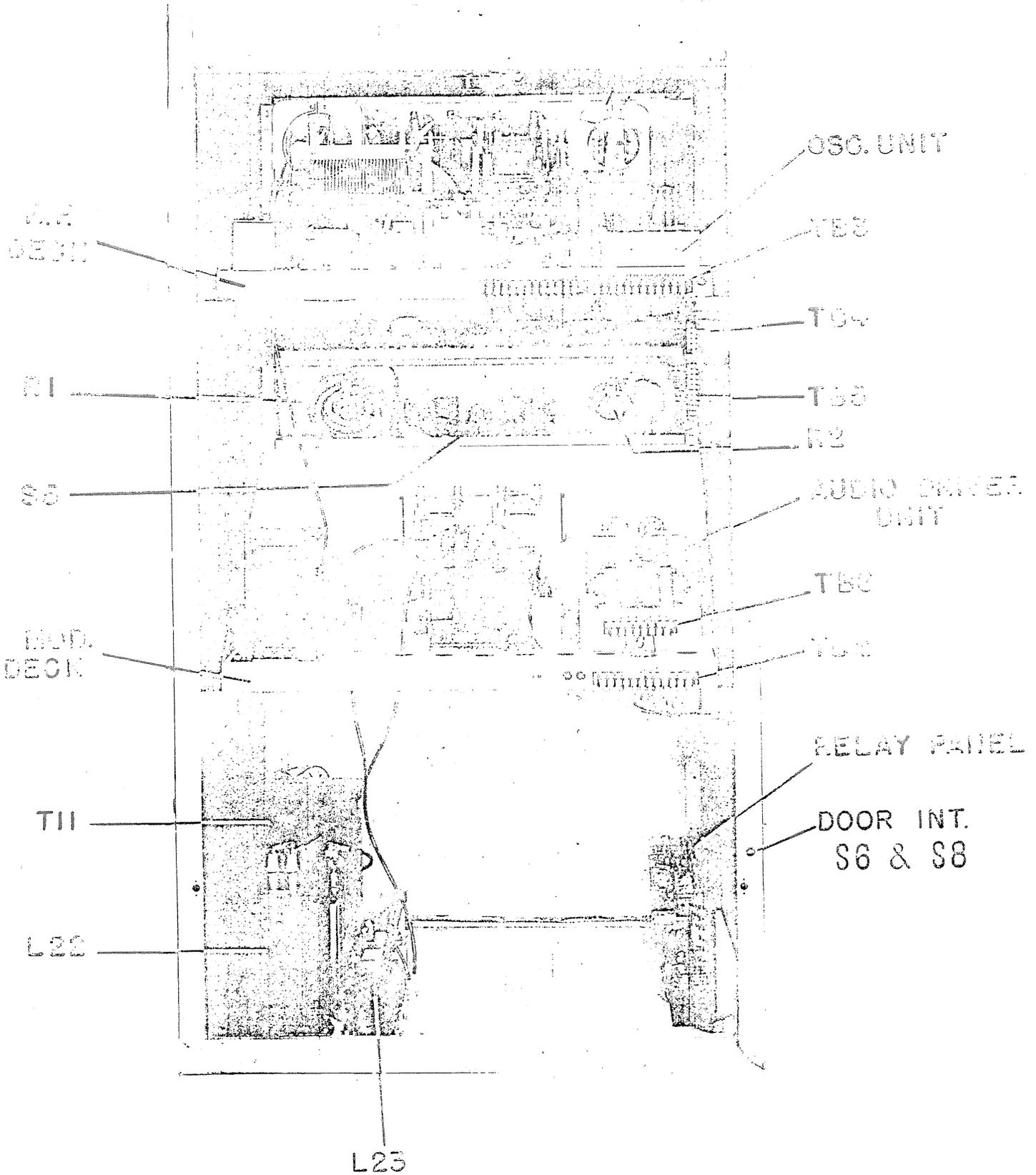
Check the P.A. tuning. One side of resonance will give more output than the other. Tune in this manner.

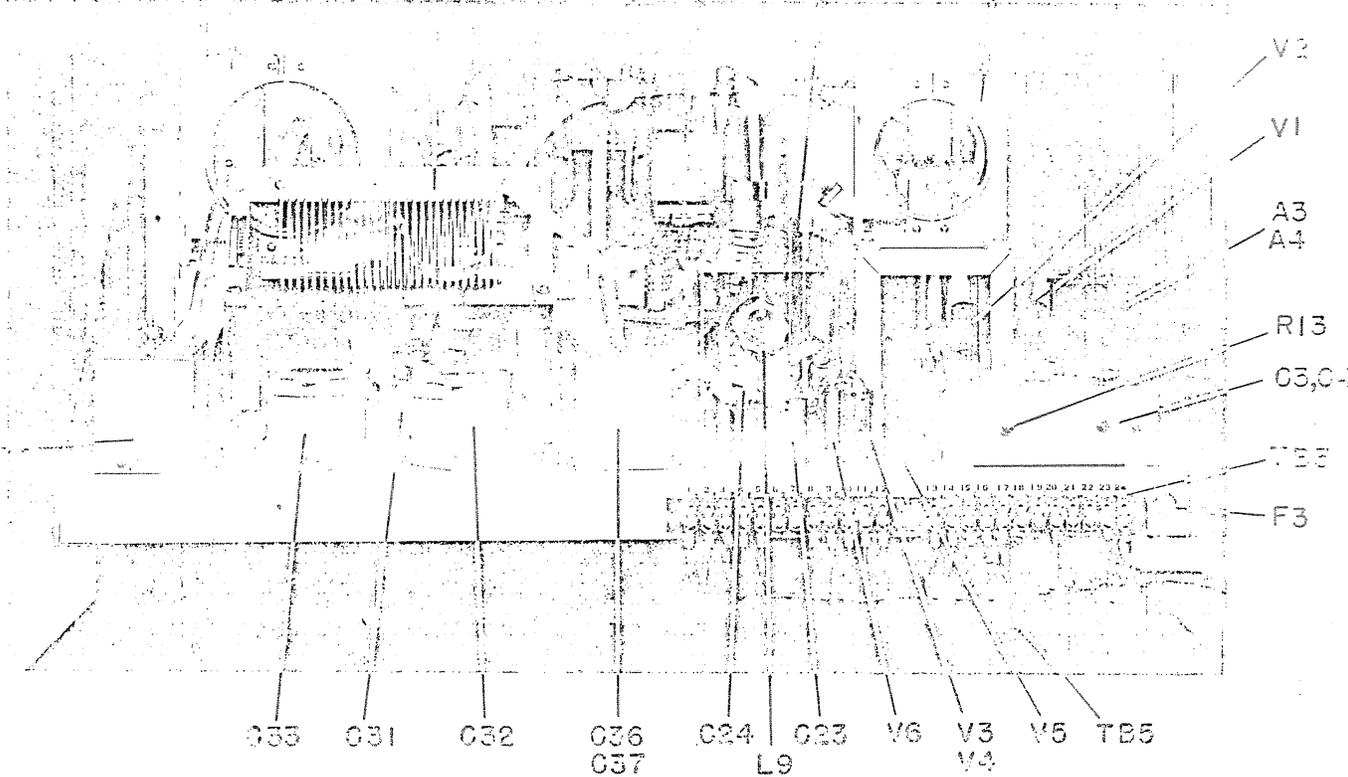
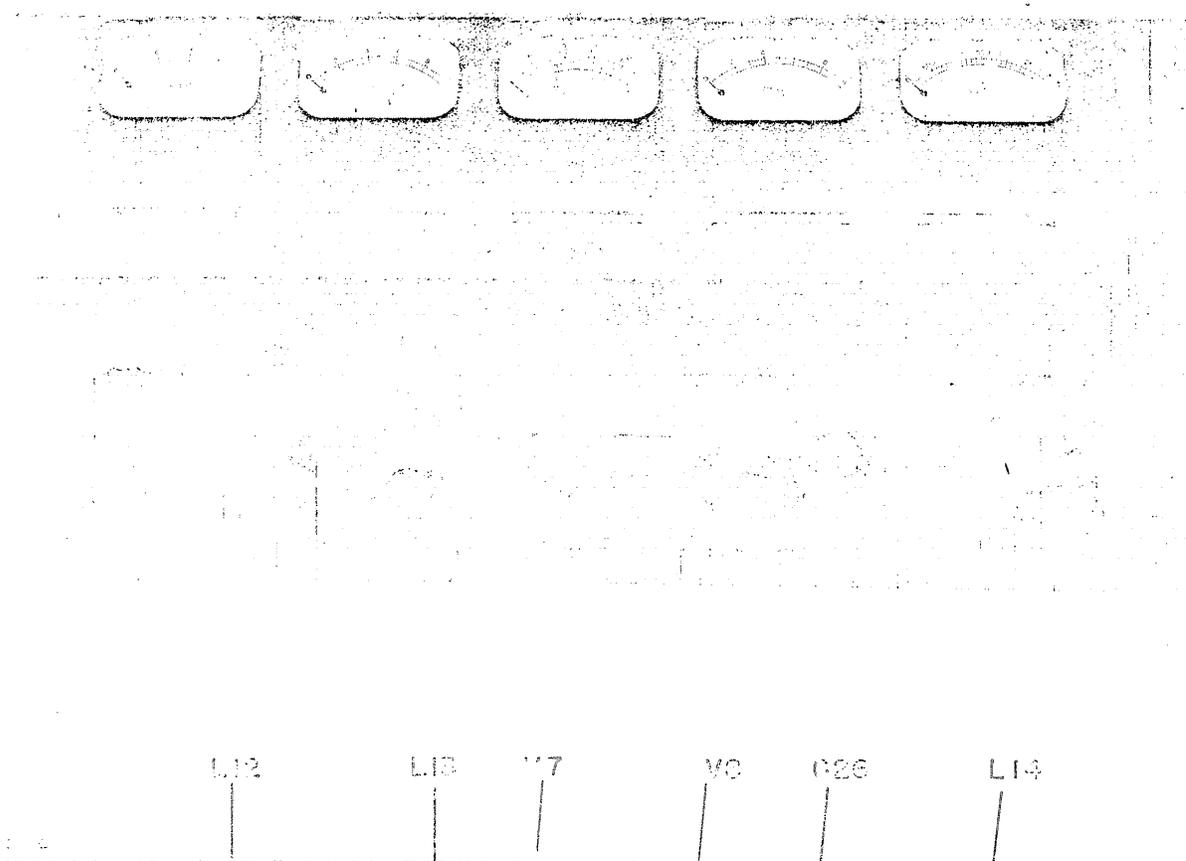
Check the tubes, substitute known good ones.

