INSTRUCTIONS

FOR THE INSTALLATION AND MAINTENANCE

OF THE GATES GY-48 COMPLETE 250 WATT RADIO STATION

AND THE BC-250GY TRANSMITTER

INDEX

The Gates BC250GY Transmitter which is part of the GY48 Radio Station is a modern high fidelity transmitter having every modern feature demanded by the modern radio broadcasting station. When properly installed and maintained it will give years of trouble-free service.

The F.C.C. rated power of the BC250GY transmitter is 250 watts and is officially approved on the records of F.C.C. as a Gates Radio Company Model BC250GY Transmitter for Amplitude Modulation. Radio transmitters do not carry approval numbers, however, the GY48 Radio Station where purchased in this manner is supplied with two approved monitors which are as follows:

Gates MO2639 Modulation Monitor	Approval 1556
Gates MO2890 Frequency Monitor	Approval 1469

The radio frequency range of the BC250GY transmitter is from 540 to 1800 Kc. but in each case specific frequency determining components are supplied for operation of the transmitter on the frequency specified by you, the customer, when ordering. In certain rare situations of critical antenna loading the calculated frequency determining components could, in an extreme condition, be in error, making resonance of one or more circuits, not complete. In such cases advise the factory immediately.

The antenna coupling system is designed for line or antenna conditions varying from 30 to 300 ohms. For other conditions advise details and correct components will be supplied.

Installation

On various pages of this book will be found helpful suggestions, as obviously an instruction book is primarily for installation procedures. However, for first installation, that is, after removing from the box, these things are important:

- Check packing list for all materials.
- Read this book through before proceeding.
- Have a place for all parts so you will not step on or otherwise break a needed component removed for shipment.
- Most engineers prefer a mounting frame to set the equipment on. It aids wiring and helps when mopping the room. Make the frame out of 2" x 4" finished lumber and paint black. Leave the center open so you may run wires from one cabinet to another. (See illustration B-10852 in rear of this book.)
- Use No. 6 wire to connect the power to the transmitter. Note the transmitter uses 230 Volts A.C. but the accessory cabinet (GY48 only) uses 115 Volts A.C.
- Be sure your power source from the public utility company is large enough. Have them graph the line for a period of days under conditions similar to yours. If time available connect four 500 watt heater elements to the line and graph the load over several 18 hour periods, noting especially mealtime periods.
- Do the job of installing well--haste oftentimes means hours off the air later on.
- Most Important--Acquaint yourself with this equipment by studying it thoroughly.

The BC250GY Transmitter is supplied standard with two sets of 100% tubes, two crystals and ovens and ready to connect to transmission line. It is not supplied with a remote reading antenna meter. Where desired two types are available listed below:

MO-3294 diode type with 3" remote meter with scales of your choice. 3, 5 and 10 ampere scales are stock.

Thermocouple type remote meter kit including 3" meter with your scale choice, choke coils, adjusting rheostat, etc.

Panel 3-1/2" by 19" to mount 3" remote meter.

In the case of the GY48 Radio Station space is provided above the modulation monitor for the 3-1/2" panel where needed to accomodate the remote meter. Where the BC250GY transmitter only is used the remote meter is usually mounted in the accessory rack cabinet. See illustration in back of this book for proper connection of remote metering where required. Remote antenna meters are not required for (a) direct coupling, (b) in most instances for shunt feed coupling either direct or via 70 ohm transmission line and (c) where the antenna even though coupled by a transmission line is a very short distance from the transmitter location. In all instances this is under the jurisdiction of the inspector. Customers in other countries, of course, must install this equipment in accordance with local regulations.

The GY48 Radio Station has supplied in addition to the BC250GY transmitter, the following material:

- Center joiner panel with call letter plate*
- Accessory cabinet with
  - (a) Frequency Monitor MO2890**
  - (b) Modulation Monitor MO2639**
  - (c) Limiter SA38
  - (d) Switching Panel
  - (e) Blank Panels
  - (f) One set of tubes
- P12P Loudspeaker or equal

The accessory cabinet sets to the right of the transmitter and the installer will recognize by inspection the method of attaching the center joiner panel. For good appearance proper shimming and a level floor are necessary requisites. The two coaxial lines coiled in the bottom of the accessory cabinet are used to connect the monitors to the transmitter.

* Call letter plate may in rare instances be delayed in shipping and will be noted on packing list as back ordered if such is the case.

**Not supplied of course where customer already owns approved monitors or requests our not supplying.

Separate instruction books are provided for the MO2890 and MO2639 monitors and the SA38 Limiting Amplifier.

The switch panel below the limiting amplifier has two switches. The first of these selects one of four input lines marked "Line 1, Line 2, Local and Auxiliary". These are connected to the terminal block as indicated on wiring diagram C-16044 in the back of this booklet. The normal procedure would be to connect lines 1 and 2 to the lines connecting the transmitter building to the studios. Where only one line is employed, of course, line 2 connection would not be used. The local switch position is provided so that an external preamplifier and microphone may be instantly switched into the circuit in case announcements are to be made from the transmitter location, while the auxiliary switch position is provided for the connection of transcription turntables, which are in certain instances desirable at the transmitter location. In all instances the impedance at this point is for a 500/600 ohm line. Under certain situations it may be desirable to add a repeater transformer between the studio line and the line connection referred to above, as the input attenuator of the SA38 limiting amplifier is unbalanced. In most cases this will not be necessary as the local telephone company equalizes and balances the line at the point of the transmitter, which automatically provides the isolation or repeater transformer. Line sing or hum will be instantly discernible in case this condition does not properly prevail.

The second switch places the limiter in and out of operation and is provided entirely to switch out the limiter in case of a tube failure in the limiter, rendering the broadcast circuit inoperative. It should be remembered where the limiter is switched out of the circuit the level of the preceding circuit must be readjusted to compensate for the gain normally provided in the SA38 limiting amplifier. This provision just mentioned is strictly an emergency convenience provision and nothing else.

All circuits connecting to the accessory cabinet should be in accordance with good engineering practice, such as the use of well shielded wiring and proper routing of wiring to prevent input and output circuits, as well as alternating current circuits from being in the same cable.

The P12P loudspeaker supplied is of the permanent dynamic type and connects directly to the low impedance loudspeaker connections as provided on the M02639 Modulation Monitor. (See instruction book on monitors.) This loudspeaker should be mounted in a cabinet sufficient in size for good baffle area or may be mounted on a 48" square cellutex baffle with a 10-1/2" hole cut in the exact center. This provides a fine high fidelity monitoring medium at low cost. The cellutex baffle may be constructed of two pieces of 3/4" cellutex 48" square cemented together with water glass, obtainable at nearly every grocery store. After this is allowed to set for a few minutes the hole may be cut in the center, the loudspeaker then bolted to the baffle and this can be hung at a 48 degree angle between the ceiling and any wall.

SECTION II - BC250GY TRANSMITTER DETAILS

The following information on the BC250GY transmitter is a running commentary pertaining to the general construction and operational detail surrounding the transmitter itself. As in all modern transmitting equipment it is best to look at the transmitter in its various sections and therefore, as pertaining to overall performance detail, the following pages are a running commentary on the transmitter in general.