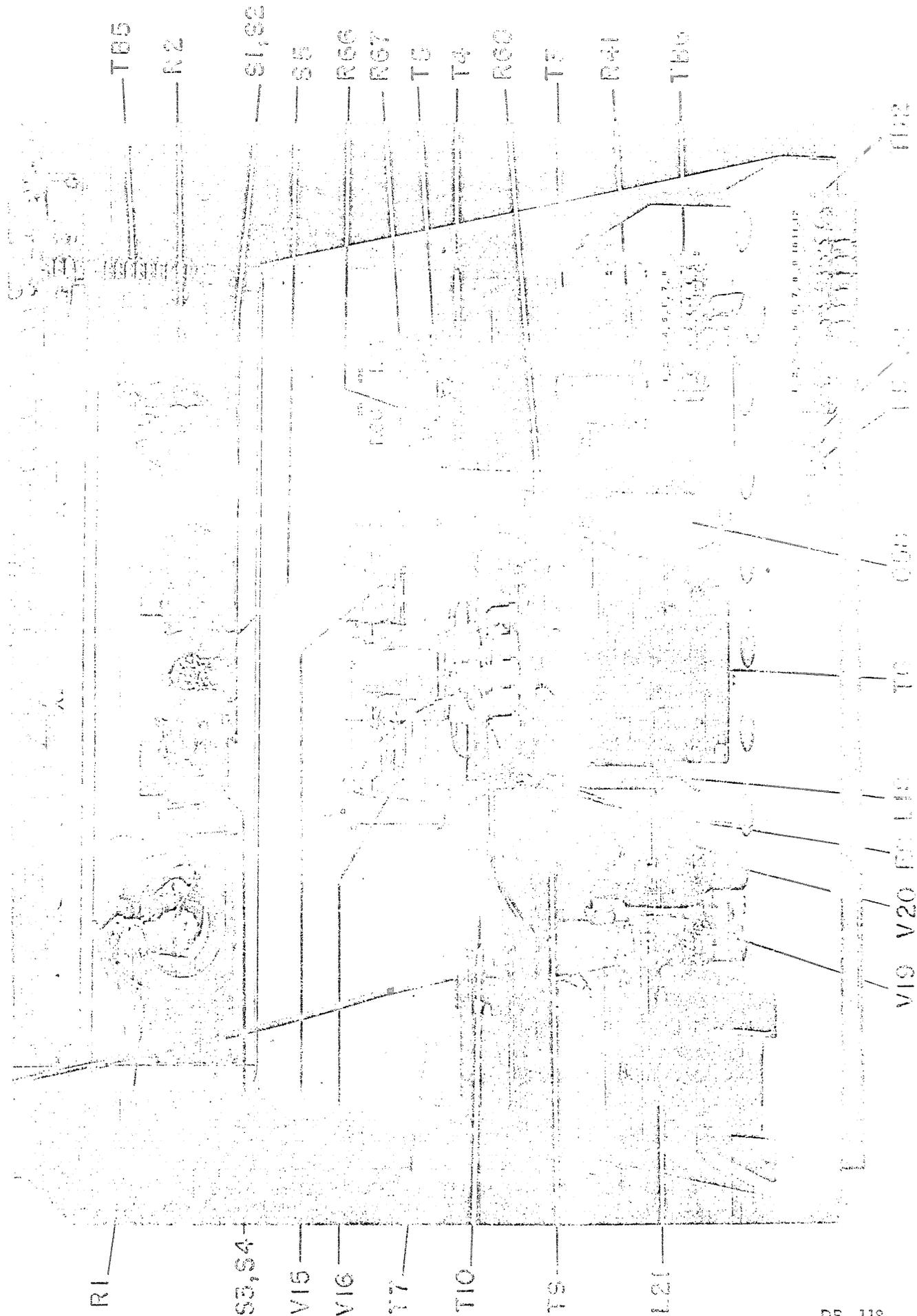
ORDERING REPLACEMENT PARTS

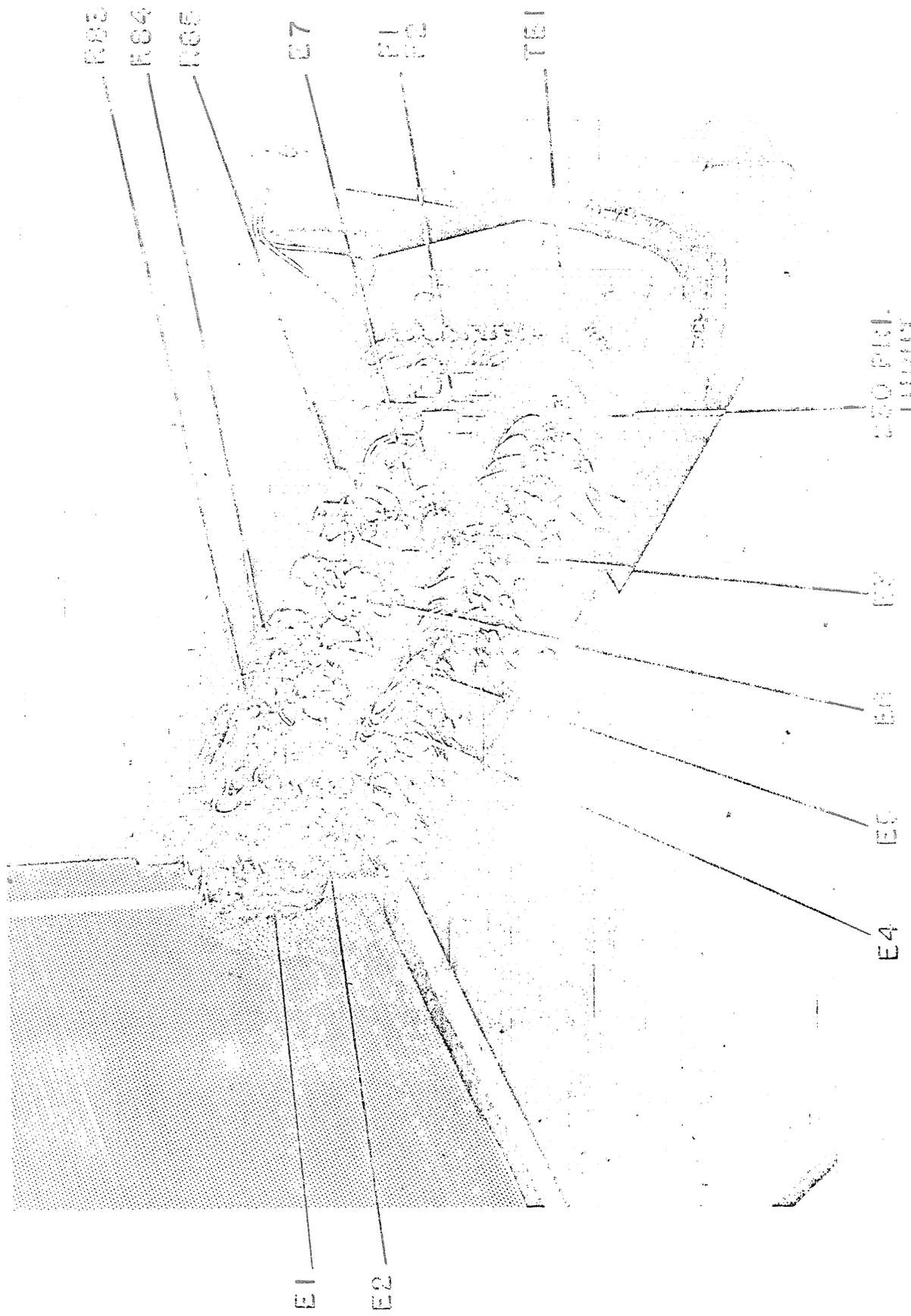
When ordering a replacement component please refer to the parts list in this instruction book. Identify the component by its symbol number, and if possible, its Gates Drawing number. The type of equipment in which the part is used is also necessary. This procedure will insure the customer receiving the correct component and at the earliest possible date.











250 P.M.
 100 P.M.
 50 P.M.

ELECTRICAL PARTS LIST FOR BC-1J, BC-500K, AND BC-250L

RADIO FREQUENCY DECK

<u>Symbol No.</u>	<u>Dwg. No.</u>	<u>Description</u>
A3		Crystal & Oven
A4		Crystal & Oven
A5		Fuseholder
C1		Capacitor, .1 mfd.
C2		Capacitor, .1 mfd.
C3		Variable Capacitor, 20 mmfd.
C4		Variable Capacitor, 20 mmfd.
C5		Capacitor, 150 mmfd.
C6		Capacitor, 680 mmfd.
C7		Capacitor, .005 mfd.
C8		Capacitor, .005 mfd.
C9		Capacitor, 47 mmfd.
C10		Capacitor, .01 mfd.
C11		Capacitor, .01 mfd.
C12		Capacitor, .0022 mfd.
C13		Capacitor, .0001 mfd.
C16		Variable Capacitor, 300 mmfd.
C17		Capacitor, 270 mmfd.
C18		Capacitor, .005 mfd.
C19		Capacitor, .005 mfd.
C20		Capacitor, .01 mfd.
C21		Capacitor, 1 mfd.
C22		Capacitor, .01 mfd.
C23	2653-PM-101	Capacitor Kit
C24		Variable Capacitor, 251 mmfd.
C25		Capacitor, .0022 mfd.
C26	C-19180-101	Neutralizing Capacitor Assembly (BC-1J and BC-250L)
C26	C-19180-102	Neutralizing Capacitor Ass'y (BC-500K)
C27		Capacitor, .03 mfd.
C28		Capacitor, .03 mfd.
C29		Capacitor, .001 mfd.
C30		Capacitor, .002 mfd.
C31		P.A. Tank Capacitor, .00025 mfd.
C32		P.A. Tank Capacitor, .00025 mfd.
C33		P.A. Tank Capacitor, .0005 mfd.
C34		Input Loading Capacitor, .003 mfd.
C35		Input Loading Capacitor, .003 mfd.
C36		Output Loading Capacitor, .003 mfd.
C37		Output Loading Capacitor, .003 mfd.
C64, C65, C66, C67, C68		Cap., .01 mfd.
F3		Fuse, 3 amp.
L1		RF Choke, 2.5 MH
L2		RF Choke, 2.5 MH
L3		RF Choke, 2.5 MH

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e.l.o

<u>Symbol No.</u>	<u>Dwg. No.</u>	<u>Description</u>
L4	A-10381-101	First IPA Plate Coil, Gates
L5		RF Choke, 5 MH
(L6 & L7)	A-10486-101	Parasitic Suppressor Assembly
L8	A-10387-101	RF Choke (6146 Plate Assembly) Gates
L9	C-19181-101	Second IPA Plate Coil Assembly
L10	C-16466-102	PA RF Choke Assembly, Gates
L11		RF Choke
L12	105VB3735	PA Tank Variable Coil, Gates
L13	26FB2843	Output Coil, Gates
L14	30VB2344	Output Variable Coil, Gates
L15	A-10391-101	Mod. Mon, Pickup Coil, Gates
L16	C-19182-101	PA Parasitic Suppressor Assembly
L17	C-19182-101	PA Parasitic Suppressor Assembly (BC-1J, BC-250L)
R3		Meter Multiplier Assembly
R4		Resistor, 51K ohm
R5		Resistor, 470 ohm
R6, R 5A		Resistor, 20 ohm
R7		Resistor, 33K ohm
R8		Resistor, 27K ohm
R9		Resistor, 35K ohm
R10		Resistor, 33K ohm
R11		Resistor, 330 ohm
R12, R12A		Resistor, 200 ohm
R13		Control, 50K ohm
R14		Resistor, 51K ohm
R15		Resistor, 8000 ohm
R16		Resistor, 27K ohm
R17, R17A		Resistor, 20 ohm
R18		Resistor, 47 ohm (Part of L6 Parasitic)
R19		Resistor, 47 ohm (Part of L7 Parasitic)
R20, R20A, R20B		Resistor, 3 ohm
R21		Resistor, 100K ohm
R22		Resistor, 56 ohm
R23		Resistor, 20K ohm
R24		Resistor, 5000 ohm
R25, R25A, R25B		Resistor, 3 ohm
R26		Resistor, 51K ohm
R27		Resistor, 27K ohm
R28		Resistor, 5000 ohm
R29		P.A. Parasitic Resistor
R30		P.A. Parasitic Resistor
R90		Resistor, 47 ohm
S7		Crystal Selector Switch, D.P.D.T.
T1	AF-10461K	Crystal Filament Transformer
T2	AF-10460K	Filament Transformer
TB3		Terminal Board
TB8		Terminal Board

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BC-1J/BC-500K/BC-250L

<u>Symbol No.</u>	<u>Dwg. No.</u>	<u>Description</u>
V1		Oscillator Tube, 6AG7
V2		First IPA Tube, 6AG7
V3		Second IPA Tube, 6146
V4		Second IPA Tube, 6146
V5		Regulator Tube, OB2
V6		Clamper Tube, 6AQ5
V7)		833A Tubes used in BC-1J
V8)		
V7 (only)		833 A Tube used in BC-500K
V7)		810 Tubes used in BC-250L
V8)		
X1		Oscillator Socket
X2		First IPA Socket
X3		Second IPA Socket
X4		Second IPA Socket
X5		Regulator Socket
X6		Clamper Socket
(X7 & X8)	D-21627-101	Dual PA Tube Socket Assembly, Gates (BC1J)
X7	D-21627-103	PA Tube Socket Ass'y Gates (BC-500K)
(X7 & X8)	C-19201-101	Dual PA Tube Socket Ass'y Gates (BC-250L)
X24		Crystal Socket
X25		Crystal Socket

MODULATOR DECK

A6		Fuseholder
A7		Fuseholder
C38		Capacitor, .5 mfd.
C39		Capacitor, .5 mfd.
C40		Capacitor, .5 mfd.
C41		Capacitor, .5 mfd.
C42		Capacitor, .5 mfd.
C43		Capacitor, .5 mfd.
C44		Capacitor, .5 mfd.
C45		Capacitor, 20 mfd.
C46		Capacitor, .5 mfd.
C47		Capacitor, 20-20 mfd.
C48		Capacitor, 20-20 mfd.
C49		Capacitor, .0025 mfd.
C50		Capacitor, .0025 mfd.
C51		Capacitor, .0025 mfd.
C52		Capacitor, .0025 mfd.
C53		Capacitor, 20 mfd.
C54		Capacitor, 20 mfd.
C55		Capacitor, 20-20 mfd.
C56		Capacitor, 20-20 mfd.

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<u>Symbol No.</u>	<u>Drawing No.</u>	<u>Description</u>
C57		Capacitor, 10 uf.
C58		Audio Coupling Cap., 1 uf.
C61		Variable Trimmer Cap., 20-125 uuf.
C62, C63		Capacitor, .01 uf.
E8		Time Delay Relay
F4		Fuse, 5 amp.
F5		Fuse, 5 amp.
L18		Bias Supply Filter Reactor
L19		350V. Supply Filter Reactor
L20		350 V. Supply Filter Reactor
L21	476 0243 000	Modulation Reactor (BC-1J)
L21	AG-10650E	Modulation Reactor (BC-500K)
L21		Modulation Reactor (BC-250L)
R31 thru R38		Resistor, 75K ohm
R39, R45		Resistor, 10K ohm
R40, R44		Resistor, 820 ohm
R41	A-3404-8	Control, 1,000 ohms
R42, R43		Resistor, 1300 ohm
R46, R47, R48, R49		Resistor, 51K ohm
R50, R57		Resistor, 62K ohm
R51, R56		Resistor, 8200 ohm
R52, R55		Resistor, 75K ohm
R53, R54		Resistor, 1.0K ohm
R58, R59, R62, R63		Resistor, 4700 ohm
R60, R61		Resistor, 8000 ohm
R64, R65		Resistor, 20 ohm
R66, R67		Rheostat, 1,000 ohm
R68		Resistor, 250 ohm

<u>Symbol No.</u>	<u>Dwg. No.</u>	<u>Description</u>
R69		Resistor, 62K ohm
R70		Resistor, 100K ohm
R71		Resistor, 75K ohm
R72		Resistor, 27K ohm
R73		Resistor, 2.2 megohm
R74		Resistor, 2.2 megohm
R75		Resistor, 2.2 megohm
R76		Resistor, 2.2 megohm
R77		Resistor, 47K ohm
R78		Resistor, 2.2 megohm
R79		Resistor, 2.2 megohm
R80		Resistor, 2.2 megohm
R81		Resistor, 2.2 megohm
R82		Resistor, 47K ohm
R91		Resistor, 6000 ohm
T3	AI-3002	Input Transformer
T4		Driver Transformer
T5		Driver Transformer
T6	AM-30469E	Modulation Transformer (BC-1J)
T6	AM-10649E	Modulation Transformer (BC-500K)
T6		Modulation Transformer (BC-250L)
T7	AP-30097K	Power Transformer
T8	AF-10463K	Dual Filament Transformer
T9		Bias Transformer
T10	AF-10460K	Filament Transformer
TB2		Terminal Board
TB6		Input Terminal Board
TB7		Output Terminal Board
TB9		Terminal Board
V9		Tube, 6SN7GTA
V10		Tube, 6SN7GTA
V11		Audio Driver Tube, 1622/5881
V12		Audio Driver Tube, 1622/5881
V13		Audio Driver Tube 1622/5881
V14		Audio Driver Tube, 1622/5881
V15)		
V16)		Modulator Tube, 833A used in BC-1J/BC500K
V15)		
V16)		810 Tubes used in BC-250L
V17		Bias Supply Tube, 5R4GY
V18		350V. Supply Tube, 5R4GY
V19		550V. Supply Tube, 5R4GY
V20		550V. Supply Tube, 5R4GY

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-5-

BC-1J/BC-500K/BC-250L

<u>Symbol No.</u>	<u>Dwg. No.</u>	<u>Description</u>
X9		Turret Socket
X10		Turret Socket
X11		Socket
X12		Socket
X13		Socket
X14		Socket
(X15&X16)	D-21627-102	Dual Modulator Tube Socket Assembly (BC-1J/BC-500K)
(X15&X16)	C-19201-102	Dual Modulator Tube Socket Assembly (BC-250L)
X17		Socket
X18		Socket
X19		H.V. Socket
X20		H.V. Socket
X26		Socket, (For Time Delay, E8)

CONTROL PANEL

A1		Filament Pilot Light Assembly (Green)
A2		Plate Pilot Light Assembly (Red)
A8		Pilot Lamp
A9		Pilot Lamp
R1		Power Rheostat, 400 ohms (BC-1J/BC-500K)
R2		Filament Rheostat, 7.5 ohms (BC-1J, BC-500K)
R1		Power Rheostat, 1000 ohms (BC-250L)
R2		Filament Rheostat, 16 ohms (BC-250L)
R95, R96		Resistor, 3000 ohms
S1		Filament Start Pushbutton Switch (Black)
S2		Filament Stop Pushbutton Switch (Red)
S3		Plate Start Pushbutton Switch, (Black)
S4		Plate Stop Pushbutton Switch (Red)
S5		Multi-Meter Switch