Oscillator Unit

The oscillator unit is located on the inside left of the cabinet facing the back directly below the 813 intermediate amplifier stage. It is completely independent of the transmitter itself, being plug-in, and quickly removable by means of knurled thumb screws so that it may be serviced or any other similar oscillator unit may be used for testing purposes. Switch S5 is the crystal change switch providing instant change-over from one crystal oven to the other. Capacitors C37 and C38 are the individual frequency adjusting capacitors for each crystal, providing an independent exact adjustment of the operating frequency of each crystal unit so that when change-over is made a readjustment of the frequency is not necessary. The crystal ovens plug into the two sockets directly behind the socket provided for the 807 oscillator tube, which is inserted directly behind the oscillator tank tuning condenser, C17, which is adjusted to resonance by minimum plate current on Meter M8, also located on the oscillator chassis. The oven supplied for the crystals is fully approved by F.C.C. for broadcast operation and does not require a thermometer for temperature indication. The oscillator tube operates with approximately 250 volts on the plate and is very loosely coupled to the 813 intermediate amplifier to eliminate frequency change when the load is added by applying plate voltage to the 813 tube. The plate voltage for the oscillator stage is obtained from the combination bias and oscillator plate supply located on the hinged audio chassis. In front of the oscillator chassis is located the crystal heater transformer, T7.

With the above being done and other portions of the transmitter made ready as in subsequent pages of this book, you are ready to place the transmitter on frequency and by turning the filaments on by means of the filament start button on the front of the transmitter, both filament and plate current is applied to the oscillator stage. Follow the usual procedures of tuning the oscillator stage by adjusting capacitor C17 to resonance by minimum plate current on meter M8 and then detuning on the low capacity side of resonance to obtain 30 Ma plate current. If possible by using a standard radio receiver, tune in another radio station on the same operating frequency as your station. By adjusting trimmer capacitor C37 or C38 (whichever crystal is in use) a slight variance in the beat frequency will be determined by hearing the oscillator in the receiver beating against the external signal from the radio station. If a complete zero beat is not possible by means of capacitor C37 or C38, adjustment of the air gap in the crystal unit itself will be necessary. Remember air gap adjustments should be made with the capacitor C37 or C38 at 50% mesh so that minor frequency adjustments are possible to bring to exact zero frequency. After approximately 48 hours of use, no further adjustment to hold the frequency tolerance within four or five cycles will be necessary.

In case the oscillator is unstable, some readjustment of oscillator tank condenser C17 may be necessary to make sure the oscillator is resonated on the proper side of the curve. Complete zero resonance on meter M8 is not desirable and resonance should be slightly off zero for best results. When the oscillator unit has been determined satisfactory, replace the dust cover over the oscillator, as it is part of the integral shielding in the transmitter itself.

Intermediate Amplifier

The 813 intermediate amplifier is located directly above the oscillator unit (tube V6) and has its associated coil and tuning condenser directly adjacent. The intermediate amplifier tank coil is center tapped to ground with neutralization of the final power amplifier to the opposite end from that of the grid drive end. The screen voltage is obtained through two voltage dividing resistors which are normally set at the factory to obtain approximately 330 volts on the screen, allowing a margin for high line voltage and furnishing ample drive for the power amplifier. The plate current of the intermediate amplifier is indicated on meter M6. This meter will also indicate grid current to the 813 intermediate amplifier when the plate current is not applied. Thus, when adjusting the oscillator section, leaving the plate voltage unapplied to the 813 stage (it obtains its plate voltage from the main high voltage supply) the installing engineer will note indication of grid current to the intermediate amplifier when the oscillator is properly functioning, or M6, as it will be noted this meter is in the filament return of the 813 stage. As meter M6 has a range of 200 MA. and a maximum grid current of between 7 and 10 MA is required for proper functioning of the 813 tube, obviously the grid indication on meter M6 will be on the extreme lower portion of the scale. The intermediate amplifier tunes to resonance by capacitor C24 in the 813 tank circuit and is tuned to minimum plate current.

Final Amplifier

The power amplifier consists of two 810 tubes operating in parallel. The load is connected through a low pass filter to the inductive branch of the tank circuit, a system which minimizes harmonic radiation. The final amplifier is resonated by means of capacitor C33 and brought to exact frequency by the variable capacitor C32. The value of C33 is determined by the carrier frequency and is usually properly provided at time of shipment. In some instances of unusual loading conditions, particularly very low impedance antennas, the value of tank padding condenser C33 may be effected as applied to normal charts and if the amplifier will not resonate with the load applied, it would be the antenna and would only be in case of direct coupling, information as to the antenna or loading characteristics should be immediately supplied to the factory.

Audio Chassis

The audio chassis is the hinged chassis on the right hand of the cabinet facing the rear and accomodates the push-pull 6L6G (1622) Class A audio driver, the push-pull class B 810 modulator tubes on the top of the chassis and also accomodates the combination oscillator bias supply and its associate 5U4G tube and the vacuum type time delay relay E6. The output of the 810 modulator tubes terminates to modulation transformer T3 located in the bottom of the cabinet. The plate voltage to the 6L6G tubes is approximately 375 volts. The modulator tubes operate at the full plate voltage of the main power supply.

For underchassis servicing of the audio deck, it is only necessary to remove the knurled thumb screws and this chassis hinges back revealing all underchassis wiring and components for fast servicing where required. It should be noted that the oscillator-bias power supply is so constructed that 45 volts is taken from the negative side of this supply to provide bias voltage for the modulators, which is individually adjustable by bias resistors R4 and R5. (See Fig. 3).

Relays

The thermal operating filament time delay relay is mounted on the audio chassis; the control element being connected across the filaments of the 6L6 tubes. The main rectifier employs 8008 tubes in a full-wave circuit. The modulator and power amplifier stages have overload relays in the filament return circuits. These are normally open. When the current becomes sufficient the contacts close, completing the circuit through an auxiliary relay with normally closed contacts in series with the high voltage contactor coil. Under normal operation modulation may provide sufficient current to cause the overload armature to pull open. If normally closed contacts were used to operate directly in series with the plate contactor coil, these modulation cycles would cause the contactor to chatter, or possibly drop out, although no overload actually occurs. Both overload relay coils are shunted by adjustable resistors for setting the overload current point. The normal unshunted operating current is 300 Ma and shunting with resistors gives a higher current rating; in the case of the modulators, also loads the inductance of the coil, preventing distortion through this element.

It should be noted that for shipping some of the relays are tied down with cloth, strap or heavy string. Also, in some instances corrugated paper is inserted between the contacts for shipping purposes. These, of course, should be removed.

General Information

For shipping purposes many of the heavy units have been removed and their location in every instance, as well as other components removed, will be quickly recognized by referring to the various photographic illustrations in the back of this booklet. Be sure all components removed are placed into proper location and securely bolted to the transmitter. Wiring is properly tagged for connections to those units removed for shipment. For general installation it will be found that the radio frequency portion of the transmitter is on the left panel facing the rear, with the exception of the antenna loading equipment which is located at the top right, facing the rear. At the bottom rear will be found the main fuses and the smaller fuses for the crystal heaters. The right portion of the transmitter facing the rear is generally for the audio eouipment and the combination oscillator-bias power supply. The operator understanding the symmetrical balance of the equipment will have no difficulty in combination with the roominess of the transmitter in acquainting himself with the various functions. The power amplifier neutralizing condenser is below the final tank condenser. Adjacent to the front panel will be found the 813 filament transformer T5 and above this transformer voltage dividers R21 and R22 for the 813 screen grid. Above the 5U4G rectifier tube will be found the load resistor R16 for the combination oscillator-bias power supply. Also adjacent are potentiometers R4 and R5 for the balanced grid voltage to the modulator tubes.

At the bottom front of the side panel is the plate contactor relay, E4, above which is overload relays E1 and E2 and auxiliary relay E3, above which will be found voltage dividers R12 and R13 for the audio input stage and the multiplier for the plate voltmeter R3. On the front panel the cathode resistor R2 for the power amplifier mounts between the plate voltmeter M5 and the power amplifier current meter, M4. On the right side from the rear below the loading condenser mounted on insulators is the power amplifier voltage rheostat, R1. Below this is filament rheostat R24.

Wiring Detail

The wiring hinges around whether the installation involves the entire GY48 Radio Station or the BC250GY transmitter only. In the case of the GY Radio Station there will be found coiled in the bottom of the accessory cabinet two coaxial cables which attach to the frequency and modulation monitors in the accessory cabinet and the coiled portion is for attachment to the monitor connections in the BC250GY transmitter. Directly under the fuse blocks on the left rear will be found two jacks (see J1 and J2 of Fig. 2). The frequency monitor cable has a single pin connector and this fits into the jack above referred to closest to the front of the transmitter. For reasons of polarization only so that the two coaxial cables cannot be interchanged, the modulation monitor connection has been to a two pin connector; both pins being parallel. The audio frequency input line which is 500/600 ohms connects to the terminal board directly below the audio chassis which in the case of the BC250GY alone is connected to any good quality amplifier having an output impedance of 500/600 ohms. In the case of the GY48 radio station the input to the transmitter is from the output of the SA38 limiting amplifier. It should be particularly noted that the output of the SA38 limiter is resistive, thus inserting a pad between the output transformer of the limiter and the input transformer of the transmitter. In case some other type of amplifier is used preceding the transmitter, it is advisable to insert a fixed H pad 500/500 ohms having a loss of approximately six decibels to assure no reaction between the transmitter and preceding amplifier, causing an error in frequency response. The power line connections are made directly to the fuse blocks A7 and A8 (see Fig. 2). Fuse block A8 is provided for the 230 Volt A.C. connection to the crystal heater transformer only while fuse block A7 is the main fuse block for the 230 Volt single phase input voltage to the entire transmitter. Thus, the wiring to fuse block A7 should be heavy, preferably No. 6 wire or better, while the wiring to fuse block A8 may be as light as No. 16.

Although jumpers may be provided between fuse block A7 and A8, these should be disconnected as it is necessary that continual voltage be available to fuse block A8 so that the crystal heater transformers may operate 24 hours per day. It is then necessary, as it can be seen, to run wiring from the main entrance box and cut-out switch to fuse block A7 and a second lighter pair of wires bypassing the cut-out switch of the main fuse block so that even disengaging the main cut-out switch will not disconnect the current from the crystal heater ovens.

The coaxial or open wire transmission line or the direct coupled antenna connects to the feed-thru insulators on the top of the transmitter. In the case of coaxial transmission line or open wire transmission line the ground portion of the transmission line should be firmly secured to the top of the cabinet also so that the ground path will not have to travel through the transmitter cabinet. Where desired, the coaxial transmission line may be brought up through the bottom of the cabinet at any number of the convenient locations as will be quickly obvious to the installing engineer's eye.

We are now ready to proceed with the initial tune-up.

SECTION III

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

1 - Proper line voltage to fuse blocks A7 and A8.
2 - Proper location of all tubes in the sockets.
3 - Proper termination of the antenna or dummy antenna equipment.
4 - Removal of all tie-down straps and other materials used for shipping purposes.
5 - A recheck to be sure components removed for shipment have been installed properly.
6 - Complete check of the transmitter with a screwdriver and wrench to be sure all bolts, screws and other connections that could possibly work loose in shipment have been brought down securely.
7 - Looking over all wiring for broken solder connections, making sure that everything is secure.
8 - Making certain the transmitter is well grounded and that the ground to the transmitter is tied to the main ground of the antenna system. THIS IS VERY IMPORTANT.
9 - Making certain that though 230 volts A.C. is used on the transmitter that in the case of the GY48 radio station only 115 volts is used on the equipment in the accessory cabinet. Remember the accessory cabinet equipment for 115 volts only.
10 - Making sure audio wiring has been properly shielded and that the shields have been properly grounded and that no input wire runs in the same cable as an output wire or a power cable.

In case the transmitter is located on the upper floor of a building particular attention must be paid to grounding of the equipment. Additional ground busses and elimination of varied ground potentials is highly important for good performance and low noise.

Assuming we are ready to operate the transmitter; that the crystals are in their sockets and the oscillator unit has generally been proved satisfactory (see oscillator unit), we are ready to apply the filament voltage, which of course, has been done when the oscillator is turned on, which is done by the filament start switch on the front of the transmitter. The crystal heater lights should indicate regardless of whether the filament switch is on or off, remembering this circuit should always operate.

Now inserting the filament start switch, adjust the filament rheostat for a filament voltage of 10 volts. Remember the plate supply for the oscillator comes on with the filaments, so after the tune-up of the oscillator we are ready to preceed with tuning up of the balance of the transmitter. Remember again in tuning up the oscillator that tank condenser C17 of the oscillator will approach to resonance gradually on the low capacity side and break sharply on the high capacity side. The plate current should operate somewhere near 30 MA. The minimum current will be as low as 15 MA on the low capacity side, but it is recalled we do not recommend operating the crystal at complete dip. For frequencies above 1000 KC, the section of the plate coil on the oscillator tank, connecting to the 807 plate, will be shorted in most instances, while frequencies between 1000 KC and 650 KC will use the entire coil. For frequencies lower than 650 KC, a 200 mmfd. padding condenser is supplied across the full coil.

The frequency monitor connection which terminates to the single pin jack connector below the fuse block is generally the first tap from the end opposite the 807 tube, or at the bottom end of the coil. The connecting point for the RF drive connection to the 813 tube is as near to the bottom end of the oscillator coil as possible and provides approximately 10 MA grid drive to the 813 intermediate amplifier. You will recall this grid drive is indicated on the 813 plate meter, M6, when the plate voltage is not applied to this tube. In case of sluggishness of the oscillator slight adjustment of the feed back condenser adjacent to the 807 tube socket will undoubtedly correct this condition. Generous use of the feed back condenser is not recommended and it should be operated as near the minimum position as good stable operation allows.

Now disconnect the high voltage connection to the final power amplifier for neutralizing purposes. This perhaps can best be accomplished by removing the high voltage connection at reactor L2 which connects through the plate rheostat R1 directly to the final tank coil.

Reduced plate voltage may be obtained by removing the plate cap from one of the 8008 rectifier tubes. Now by resonating tank condenser C24 of the intermediate amplifier to mininum plate current dip it can be quickly determined whether this section is operating satisfactorily. As with full plate voltage on the 813 stage, the current will be from 150 to 180 MA, it is reasonable to believe that with half voltage from T1, as we are now operating, the current will be about half that shown above, or from 75 to 90 MA and, of course, the screen voltage will likewise be half. At the same time grid current will indicate when proper resonance is obtained on meter M3 which is the grid current meter to the final amplifier stage. Normal grid current with full plate voltage is approximately 100 MA, so with the preliminary tune-up it will be approximately 50 MA when normal. The off-resonance plate current of the 813 stage is only slightly more than the resonance point and this is considered normal. Care is necessary particularly when tuning up for low frequencies, that the intermediate amplifier is not doubling by operating on the fundamental frequency. Remembering that the plate voltage is still disconnected from the final

power amplifier, we are ready to check the neutralization of the final power amplifier by using a 1/4 watt neon lamp held against the power amplifier tank coil near the plate end. Now by resonating tank condenser C32 of the final power amplifier, if the neon light indicates at any point during this resonance, adjust neutralizing capacitor C28 until the neon light will no longer indicate. Other methods of neutralization, of course, may be used, such as a current squared galvanometer connected to a turn or two of wire inserted near the low end of the tank coil or the use of a small 60 Ma pilot light, likewise connected to a turn or two of wire inserted in the low end of the tank coil L6 will be a satisfactory neutralizing procedure.

As transmitters are always neutralized and fully tested before shipment, all of the foregoing can be considered satisfactory in most cases.