METER PANEL

M1		Filament Voltmeter, 0-15-V. A.C.
M2		Modulator Plate Meter, 0-1 amp. in BC-1J, 0-500 MA in BC-500K and BC-250L
M3		Multi-meter, 0-1 MA D.C. Movement with 0-30; 0-300 MA D.C. Scale
M4		P.A. Plate Meter, 0-1 amp. in BC-1J 0-500 MA in BC-500K and BC-250L
M5		P.A. Plate Voltmeter, 0-3000 V. D.C. in BC-1J and BC-500K, 0-2500 V. D.C. in BC-250L
R89	A-10534-101	Multimeter Series Resistor Assembly

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BC-1J/BC-500K/BC-250L

RELAY PANEL

<u>Symbol No.</u>	<u>Dwg. No.</u>	<u>Description</u>
E1		Filament Contactor
E2		Plate Contactor
E3		Master Overload Relay
E4		Modulator Overload Relay
E5		P.A. Overload Relay
E6		Grid Undercurrent Relay
E7		Time Delay Relay
F1		Cartridge Fuse, 30 amp.
F2		Cartridge Fuse, 30 amp.
R83		Adjustable Resistor, 5 ohm
R84		Adjustable Resistor, 5 ohm
R85		Resistor, 6000 ohm
TB1		Terminal Studs (Part of Mechanical Ass'y)
X23		Time Delay Relay Socket

CABINET ASSEMBLY

B1		Ventilating Fan
C59		Input Filter Capacitor, 8 mfd.
C60		Output Filter Capacitor, 2 mfd.
L22	AC-10458E	Input Swinging Choke (BC-1J)
L23	AC-10457E	Output Smoothing Choke (BC-1J)
(L22 & L23)	C-19199-101	Filter Choke Ass'y (BC-500K, BC-250L)
R86		Fan Dropping Resistor, 500 ohm
R87		Fan Dropping Resistor, 750 ohm
R88		Bleeder Resistor, 100K ohm
R89, R90		PA Dropping Resistor, 3500 ohm, 160M
S6		Door Interlock Switch
S8		Door Interlock Switch
T11	AP-10459E	Power Transformer (BC-1J)
T11	AP-12001E	Power Transformer (BC-500K)
T11	472-0524 000	Power Transformer (BC-250L) 814 8755 001
T12	AF-10456K	Rectifier Filament Transformer
TB4		Meter Terminal Board
TB5		Control Panel Terminal Board
TB1		Modulation Monitor Terminal Board
V21		Rectifier Tube, 8008
V22		Rectifier Tube, 8008
X21		Rectifier Socket
X22		Rectifier Socket

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-7-

BC-1J/BC-500K/BC-250L

Req.	C17	C23	C32	C33	C34	C35	C36	C37	L12 IND VHT	L12 TURNS APPROX	L13 IND VHT	L13 TURNS APPROX	L14 IND VHT	L14 TURNS APPROX	P.A. TUBE	F %
00	C17 not used on these freq.	C23 not used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33 not used on these freq.	C34, .003 used on all frequencies	C35 not used on these freq.	C36, .003 used on all frequencies	C37 not used on these freq.	20.2	16.3	3.5	10.6	3.18	7.5	12.5	160
50									22	16.9	3.95	10.9	3.5	7.9	11.9	155
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	24	17.7	4.35	11.5	3.8	8.2	11.4	150
50									25.5	18.3	4.85	12.1	4.15	8.55	11.1	145
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	27.3	18.8	5.15	12.5	4.2	8.6	10.8	140
50									29	19.4	5.5	12.9	4.7	9.1	10.4	135
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	31	20.2	6.1	13.6	5.1	9.6	10.2	130
50									33.5	21	6.5	14.0	5.4	9.75	10	125
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	36.5	21.8	7	14.5	5.85	10.3	9.4	120
50									40	22.8	8	15.5	6.4	10.6	9	115
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	43.5	23.8	8.8	16.4	6.95	11.1	8.6	110
50									48.5	25.2	10	17.4	7.7	11.7	8.2	105
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	53.5	26.4	11.1	18.3	8.45	12.2	8	100
50									59.5	27.8	13	19.8	9.3	12.8	7.5	95
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	67	29.6	15	21.2	10.4	13.5	7	90
50									75.2	31.3	18	23.3	11.4	14.2	6.4	85
00	C17, .00027 used on these freq.	C23, .0001 used	C31, .00025 & C32, .00025 always connected in parallel on all freq.	C33, .0005 connected in parallel with C31, C32	C34, .003 used on all frequencies	C35, .003 used on these freq. parallel with C34	C36, .003 used on all frequencies	C37, .003 used on these freq. parallel with C36	84	35.8	21.6	26.1	14.1	17.1	5.8	85
50									92	34.4	18.8	23.8	14.6	16	8.4	540

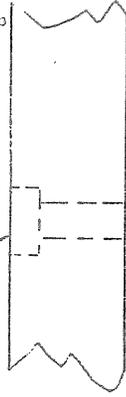
NOTE: A - C17, a .00027 mica used only on frequencies of 850 KC to 540 KC.
 B - C23, a F2 mica padder, not used on frequencies of 1600 KC to 1000 KC. From 1260 KC to 850 KC a .0001 mfd. used. From 900 KC to 720 KC a .00025 mfd., used. From 730 KC to 620 KC a .0004 mfd. is used. From 680 KC to 580 KC a .0005 mfd. is used. From 610 KC to 540 KC a .0006 mfd. is used.
 C - C31, a .00025 mica and C32, a .00025 mica always connected in parallel and used on all frequencies. C33, a .0005 mica paralleled with C31 & C32 on frequencies from 850 KC to 540 KC.
 D - C34, .003 mica and C36, .003 mica used as load condensers, 1600 KC to 660 KC.
 E - C34, .003 and C35, .003 used in parallel for frequencies 850 KC to 540 KC.
 F - C36, .003 and C37, .003 used in parallel for frequencies 850 KC to 540 KC.
 G - Short out R.F. choke L11 on Freq. 1200 KC and 540 KC use both L10 & L11 in series.

TUNING CHART BC-1J, 50/70 OHM OUTPUT
 Dwg. A-10860

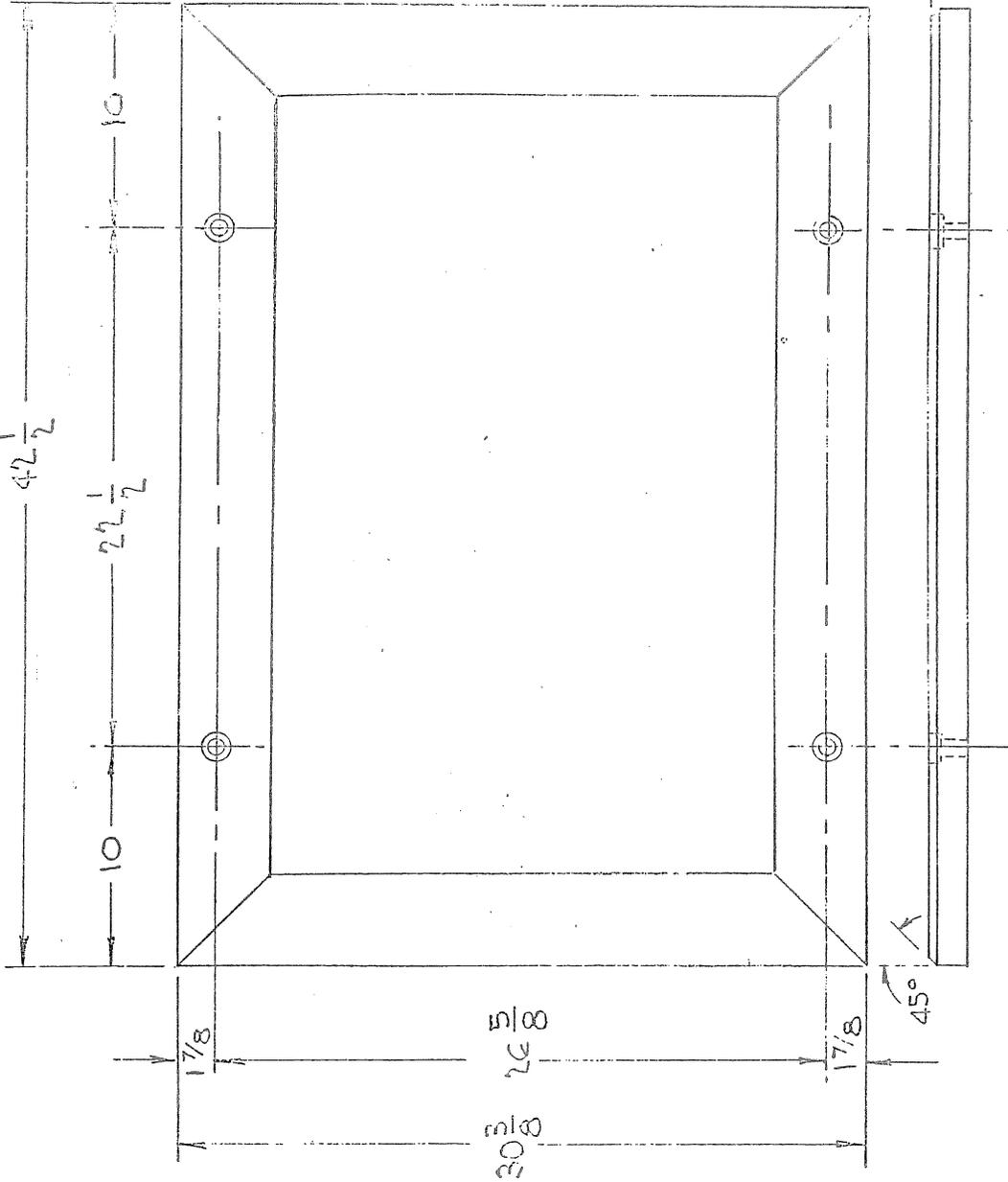
DRAWING NUMBER

A-10349

DRILL & CIR BOLT
TO CLEAR 1/2"
FOUNDATION BOLT



BOLT HOLE DETAIL



WOOD BASE FOR

BC-1J, BC-500K, BC-250L

2" X 4" MATL. YEL. PINE RUBBER FIN. BLACK

PART NO.