Reconnect the plate voltage to the power amplifier which has assumedly been removed at the point of the modulation reactor L2. Adjust the modulator bias resistors R4 and R5 to minimum current, or entirely counter-clockwise, which will prevent the possibility of high modulator current on the initial turn-on. Make certain coil L12, which is adjacent to the final tank coil and is the modulation monitor pickup coil, is at minimum relation or minimum pickup so that the modulation monitor will not be overdriven as we are not at the moment concerned with this part of the operation. Now insert the filament start button which will turn on the oscillator and filaments and when the time delay relay cycle has passed, which is approximately 30 seconds, you can insert the plate button, making sure the back door is closed and engaging the door interlock. Resonate the final amplifier for minimum plate current on the meter M4 by using the tank condenser C32, and if proper loading or approximately proper loading of the antenna or dummy antenna is taking place the required current will be indicated on meter M1. If the currents are excessive with the full plate voltage the overload relay will operate and this will require adjustment of the antenna loading condition so that the currents will not be excessive. The voltage and current may be reduced for this initial tune-up of the power amplifier the same as previously done for tuning the 813 driver; that is, by removing the plate cap from one of the 8008 rectifier tubes.

General Operational Procedure

It will possibly be noted the frequency monitor is not indicating properly. It is assumed the frequency monitor has already been adjusted in accordance with the instructions pertaining to the frequency monitor and is ready for use. It must be remembered that the crystal ovens in the transmitter must operate about four hours before proper frequency adjustment can be obtained. It may be necessary to readjust the frequency controlling devices on the oscillator unit after the full voltages have been applied to the intermediate and final amplifier as the load created by the 813 intermediate amplifier under certain conditions will affect the load on the oscillator and require a readjustment. This procedure must be followed with the utmost care as it is necessary to make these adjustments

with the back door open and it is recommended that while these adjustments are made and the necessity of strapping out the interlock to make the adjustments is prevailing, at least two persons be in attendance.

The adjustment to exact frequency is made as covered under the heading "Oscillator Unit" by adjusting the crystal air gap spacing and frequency adjusting condensers C37 and C38 until proper frequency is obtained. It is well to caution that the frequency monitor is not an accurate indicating device until the entire exactness of the frequency is determined by the external measuring source. Thus, in the original equipment tests where your frequency is determined by the external source, the usual procedure is to adjust the transmitter to exact frequency and then adjust the frequency monitor accordingly; subsequently thereafter the frequency monitor becomes the standard because of its precision design.

Bias voltage on the modulators adjusted by potentiometers R4 and R5 on the audio chassis is adjusted to approximately 32 volts. As the modulators will be drawing no current if these potentiometers are turned off, a good procedure is to adjust R4 until the plate current (no signal input) to the modulators is about 40 Ma. static. Then adjust the remaining potentiometer until the plate current reads 80 Ma. Slight readjustment of these potentiometers may be necessary later on to obtain minimum distortion.

In case of breakage of the time delay relay by accident or failure, for it to operate otherwise, a temporary expedient can be had by removing the time delay tube from the audio chassis and placing a jumper between terminals 67 and 68. In this way there is no time delay action and the overloads may trip from a cold start. This is usually due to the bias voltage not having obtained full value. By waiting a few seconds after the initial start no trouble will be encountered. Using the transmitter without the time delay tube, of course, is not recommended and the above is mentioned only for servicing and emergency procedure. It is well at this point to check the door interlock again which can be done by simply opening the back door, which will immediately drop out the plate contactor, all high voltage meters should drop to zero, which then indicates proper functioning. The overload circuit can be checked by leaving the power transformer primary leads disconnected from terminals 50 and 51 and holding the door interlock, pushing up on the armature of the plate contactor with a wooden dowel, the contactor will seal in when the contacts are made. Pushing the armature of the overload relays with the wooden dowel, which are the two relays towards the front on the overload panel, should cause the oscillator relay, also mounted on this board, to open its contacts and drop out the plate contactor. CAUTION: The armatures of these relays are in the 220 volt circuit and should never be touched with the body.

In case of changing frequency to a new frequency from that previously supplied when manufactured, the following information regarding the neutralizing procedure will be valuable. Set condenser C28 at half capacity. The plate coil connections of the 813 intermediate stage

should be set equi-distant from the center tap connection. The tuning ranges will be as follows: For 1200 Kc to 1600 Kc use 15 turns on each side of center tap (first tap from center tap). The second tap from center (21 turns) will provide a tuning range from 1500 Kc to 950 Kc. The full coil provides tuning from 720 Kc to 1100 Kc. Tuning from 550 Kc to 950 Kc requires the addition of a 500 mmfd. padding condenser (C41). Where overlap occurs, both ranges should be tried for best operation. Normally, the unused portions of the coil should be shorted out. On the high frequency end of the band, where the first tap from center is used, the shorting links may give better performance by being connected across a portion of the unused coil, and not across the entire unused portion.

Connecting the Load

It is difficult in these instructions to give loading information as various types of loads are applied in almost each broadcasting installation. Where a 70 ohm transmission line is provided, the line current meter M1 is usually 0-3 amperes, while for a 250 ohm transmission line meter M1 is usually 0-2 amperes. The formula of I^2R is usually employed in computing the proper line current where the line impedance is known, and of course, is likewise employed where the antenna resistance is known in the case of direct coupling. A dummy antenna of known value is usually preferable in the initial tune-up so that it can be determined whether the transmitter is functioning properly and thus full attention can be given to the antenna loading problems for final successful operation. The Ohmite D250 dummy antenna for 73 ohms operates excellently where the transmission line is 73 ohms. Or, in the case of 250 ohm transmission lines, four of these dummy antennas may be wired in series which will give slightly higher resistance than the open wire transmission line, but usually will be satisfactory as the resistance is known.

As a less satisfactory dummy antenna, 150 watt lamp bulbs may be employed which have a resistance of about 100 ohms, but are not dependable as their resistance will vary with intensity. Two may be paralleled to give a 50 ohm dummy antenna or three may be series to give a 300 ohm dummy antenna. One in series with two in parallel will give approximately 75 ohms. Two series connected in series with two parallel connected will give approximately 250 ohms. As light bulbs are highly reactive, the actual load will be considerably removed from the proper condition but will serve to allow a good preliminary checkup. As the power amplifier tank circuit is directly affected by the load, it is will to discount this in the subject of loading conditions. The power amplifier tank is usually provided with a padding capacity C33 in addition to the variable tuning capacity C32. The tank capacity and the coupling capacities C34 and C35 determine the harmonic suppression, a chart of recommended values for various frequencies and common loadings is given elsewhere in this instruction book. Special loading conditions may require modification, and frequently the addition of a series condenser. In this latter case, the condenser is between the line coil L11 and meter M1. The proper loading of the transmitter to your particular condition must be admitted as more or less on

a cut-and-try basis, adjusting C34 and the taps on coil L11; maintaining the final power amplifier in complete resonance will eventually produce the desired results where the load is not below 30 ohms or exceeds 300 ohms. Final current into the line load on the formula I^2R is, of course, the answer to the correctness of the load. The efficiency of the BC250GY transmitter is 70% and seldom over 75%. It should be remembered that efficiency is measured into a known load, and preferably a resistive load designed for radio frequency operation. It should also be remembered that a radio transmitter of standard construction is not normally inefficient when, of course, properly adjusted and tuned. Thus, lack of efficiency in operation can usually always be attributed to lack of proper loading conditions to the transmitter itself, which is usually indicated by unbalanced line currents in the case of a transmission line, and of course, can be checked by making sure ground connections to the transmitter are well made directly to the radiating system of the antenna.

Abnormally high efficiency is quite frequently found to be in the antenna system. This may be checked if a dummy antenna of equivalent resistance is substituted for the line or antenna. It may be found that the line current meter is measuring reactive currents, which would give a false impression of efficiency.

We are now ready to adjust the pickup loop L12 which connects the modulation monitor to the transmitter. This coil has been designed particularly to operate the Gates MO-2639 Modulation Monitor, part of the GY48 Radio Station, but is sufficiently designed to operate any good modulation monitor. By consulting the instruction book on the MO-2639 Modulation Monitor as to proper carrier adjustment and rotating coil L12 until proper excitation is obtained, no difficulty will be had in operating the monitor. This adjustment is minimum coupling to give satisfactory operation.

Making Measurements

If your station is fortunate enough to have noise and distortion measuring equipment, much can be accomplished that would be difficult otherwise. The Gates SA-131 Proof of Performance kit contains the required instruments for making measurements. The BC250GY transmitter should produce uniform frequency response within 1-½ decibels from 30 to 10,000 cycles, and the distortion content with good tube balance and proper tune-up should not exceed 3% at all usable frequencies. The noise level with a good installation well grounded and properly tuned and with the audio input shorted, should be in the neighborhood of 60 decibels below 95% modulation. The MO-2639 modulation monitor would be used for making frequency response measurements in conjunction with a good quality audio oscillator, remembering to correct the input level at various frequencies by placing an indicating meter directly at the input terminals of the transmitter. Excessive noise is usually indicated when grounding is improper, where a noisy tube prevails, or in some instances where the shields between the measuring equipment and the transmitter have not been properly bonded. Excessive radio frequency radiation in some instances will make its way back into the testing equipment indicating as noise. Not having a distortion and noise analyzer, the installing engineer may use an oscilloscope for checking wave form and general performance with satisfactory

results. Excessive distortion can usually be corrected by adjustments of modulator bias controls R25 and R26 and likewise by making sure that both the 6L6 and 810 modulator tubes are balanced; particularly is this important in the 6L6 stage. The checking over of noise or general performance by means of a radio receiver in the same room as that of the transmitter is not considered satisfactory, as quite often blocking conditions or re-radiation from power lines will induce spurious noises and other effects into the receiver that do not indicate the exact performance being obtained. In the final analysis where measuring equipment is not available, the good listening quality is the only way proper performance can be determined. In this connection it should be remembered that every installation is only as good as its weakest link and it is not necessary to inform the experienced installing engineer that poor accessory equipment such as transcription pickups, microphones or any other unit in the broadcast circuit will not enhance the operation of the best transmitting equipment. The audio input level to the transmitter will be approximately +14 VU for 100% modulation, but, of course, will vary depending upon the final determined efficiency of operation of the transmitter. A thorough study of the operation of the SA38 limiting amplifier where provided with the GY48 radio station is desirable by reading the instruction book on the SA38 equipment. It should be pointed out that any new transmitter will have perhaps certain peculiarities in the settling-down process. Carrier frequency drift will possibly be noted more than normal for as much as two weeks' time until the crystals settle down. Flashing condensers, such as tank and loading condensers which are much more adequately spaced than necessary for this equipment indicate improper tune-up and improper loading and these are good clues to recheck the installation procedure throughout. It must always be remembered that the power doubled in any transmitter must have a place to go and when it is choked off by means of improper loading, flashing condensers and general improper service of many components will frequently appear as the offenders but instead will be indications of an abnormal condition. Regardless, contacts should be regularly inspected and cleaned. However, avoid filing contacts to remove burrs. Instead, use a burnishing tool or crocus cloth, taking care to remove any lint from the contacts.

SECTION IV - TYPICAL VOLTAGE CONDITIONS OF BC-250GY TRANSMITTER

These readings are average and subject to variation:

(a) - 6L6 Audio Driver

Plate Voltage	330 V.
Screen Voltage	230 V.
Total Cathode Current	110 Ma.
Cathode Voltage	14V.
Filament	6.3 Volts A.C.

(b) - Modulators

Plate Voltage	1400 V.
Total Static Plate Current (M2)	50 Ma.
Bias approx.	-32
Filament (M7)	10 volts A.C.

(c) - 807 Oscillator

Plate voltage	250 V.
Cathode Current (M8)	30 Ma.
Screen voltage	125 V.
Filament	6.3 volts A.C.
Cathode voltage	3 volts

(d) - 813 RF Driver

Plate voltage	1400 V.
Screen voltage	330 V.
Cathode Current M6	130-160 Ma.

(e) - Power Amplifier

Plate Voltage (M5)	1350
Plate Current (M4)	246 Ma. (typical only, will vary)
Filament	10 volts A.C.
Grid Current (M3)	75-120 Ma.

(f) - Line Current (M1) (250 watts output)

250 ohm load	1 amp.
72 ohm load	1.84 amp.
50 ohm load	2.24 amp.

Conclusion

A radio broadcast transmitter, regardless of its size, cannot be fully described in an instruction book such as this as to every possible condition that may arise in the process of installing and placing into operation. There have been provided on the following pages numerous drawings showing the entire transmitter construction and ballooned pictures showing the parts as to their location in the transmitter. In preparing the instruction book it has been recognized that the installing

engineer undoubtedly is very familiar with general broadcast equipment procedures and that many of the things referred to are well known by him. It is suggested, therefore, that the installing engineer and likewise the personnel who will use 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 BC250GY transmitter and the GY48 Radio Station has done everything to provide for you the finest equipment available today. It is not possible for us to provide the location, the antenna, 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 you to do and certain analyses must be left for you to determine. In every instance the use of good engineering practice and sound fundamental reasoning will develop the desired high quality results possible from this equipment.

The GY48 Radio Station as previously outlined consists basically of the BC250GY transmitter and the accessory cabinet consisting of monitors and audio equipment. Thus, the knowledge of the equipment in the accessory cabinet has been left to the individual instruction books pertaining to the basic units used in the accessory cabinet. Likewise, by referring to block drawing B-10836, conduit drawing B-10872, audio rack diagram C-16044 the installing engineer will have no difficulty in quickly determining the mode of operation of the entire GY48 Radio Station.

It is repeated again, make a good installation, eliminate haste and in so doing keep the record of failures a blank on your log book. Also remember that cleanliness in the maintenance of your broadcasting equipment will pay big dividends. Take a period each week for cleaning the inside and outside of the transmitter and accessory equipment, for testing tubes, making sure all connections remain solid (they can work loose you know, even from vibration from daily walking around the room) and the many other things that are entitled good maintenance. In so doing, happy and satisfactory performance from Gates broadcasting equipment will result. In case of any problem that is perplexing to you feel free to contact the engineering department of the Gates Company who will gladly cooperate with you in every way to obtain the most satisfaction from your Gates equipment.

DIODE REMOTE METER

The diode type remote meter shown in schematic A-5001 is preferred because the coupling to the antenna circuit is inductive and less vulnerable to lightning damage. The main diode rectifier is located at the tower tuning house and feeds to the remote meter by an ordinary pair of lead covered wire, usually No. 14 for strength, though smaller may be used. The diode power circuit may usually be taken from the tower light wiring by adding a third wire to this circuit. Installation is simple and rheostat R27 is adjusted so the remote meter indicates the same as the official antenna meter. It is desirable that the remote and official antenna meter have the same scale reading. When ordering specify the Gates MO-3294 diode remote meter with scale reading to be the same as your official antenna meter. Ranges of 3, 5 and 10 amperes are stock standards.

THERMOCOUPLE REMOTE METER

In schematic A-5479 is shown the much used thermocouple type of remote meter. This type requires no line voltage at the point of the antenna tower but is usually considered higher in maintenance cost as the thermocouple is directly in the antenna circuit and vulnerable to lightning. The choke coils 4550 and capacitors .005 mfd. are located directly adjacent to the thermocouple which choke out the R.F. current & feed direct current to the line feeding the remote meter at the transmitter. This line may be a lead covered pair of #14 wires. The rheostat C151 may be located either at the tower coupling unit or at the remote meter and is adjusted so the remote meter reads the same as the official antenna meter. When ordering specify the "remote meter thermocouple kit" specifying the scale range desired for the meter. Ranges 1.5, 3, 5 and 10 amperes are stock standards.