1

.75%

DRAWN BY A.W.C.

DATE 1-9-54

CHECKED BY F.W.W.

DATE

DWG. NO.

A-10349

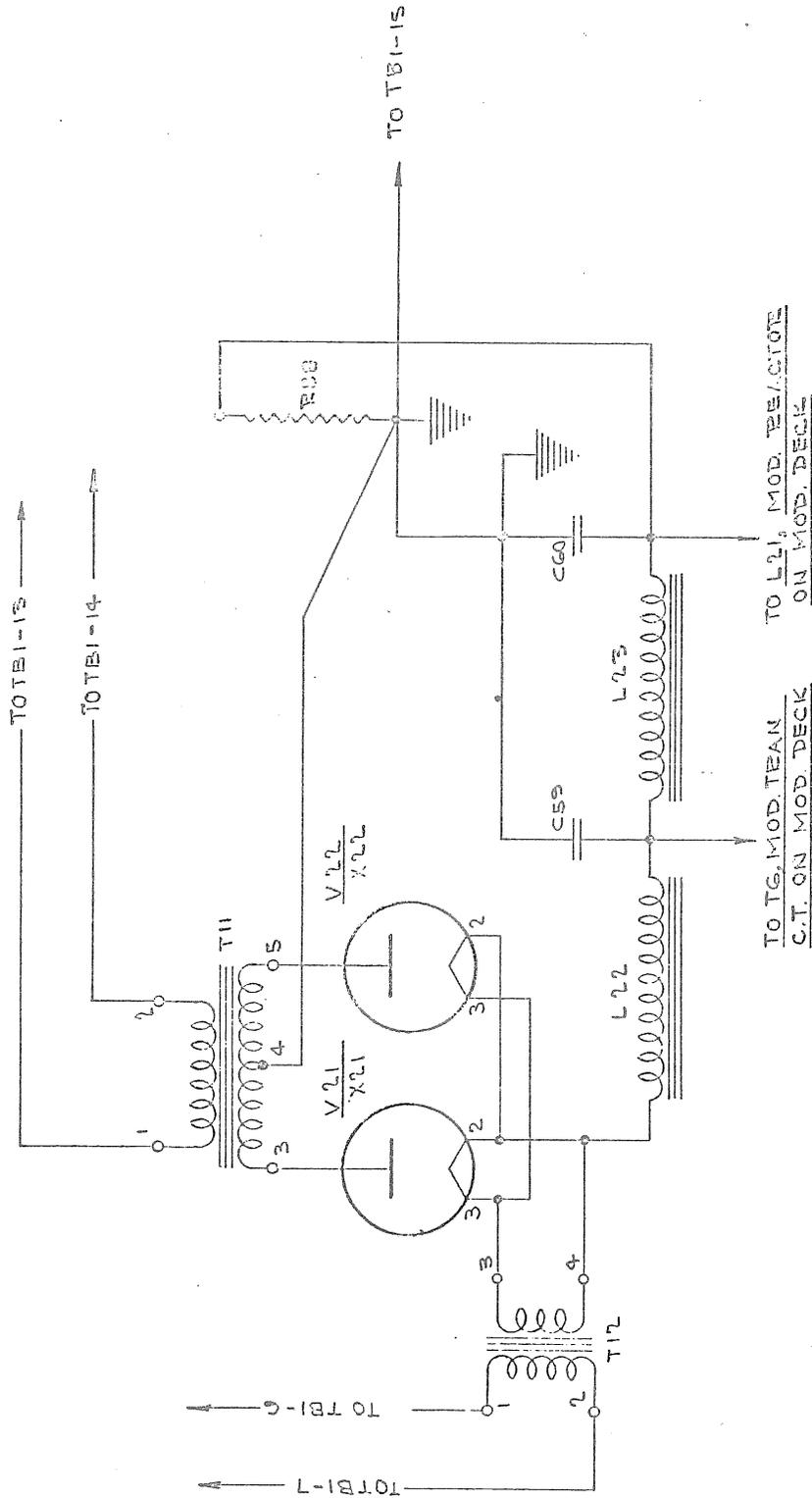
GATES RADIO COMPANY
QUINCY, ILLINOIS

SCALE 1/8" = 1"

Variations on Finished Dimensions unless otherwise marked.

Size Dimensions	Fractional Dimensions	Decimal Dimensions
Up to 1/4	± 1/128	± .005
Above 1/4 to 6	± 1/64	± .005
Above 6 to 24	± 1/32	± .010
Above 24	± 1/16	± .015

Drawing Number
B-13342



Values on Finished Equipment		Values on Parts	
Part	Value	Part	Value
Resistor	± 1/2%	Resistor	± 0.5%
Capacitor	± 10%	Capacitor	± 0.5%
Inductor	± 10%	Inductor	± 0.1%
Transformer	± 1%	Transformer	± 0.1%

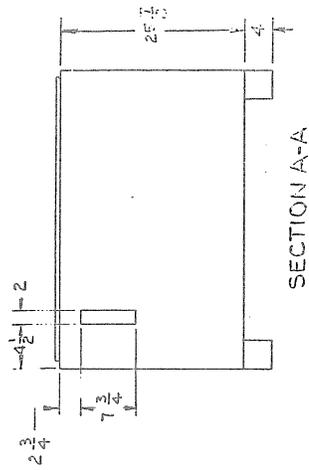
POWER SUPPLY SCHEMATIC
 BC-1U BC500K, BC-250L+HF1M

WASL. FIN. PART NO.
 DRAWN BY: *ACC* 15
 DATE: 2-1-55
 CHECKED BY: *WV*
 DATE: *WV*

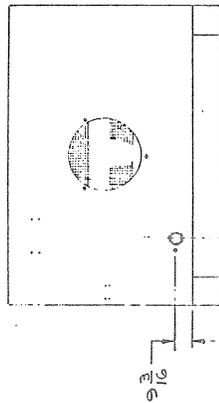
GATES RADIOS COMPANY
 CURETOWN, N. CAROLINA

DWG. NO. **B-13342**

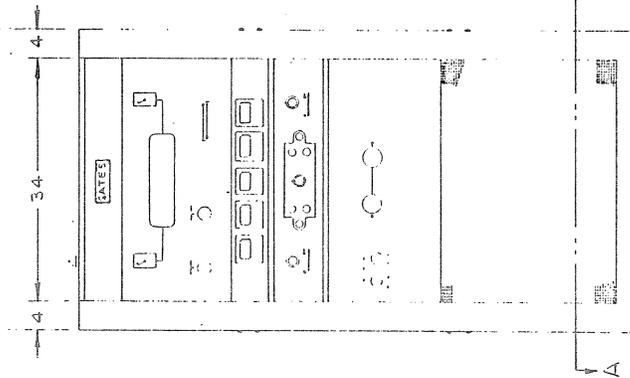
Bearing Part
C-1914-A



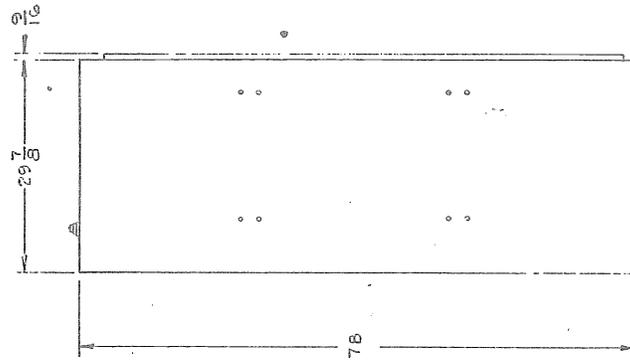
SECTION A-A



TOP VIEW



FRONT VIEW



SIDE VIEW



REAR VIEW

SCALE 1"=1"

Rev	Issued	By	Checked	Date
1	1/28	W. J. W.	W. J. W.	1/28
2	1/28	W. J. W.	W. J. W.	1/28
3	1/28	W. J. W.	W. J. W.	1/28
4	1/28	W. J. W.	W. J. W.	1/28
5	1/28	W. J. W.	W. J. W.	1/28

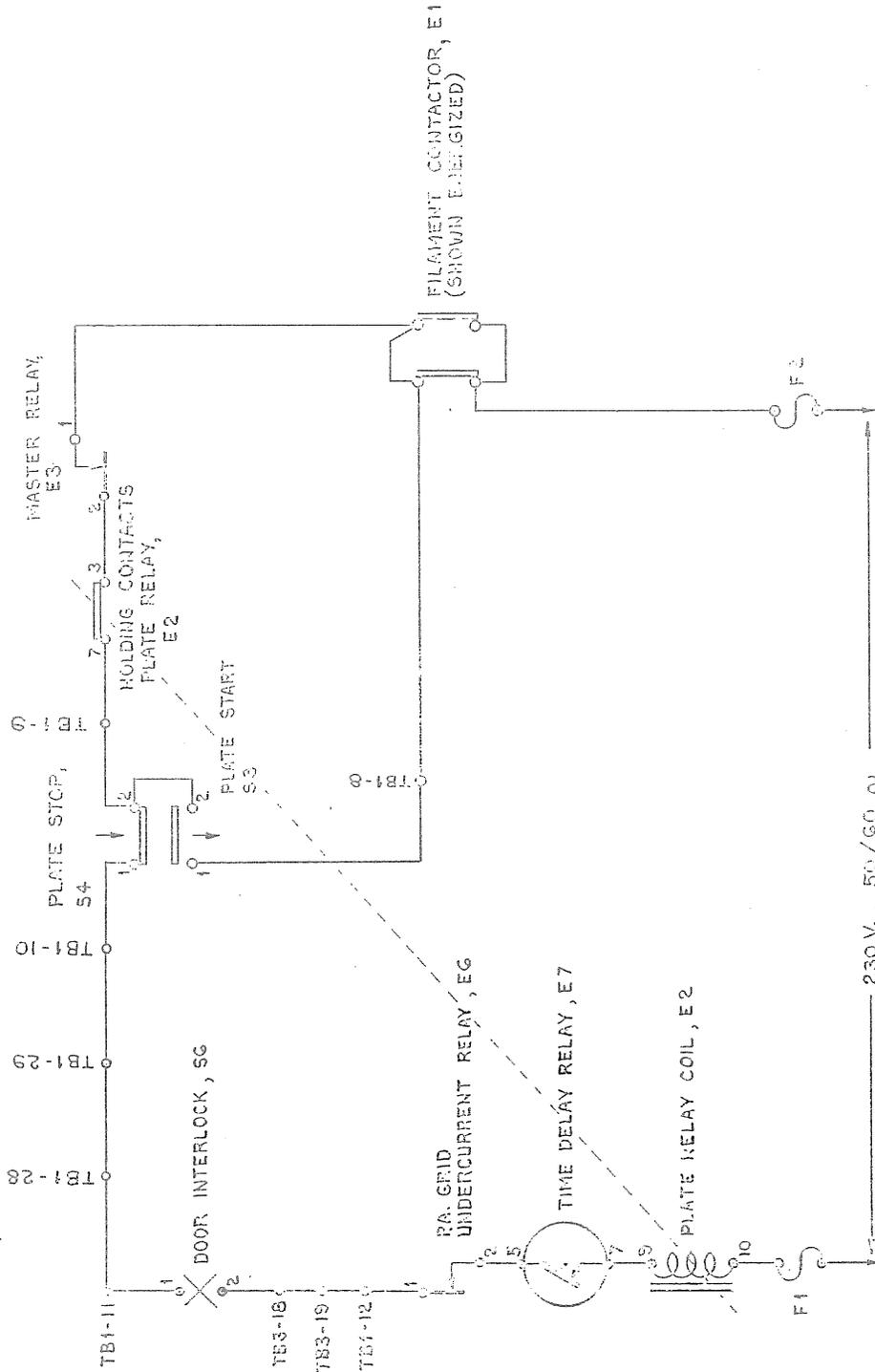
OUTLINE DIMENSIONS
BC-1J/BC500K/BC250L

MATERIAL: PHIL.
DESIGNED BY: W. J. W.
DATE: 1/28
CHECKED BY: W. J. W.
DATE: 1/28
GATES RADIO COMPANY
QUINCY, ILLINOIS

PART NO. C-1914-A
DWG. NO. C-1914-A

DRAWING NUMBER

13-13763



SIMPLIFIED CIRCUIT, PLATE RELAY START/STOP, BC11-M4915, BC5001-M5157 BC 250L 5.7	
UNLESS OTHERWISE SPECIFIED, ALL DIMENSIONS ARE IN INCHES.	
DESIGNED BY DATE 10/26/56	CHECKED BY DATE 10/26/56
ENG. APPROV. DATE 10/26/56	
GATES RADIO COMPANY GURNEE, ILLINOIS	
DRAWING NUMBER 13-13763	

4-12-00-1-00-1

GATES RADIO COMPANY
QUINCY, ILLINOIS

SHEET 2 of 2

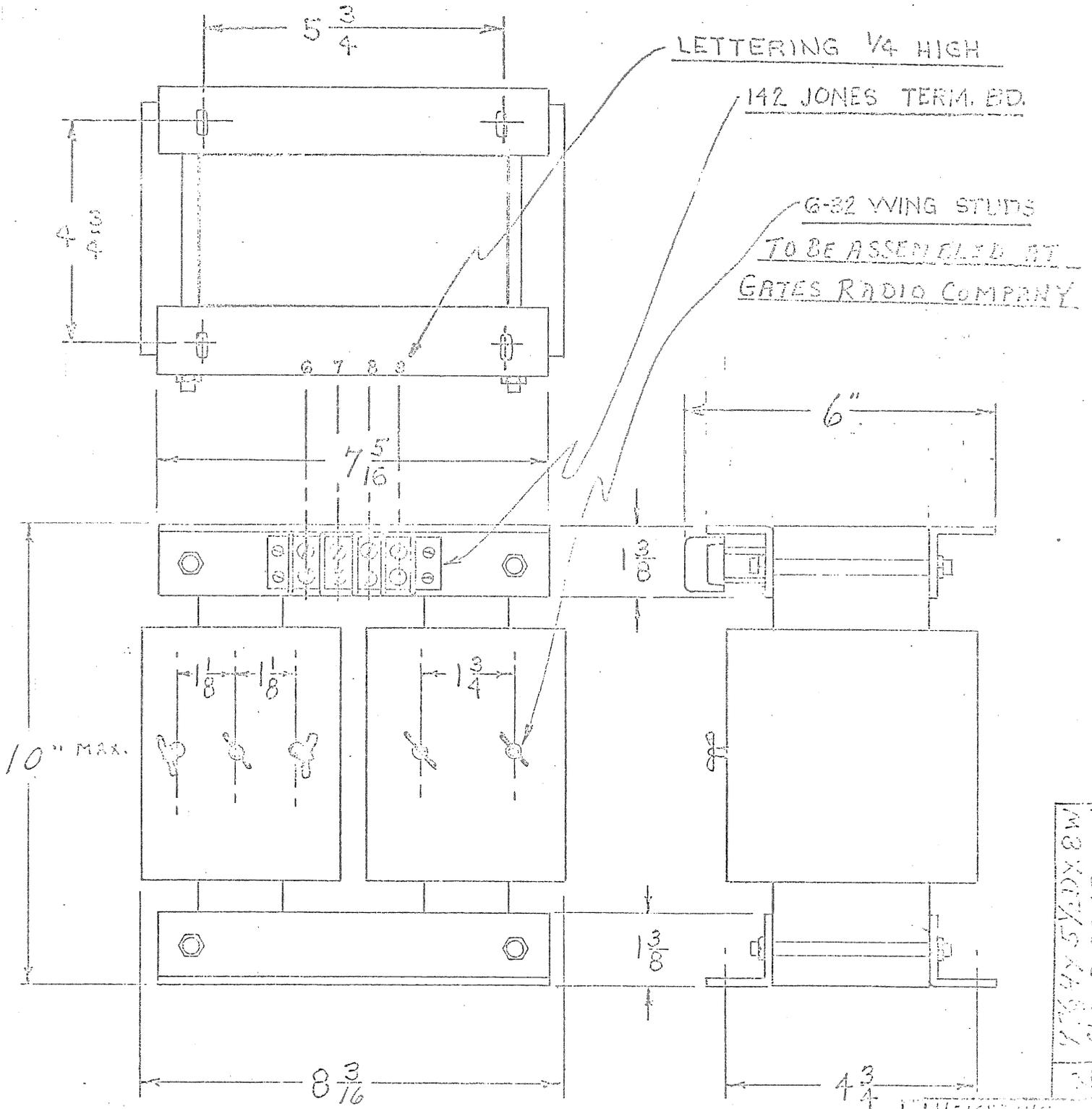
AM-30464E

SCALE 3/8

100	103	102	101	GR. MADE FOR
				NO.

LIST OF PARTS

QTY.	QTY.	QTY.	ITEM	REFERENCE	PT. OR G.N.	FIN.	DESCRIPTION	MATL.
------	------	------	------	-----------	-------------	------	-------------	-------



1/2" x 5/16" DIA. 8 W
 1/2" x 3/8" DIA. 6 W
 1/2" x 3/8" DIA. 6 W

CH. BY <i>W.C.</i>	MTL.
DATE <i>7/1/27</i>	
DR. BY <i>W.C.</i>	ENG.
DATE <i>10/28/27</i>	FIN.

TITLE MODULATION XFMR, BC 4T
1 KW AM XMITR M5393

UNLESS OTHERWISE SPECIFIED
ALL TOLERANCES PER GATE SPEC GDM102.
AM-30464E

TRANSFORMER CLASSIFICATION

MODULATION TRANSFORMER

SPECIFICATIONS ARE TO MIL-STD-20000 STANDARDS UNLESS OTHERWISE NOTED.

PRIMARY—To match P.P. 833A, Class B, Mod.
(Pri. P. to P., 8600 ohms.)

SECONDARY— #1 To match into 4750 ohms.
Max. operating level 700 watts.

#2 Tapped for 2, 4 and 8 watt.
To match 3000 ohm.

Freq. Response— .5 db, from 40 cycles to 15,000 cycles.

SHIELDING— None

TYPE OF CONNECTIONS— Coil Studs with wing screws.

HIPOT TEST (ALL VOLTAGES ARE RMS)

COIL TO COIL— 7500V. R.M.S.

PRIMARY TO CORE AND CASE— 10,000V. R.M.S.

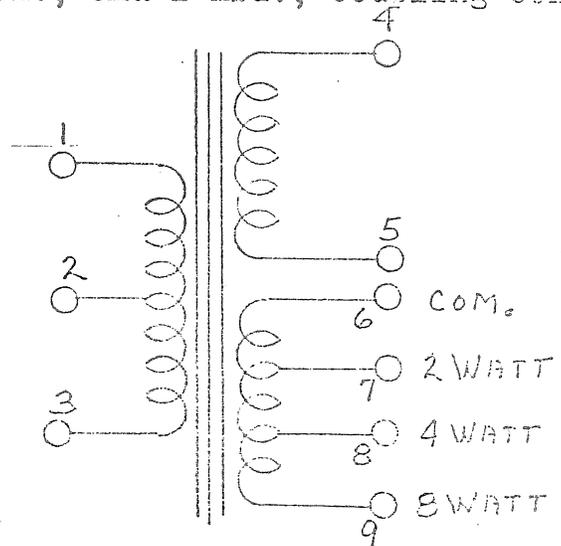
SECONDARY TO CORE AND CASE— 10,000V. R.M.S. (Terminals 4 and 5)
3,000V. R.M.S. (Terminals 6,7,8, and 9)

TEMPERATURE RISE— 55° C.