GUARANTEE

This equipment is fully guaranteed by the Gates Radio Company of Quincy, Illinois, to be free from all defects in materials and workmanship and will be repaired, replaced or adjusted in accordance with the manufacturer's option and terms as outlined below.

1 - Gates believes the purchaser has every right to expect first-class quality materials and workmanship and has created rigid inspection and test procedures plus excellent packing methods to assure good arrival at destination.

2 - Gates agrees to supply daily factory service, and will make emergency shipments at any time where possible.

3 - Gates fully guarantees, under normal and proper usage, all component parts in Gates equipment, except as noted. These parts will be replaced or repaired at the option of Gates as follows:

<u>Transmitter Parts</u>: main power or plate transformer, modulation transformer, modulation reactor, main tank condensers.

(replacements or repairs) - where less than 1 year old...no charge, between 1 and 2 years old 50% or new price

<u>Moving Parts</u>: Guaranteed for six months.

<u>Electron Tubes</u>: Subject to manufacturer's warranty at the time of shipment. Adjustment will be made to the customer as given to Gates Radio Company by the tube manufacturer.

<u>All other component parts</u>: (Except as listed above or below) Guaranteed for one year.

<u>Abuse</u>: Damage resulting from an Act of God, or by fire, wind, rain, hail, or any other condition other than normal usage is not covered by the guarantee.

4 - Date of invoice to original user-purchaser and date of receipt by Gates Radio Company of notification from the customer will determine the age of equipment or parts.

5 - In case of adjustment, as on certain transmitter parts listed above "new price" is Gates' current price at time of replacement and/or adjustment.

6 - This guarantee covers only Gates manufactured parts and complete Gates equipments including all parts therein, with exceptions as noted. Any purchased part not manufactured by Gates will be subject to the manufacturer's guarantee, unless such part is a unit incorporated in Gates manufactured equipment.

7 - Transcription pickups, regardless of make, are guaranteed for ninety days - said guarantee including every associated part of the pickup except the stylus, which because of its fragility is not guaranteed by Gates.

8 - Where the replacement part in question must be supplied under the guarantee before the defective part can be returned for inspection, as might sometimes be required, the customer will be billed in full and credit or adjustment will be given on receipt of the defective part in accordance with this guarantee and the terms herein. In order for credit adjustment to be received in line with this guarantee the defective or replaced part must be shipped prepaid to Gates Radio Company or to any other destination requested by Gates within two weeks of the date of the invoice covering the replacement part. Any item alleged defective shall not be returned to Gates until after written permission has been first obtained from Gates' home office at your request.

9 - All shipments under this guarantee will be made f.o.b. Quincy, Illinois and all materials returned will be shipped prepaid by the customer f.o.b. Quincy, Illinois

10 - As a material part of this guarantee the customer agrees to employ capable technical personnel to maintain all equipment under this guarantee in good, normal condition, properly serviced and cleaned and to use said equipment as and for the purpose intended by seller. This guarantee does not extend to the supply by Gates of any personnel to make any replacement, repair or adjustment.

11 - Gates shall not be responsible for damages to items in transportation or careless handling; or injuries to persons or damage to property arising out of the use or operation of Gates equipment or parts, but Gates will supply repair or replacement items speedily, which will be billed to the customer who, in turn, will place claim with the carrier, with assistance from Gates if necessary and when so requested.

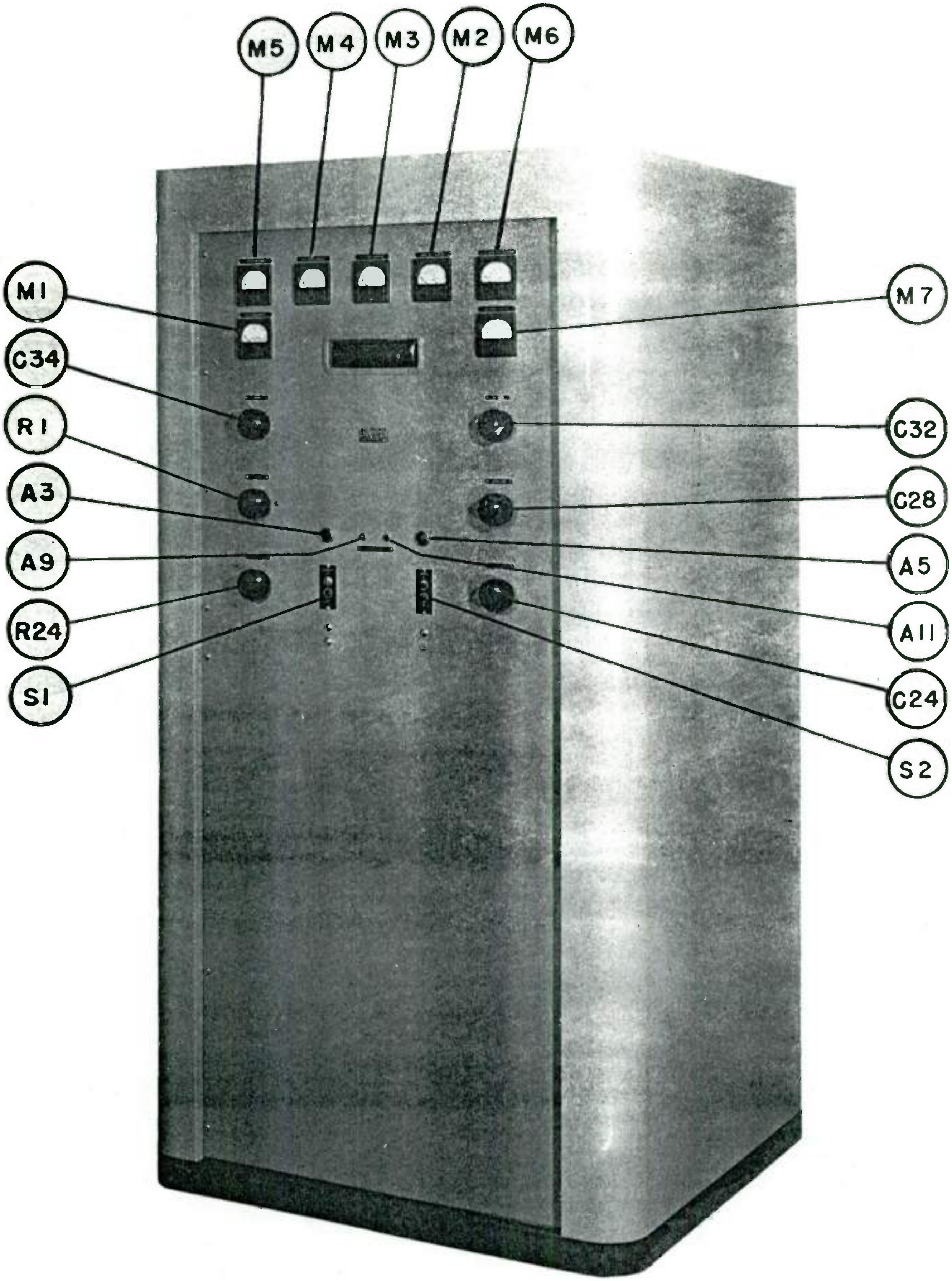
12 - Delays in fulfilling any part of this guarantee because of depleted stock, floods, war, strikes, power failures, transportation delays, or failure of suppliers to deliver, or because of Acts of God or any other conditions beyond the control of Gates, does not in any way render Gates liable under this guarantee; however, every effort will be made to render prompt service.