ADDITIONAL INFORMATION— Open Core Design

Finish with non-nutrient varnish for fungus prevention.

CIRCUIT APPLICATION: Used with 40 Henry choke, 170 ohm Res. @ 600MA,
DC, Max. Current, and 1 mfd., Coupling Condenser.



CASE DIMENSIONS: See Drawing No.
AM-30469, Sheet 2.

Sheet 1 of 2

SCHEMATIC

OUTLINE

Identical Units Electrically

Manufacturers Part No.
Electro/Hevi-Duty
E-12461/081422A-6

Date— 6-5-61
Eng.— F.W.W.

First Made For—
BC-1T

Gates Radio Company
Specialty Mfg. Division
AM-30469B

Prod. Resd. was
EC-10XG 5-22-67
W.C.

Electro/Hevi-Duty
E-12461/081422A-6
W.C.

HELPFUL GENERAL INFORMATION

This information, of a general nature, will be recognized by many as standard fundamental electronic information. Frequently, when problems exist, one or more of the well known fundamentals may have been overlooked. The following information, therefore, is a check list and/or a suggestion list. You will quickly note it applies to many types of installations, the fundamentals for which are all basically the same.

1. **COMPUTING EFFICIENCY.** The transmitter efficiency determines its satisfactory operation. If it is under-efficient, it will consume excess primary power, will work all components harder and tube life will be shorter. If it is over-efficient, it probably indicates either an error in a computation such as tower resistance measurements or an error in a meter. To measure efficiency in an AM transmitter, multiply the plate voltage by the plate current of the final radio frequency power amplifier. For example, if plate voltage was 2500 volts and plate current was 550 mA, we have:

$$\begin{array}{r} 2500 \\ \times .550 \\ \hline 1375.000 \end{array}$$

The above means that 1375 watts are being placed into the radio frequency power amplifier. If this power amplifier is producing 1000 watts into the antenna, it would then indicate an efficiency of 73%, or

$$\frac{1000}{1375} = 73\%$$

2. **TRANSMITTER EFFICIENCIES.** There are two types of radio frequency power amplifiers. (1) High level and (2) linear amplifiers. Normal efficiency of a high level transmitter ranges from 65 to 77% for transmitters of powers up to and including 1000 watts and 72 to 82% for transmitters having powers of 5000 watts to 10,000 watts. For linear amplifiers with no modulation, the normal efficiency at any power is approximately 30%. It is important to note that in a linear amplifier the efficiency increases under modulation, therefore when defining normal efficiency it must be defined without modulation.

NOTE: Variations in efficiency such as a range of 65 to 77% are expressed for reasons of: (a) transmitter used with directional antenna, which would reduce efficiency, (b) slight but not out of tolerance meter error, and (c) possible mismatch to transmission line having slightly higher than normal standing wave ratio.

If the efficiencies are within the ranges expressed, however, the installation could be considered satisfactory and of course the higher the efficiency, the better.

3. **COMPUTING POWER OUTPUT.** Power output is computed either into the radiating antenna or a known dummy antenna. In either case, the resistance measurements are known. Your consulting engineer will measure your antenna tower and give you the resistance measurement. In most Gates built AM transmitters an inbuilt dummy antenna is provided, having a resistance measurement of 50 ohms. The formula I^2R is employed. I = The current reading of your antenna meter at the tower or the meter to the dummy antenna. R = The resistance measurement of the tower or the dummy antenna. If the resistance measurement is 50 ohms and your antenna current was 4.5 amperes, then I^2R develops this result: $4.5 \times 4.5 = 20.25$. 20.25×50 (the antenna resistance) = 1012.5 watts. In the foregoing you have determined that you have a direct power output reading of 1012.5 watts if your antenna current is 4.5 amperes into a 50 ohm antenna.

4. **CORRECTING LOW EFFICIENCY.** Basically a broadcast transmitter by inherent design can not produce low efficiency unless, of course, it is incorrectly tuned, or the matching load to the transmitter, which is the transmission line and antenna, is incorrect. Here the use of the dummy antenna of known resistance is of great value. Light bulbs or improvised dummy antennas are of little value in computing efficiency. By using the formula in Paragraph 3 above, it is easy to determine how efficient the transmitter is operating when it is not connected to the antenna or transmission line. If the efficiency proves satisfactory into the dummy antenna, then any inefficiency is probably in the match of the transmitter to the radiating antenna and its associated tuning unit and transmission line.

If the efficiency of the transmitter is low into the dummy antenna, check the plate volt meter and power amplifier current meter to be sure they are accurate. In rare cases they are damaged in transit. This checking can be done with another known meter such as a good quality voltohmmeter, being very careful as the voltages are lethal.

Another cause of low efficiency is a defective RF ammeter. If you suspect this, the best way is to borrow one from a nearby station. It does not have to be the exact same range as you are only interested in a comparative reading. Here an error of only .2 of an ampere can make a large difference in the efficiency. Using Paragraph 3 above, again you will note a meter reading example of 4.5 amperes was used to give us

1012.5 watts output. If this meter had read 4.4 amperes, the output would have been 968 watts. By the meter being off only 0.1 amperes, 44 watts of error or loss was determined, which is nearly 5% of the 1000 watts desired power output. ----- Most radio frequency ammeters are very carefully checked and should be accurate but here again on a sensitive item, transportation roughage can affect it and therefore be sure.

5. **ARCING.** The power developed in the transmitter must go somewhere and of course to the antenna. When it is sidetracked, frequently arcing develops. Low efficiency and arcing will often go together as all transmitters are very well insulated against arcing. Its presence would indicate one of several things:

- Improper tuning of antenna coupler.
- Standing wave ratios on the transmission line, usually indicated by a different current reading at each end of the line.
- Improper ground return from the ground radials to the transmitter.
- Incorrect resistance measurements to the tower.
- Improper neutralization where it is required.
- An intermittent connection such as a loose connection in the tuning unit, a loose connection in the transmission line, poor brazing of the ground system and infrequently a grounded tower light wire.

6. **TUNING ANTENNA COUPLER.** Your consultant will be of invaluable assistance in tuning up your antenna coupler correctly with a radio frequency bridge at the same time he measures your tower. It will be money well spent. Where this is not possible and a bridge is not available, then the standard cut and try procedures must be followed. The desired result, of course, is the greatest antenna current without increasing the power input to the transmitter to obtain this increased antenna current.

7. **STANDING WAVES.** This is commonly called VSWR and high standing waves are caused by improper impedance match between the output of the transmitter to the transmission line and/or the output of the transmission line to the antenna coupler and its antenna. The result will nearly always be inefficiency as it reduces the power transfer between the transmitter and the antenna. High standing waves may also be caused by a poor or no ground to the outer shield of the transmission line. This line should be grounded to the ground radials at the tower and to the transmitter at the opposite end of the transmission line. The only exception to this might be with a directional system but in all instances the outer shield of the transmission line must be grounded securely.

8. **IMPROPER GROUND.** In an AM transmitter we place at least 120 ground radials into the ground but sometimes fail to connect them securely to the transmitter. In the simplest form, the antenna and the ground can be likened to the two wires of an electric light circuit. One is as important as the other. Where the ground radials are bonded together at the tower, we suggest extending a 2" copper strap directly to the ground of the broadcast transmitter. DO NOT attach one of the outer radials closest to the transmitter as your ground system. Don't forget to ground the cabinets of the antenna coupling unit and the tower lightning chokes, and again the outer shield of the transmission line.

9. **INCORRECT TOWER MEASUREMENTS.** Your consulting engineer is provided with expensive and accurate measuring equipment for tower resistance measurements. His measurements will be accurate. It would be extremely rare to find an incorrect tower measurement by a capable consulting engineer. It has happened, however, and we include this paragraph only to point out that if all else fails for proper transmitter performance, rechecking of the tower measurements would not be amiss. Several years ago one of the world's leading consultants measured a tower incorrectly and quickly admitted it. The cause was simply one of his measuring instruments falling out of his car unbeknownst to him and upsetting the calibration of his equipment.

10. **FUSE BLOWING.** It seldom happens if the fuses are of adequate size. If it does happen, the first thing is to determine that the fuses are not overloaded. Usually overloaded fuses caused by a long period of overload of an hour or more have blackened fuse clips. Remember a very hot day and borderline fuses are trouble-makers. Also don't forget to compute the window fan, the well pump, the air-conditioner, or other items that are foolers as to power consumption.

If fuses are of adequate size and continue to blow, here are a few helpful hints:

If your transmitter has mercury vapor rectifiers, it is a cold morning and the heat in your building has gone down overnight, the mercury will likely cool at the bottom of the rectifier tubes and when high voltage is applied, cause an arc back. In such a condition, you are fortunate in blowing the fuses as an arc back can often destroy a filter reactor or power transformer. You can correct this condition by keeping adequate heat in the transmitter building or at least adjacent to the mercury vapor rectifier tubes. A light bulb placed near the rectifier tubes, to operate in cold weather when the transmitter is off, is helpful.

Dirt or scum is an evil with many results and fuse blowing caused by arc-overs is one of them. A good maintenance program prevents this.

On new transmitters, look for cable abrasions. Sometimes in transit it is possible for a wire to rub against a metal support and wear off the insulation. This is unlikely but with such a serious problem as fuses blowing, you look for everything.

If by the time you have found the trouble you have blown a number of fuses, now investigate your fuse box to be sure the clips are clean and not charred. If they are charred, fuse blowing will continue anyway and it will be necessary to replace the clips that hold the fuses.