13 - Gates agrees that this equipment sold is manufactured, where need be, under Royalty License Agreements with Western Electric Company and Radio Corporation of America.

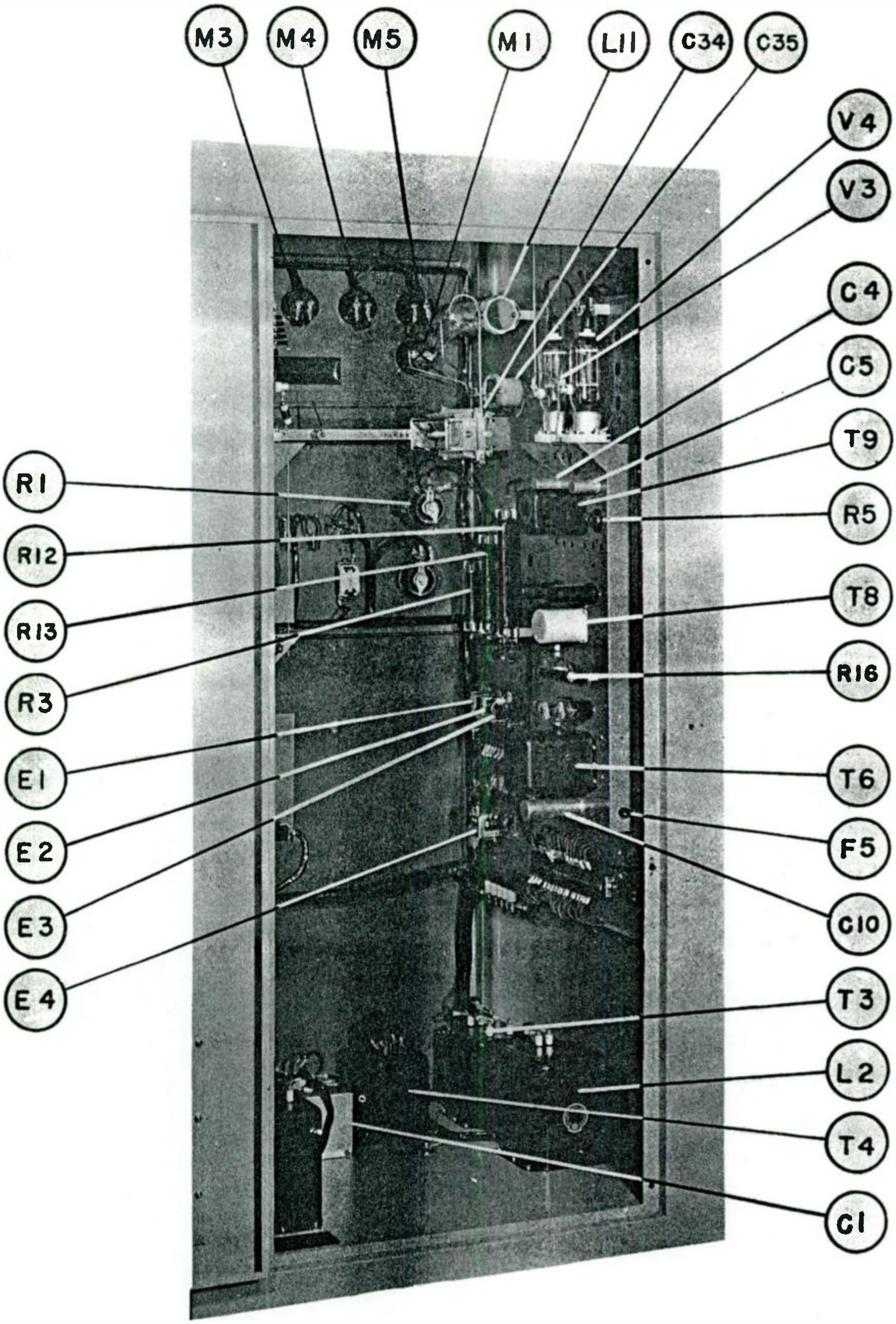
14 - This Guarantee is not transferable from the original user-purchaser, and no right of subrogation is given herein.

15 - This Guarantee is effective on all standard Gates cataloged items sold after June 11, 1951.