11. **UNEXPLAINED OUTAGES.** This one puzzles the best of them. A transmitter that goes off the air for no reason and can be turned back on by pushing the start button brings the query, "What caused that?" If this happens very infrequently, it is probably caused by a power line dip, a jump across the arc gap at the tower base, or other normal things that activate the protective relays in the transmitter as they should.

Your transmitter always looks like the offender. It is the device with meters and it is the device that complains or quits if there is a failure anywhere in the entire system. An open or short circuit in a transmission line only reacts at the transmitter. A faulty insulator in an antenna guy wire or a bad connection in the tuning unit or ground system reacts only at the transmitter. Here again the dummy antenna is of great value. If these unexplained outages do not appear in operating into a dummy antenna, then you must look elsewhere for the problem. It is always well to remember that the transmission line tuning units and associated connections, including the tower chokes, are somewhat like the drive shaft between the automobile motor and the rear wheels. If the drive shaft fails, it does not mean that the motor is defective.

12. **STEP BY STEP TROUBLE-SHOOTING.** Never troubleshoot on the basis of "it might be this or that". Instead, start from the beginning. If the transmitter was satisfactory on the dummy antenna, then the question becomes "Where is the trouble?" If a transmission line connects the transmitter to the antenna coupler, then disconnect the antenna coupler and provide a dummy antenna at the far end of the transmission line and repeat the test. If you noticed the outage at this point, then the trouble is in the transmission line. If not, reconnect it to the antenna coupler unit and put the dummy antenna at the output of the coupling unit. This is known as step by step checking to locate problems.

The same process is used in trouble-shooting the transmitter. In checking voltages, you start with the oscillator and go through to the power amplifier and with the first audio stage to the final audio stage. Other outage conditions not affecting the transmitter are listed below for your checking:

Under certain conditions, especially at higher altitudes, the guy insulators will arc, usually caused by static conditions. This will nearly always cause an outage as it changes the antenna characteristics. This is hard to find as it is hard to see. Use of field glasses at night is the best way. If it happens, the insulator should be shunted with a resistor. Write our Engineering Department for advice, giving full antenna detail when writing.

At times the arc gap at the base of the tower is set too close or has accumulated dirt. This causes an arc to ground under high modulation.

A crack in the tower base insulator is very unlikely but it should be inspected and keeping the base insulator clean is necessary. A low resistance path at this point is highly undesirable.

Look at the tower chokes. Though they are husky, they are in a vulnerable position for lightning. You might find a charred point that is causing the trouble.

Shunt fed towers or those with no base insulator are usually more sensitive to static bursts than series fed towers. The best method is to try and make the feed line to the tower equal the impedance of the transmission line. Talk to your consultant about this.

One side of the tower lighting circuit shorted to the tower itself, either permanently or intermittently, can cause trouble even though the lights may function perfectly.

13. **OTHER OUTAGES.** If the transmitter is the offender, such as acting improperly on a dummy antenna, the process of elimination by starting at the first and following through is preferred, unless of course the cause is actually known. The following may be helpful:

(FALL OUT) The transmitter turns off at high modulation. Possibly the overload relay is set too sensitive. The transmitter may not be properly neutralized where neutralization is required.

(HARD TO MODULATE) Cause can be either improper impedance match between transmitter and the transmission line or low grid drive to the final power amplifier. Consult the instruction book for correct grid drive. The correct match of the transmitter to load is covered in the instruction book. Usually an antenna current meter that does not move up freely with modulation indicates a mismatch between the transmitter and its loading equipment.

(BAD REGULATION) The size of the primary lines between the meter box and the transmitter is extremely important. If they are too small, bad regulation will exist. In some instances the power line has bad regulation too. This

may be caused by a too small pole transformer, overload of the power lines in the entire neighborhood, or insufficient line capacity between the pole transformer and the transmitter building. In some instances voltage regulators, if employed, must be inspected for good wave form and good regulation. The best way to check regulation is to check the primary line voltage when the transmitter is not modulating. Then modulate the transmitter with a constant tone to 100% and note the change, if any, in the primary voltage between zero and full modulation. If the change was substantial, then investigate the reason and correct it.

14. **SHORT TUBE LIFE.** It is usually not the fault of the tubes. Instead, it is caused by overloading the tubes. See Paragraphs 1 and 2 on Efficiency.

15. **POOR QUALITY.** The reasons for poor transmission quality could be many as between the microphone or transcription turntable and the transmitter there are many items of equipment. In a listening test, it would seem foolish to even suggest that a poor stylus on a transcription turntable could be the cause but as we are discussing elementary things, let's check it. Every station must take proof of performance measurements. Proof of performance equipment should be owned by each radio station as it is difficult to keep a radio station in top performance through the years without one. With this equipment, each major equipment item may be checked for frequency response, noise and distortion, to determine good or bad quality where it exists. The Gates SA131 proof of performance package, listed in all Gates catalogs and selling for under \$ 700.00, is an excellent investment.

These items could cause poor quality:

A poor microphone, don't forget those that are dropped on the floor are seldom reported.

Radio frequency leakage or a small amount of RF getting into other equipment such as the limiting amplifier, audio cables, and the speech input equipment, which can be corrected by proper grounding and shielding.

Lack of grounding in important places of the system and in some instances actually use of too many grounds. The common ground is usually preferred to grounding both ends of audio cables and other similar shielded circuits.

The use of too small a ground. Cabinets of equipment, speech input consoles, etc., should be grounded with copper strap, particularly if they are closely associated with the transmitter.

Do not run RF cables, such as frequency and modulation monitor cables, in the same conduit as audio cables.

Do not run a high level audio circuit in the same conduit or cable package as a low level circuit. For example, do not run a loudspeaker line in the same cable package as a microphone.

Watch overloading. Most equipment is rated for minimum input and maximum output levels. Do not exceed these. Sometimes they are exceeded unknowingly, so check again.

Review any short-cuts or throwing of precaution to the wind that might have existed in trying to get the equipment on the air fast. The answer here, of course, is don't take short-cuts.

16. **PREVENTIVE MAINTENANCE.** Few of us would fly in commercial airplanes if we felt that planes were not carefully checked and subject to a most rigid regular maintenance program. We even check our automobile tires before taking a long trip. The wife cleans to prevent moths. In broadcasting equipment, preventive maintenance is mandatory. Most offages can be eliminated before they happen by maintaining a regular weekly maintenance program, which should take from two to six hours a week, depending upon the size of the station. This maintenance program should include:

Complete cleaning. Dirt is the first cause of all trouble.

Clean air filters as heat is the number two cause of all problems. With the advent of unattended operation, commonly known as remote control, often the locked building has also locked out regular maintenance. Keep the transmitter and its associated building as clean as if you were in it 18 hours a day. Keep windows closed in the summer months and provide ventilation by filtered suction and exhaust fans.

Air exhaust. Exhausting hot air is vitally important as cool air is a trouble-free transmitter and long lasting tubes.

Tube checking. Check tubes at least monthly and it is just as easy to do it each week during the periodic maintenance program. Certain tubes will become gaseous if left on the spare tube shelf too long. This type of tube should be rotated into the transmitter to prevent an emergency change to the spare tube, only to find it blowing out because of a gaseous condition.

Oiling. If the transmitter has blowers, oil them as required, but do not over-oil. Some types of turntables require oiling the motors.

Relay contacts. Burnish the contacts with an approved burnishing tool. This should be done about every six to eight weeks.

Other preventive ideas. Clean mixing attenuators if they are not the sealed type, with carbon tetrachloride, about once monthly. Every station should have a small suction type cleaner. Even your wife's Hoover with the suction attachments will do an excellent job of pulling dust from the inside of the hard to get corners of a transmitter. Take a leaf from the Navy book which says everything must at all times be sparkling clean or what is known as ship-shape.

17. ADEQUATE TEST EQUIPMENT. To have a maintenance program, certain capital equipment is necessary. Do not be ashamed to tell your Manager about this because he will recognize that proper maintenance is saving money and not spending money. As a minimum, you should have this equipment:

Dummy antenna (frequently supplied in Gates transmitters).

Proof of performance equipment, which includes an audio oscillator, distortion meter, gain set, and RF pickup coil or rectifier, known as the Gates SA131 proof of performance package.

A good grade of voltohmmeter.

A spare antenna current meter.

An inexpensive oscilloscope.

All of the above will cost less than \$1000.00 and will pay for itself many times through the years.

18. THE CHIEF ENGINEER. He has the job of keeping everybody happy - listeners, Manager, and stockholders. When trouble comes, he is under pressure. He will do his best to correct the problem as fast as he can. It is well to remember that electronic equipment has many circuits and many avenues of travel. Where problems are known, the solution is usually quick. Where the problem must be found, the solution will take time. It is well to remember that if equipment did not need maintenance, it would not need a Chief Engineer. The greatest service he renders is the insistence on a regular preventive maintenance program, which he knows will prevent most problems. If the unusual problem does arrive, causing an outage, everyone in the broadcasting should be understanding and tolerant as the problem can be solved quickest by not breathing over the Chief Engineer's shoulder.

19. GATES ASSISTANCE TO HELP. Gates sincerely believes that the best type of assistance it can render to the technical personnel in the radio broadcasting industry is in providing full cooperation, day or night, in solving any problem no matter how small. Gates technical people recognize that sometimes the biggest problem is solved in the most simple manner. This is part of electronics and never is fun poked at a simple solution because this is the happiest kind. It is only by asking questions of any calibre, simple or complex, of Gates people and mutually working together that the finest degree of broadcast programming is possible in your broadcasting station and the industry.

Service avenues. Unless the problem is of an emergency nature, Gates suggests that you write to the Gates Service Department about problems that you are experiencing. If you have a problem that can not wait, call the Gates Service Department during daylight hours at Area Code 217, 222-8202. Gates daylight hours are from 8 A.M. to 5 P.M., Monday thru Friday, Central Standard Time or Central Daylight Time, depending upon the period of the year. Gates nighttime service can be obtained by calling Area Code 217, 222-8202.

GATES RADIO COMPANY - QUINCY, ILLINOIS
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