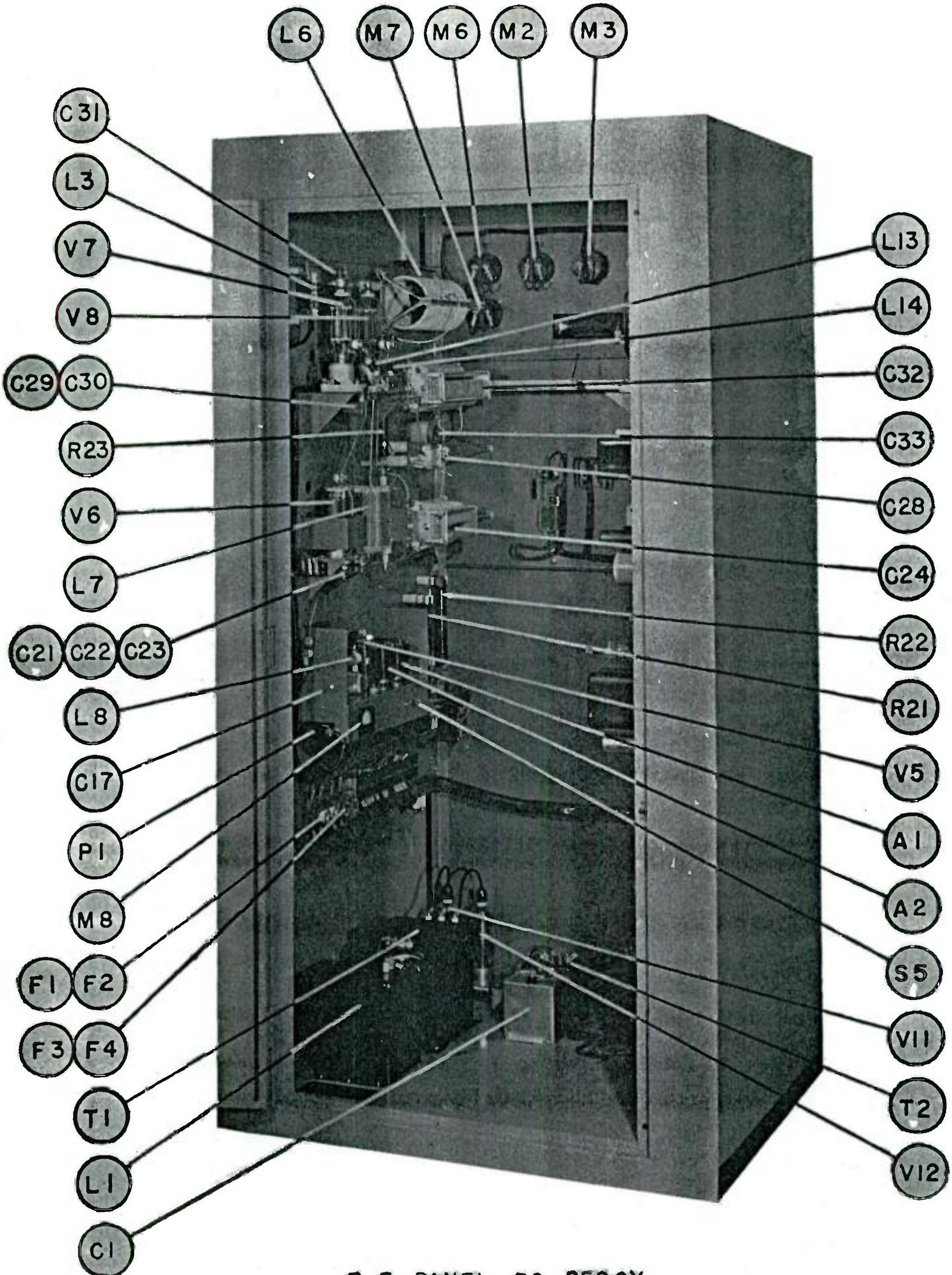
Gates Radio Company
Quincy, Illinois



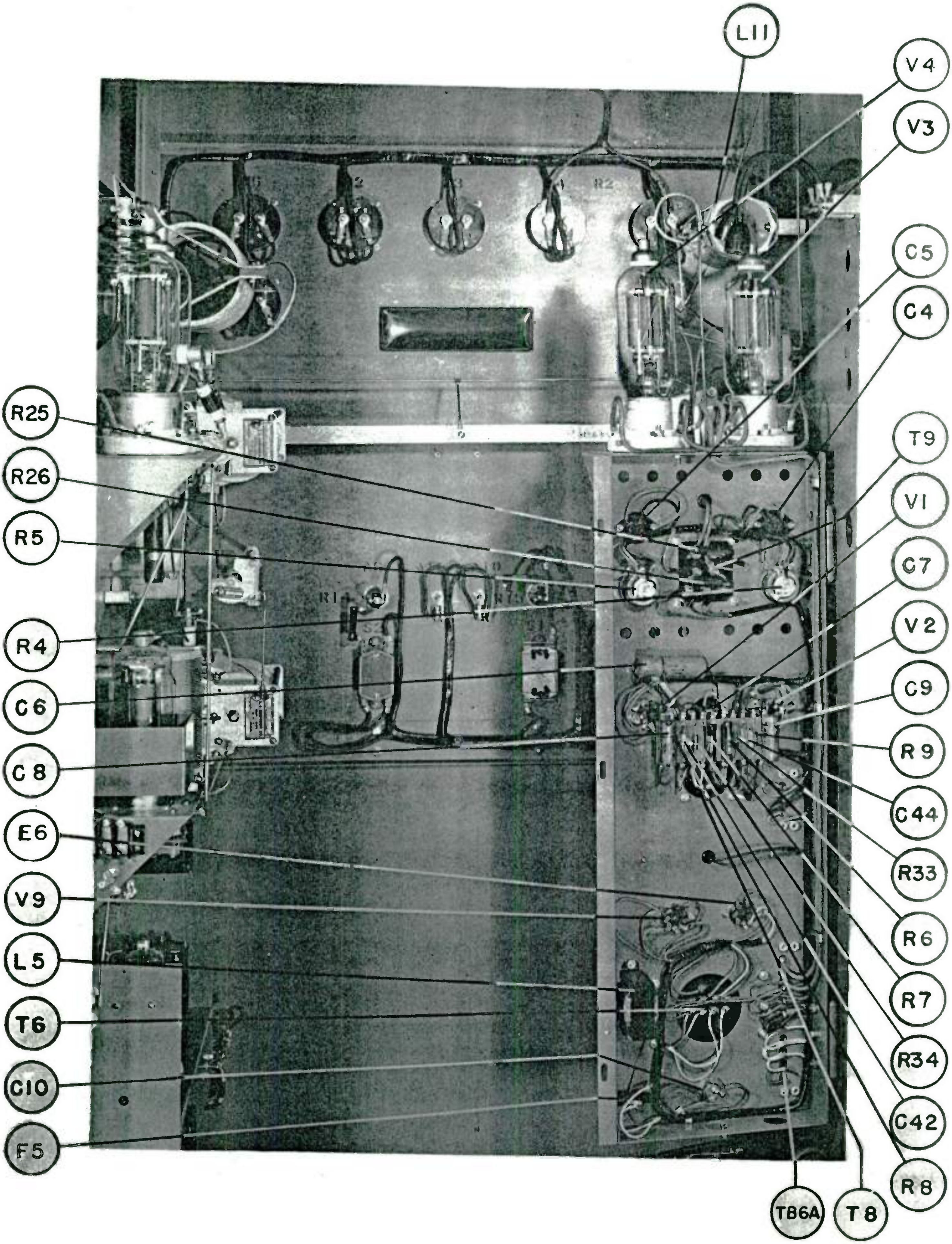
FRONT VIEW BC-250GY



MODULATOR & AUDIO BC-250GY



R. F. PANEL BC-250GY


L11
V4
V3
C5
C4
T9
V1
C7
V2
C9
R9
C44
R33
R6
R7
R34
C42
R8
T8
TB6A
R25
R26
R5
R4
C6
C8
E6
V9
L5
T6
C10
F5

PARTS LIST (226-PE-101)

SYMBOL NO.	DRAWING NO.	DESCRIPTION
A1		Crystal & oven (MO3AB Bliley) or (JK57M) James Knight
A2		Crystal & Oven (MO3AB Bliley) or (JK57M James Knight)
A3		Pilot Light Assembly, Green, #31101-112 Dialco
A4		Lamp, S6, 10W. 230V.
A5		Pilot Light Assembly, Red, #31101-111 Dialco
A6		Lamp, S6, 10W. 230V.
A7		Fuse Block, 2 pole, 62965 G. E.
A8		Fuse Block, 2 pole, 62965 G. E.
A9		Pilot Light Assembly, Red, #510M-431 Dialco
A10		Lamp, 6-8V. #46
A11		Pilot Light Assembly, Red, #510M-431 Dialco
A12		Lamp, 6-8V. #46
A13		Fuse Holder, 341001, (10756) Littlefuse
C1		Capacitor, 10 mfd., 2000 W.V., TJL-20100 (C-D)
C2		
C3		Capacitor, 1 mfd., 1500 W.V., TJU-15010 (C-D)
C4		Capacitor, 40 mfd., 150V., UP-4015 (C-D)
C5		Capacitor, 40 mfd., 150V. UP-4015 (C-D)
C6		Capacitor, .5 mfd., 600 W.V., Paper Tubular
C7		Capacitor, 20 mfd., 450V., UP-2045 (C-D)
C8		Capacitor, .1 mfd., 600 W.V., Paper Tubular
C9		Capacitor, .1 mfd., 600 W.V., Paper Tubular
C10		Capacitor, 4 mfd., 600 W.V., Aerovox Hyvol 610D or Equivalent (Both Terminals Insulated)
C11		
C12		Capacitor, .1 mfd., 400 W.V., Paper Tubular
C13		Capacitor, .1 mfd., 400 W.V., Paper Tubular
C14		Capacitor, .01 mfd., 1 KV ,HiKap, DD-103 Central
C15		Capacitor, .01 mfd., 1 KV.,Hi-Kap DD-103 Centrala
C16		Capacitor, .01 mfd., 1 KV ,Hi-Kap DD-103 Centrala
C17		250 mmfd., Variable Cond., #250 L15 Johnson
C18		Capacitor, 600 W.V., Type H Sangamo
C19		Ceramic Trimmer, 20-125 mmfd., Type 823-AN Centralab
C20		Capacitor, .0001 mfd., 600 W.V., Type H Sangamo
C21		Capacitor, .005 mfd., 1200 W.V., Type H Sangamo
C22		Capacitor, .002 mfd., 600 W.V., Type H Sangamo
C23		Capacitor, .002 mfd., 600 W.V., Type H Sangamo
C24		500 mmfd., Variable Cond., 500D35 Johnson
C25		
C26		Capacitor, .0015 mfd., 2500 W.V., Type H Sangamo
C27		813-810 Coupling Cap., 2500 (W) V. Type H Sangamo (Value Det. by Freq.)

PARTS LIST (226-PE-101)

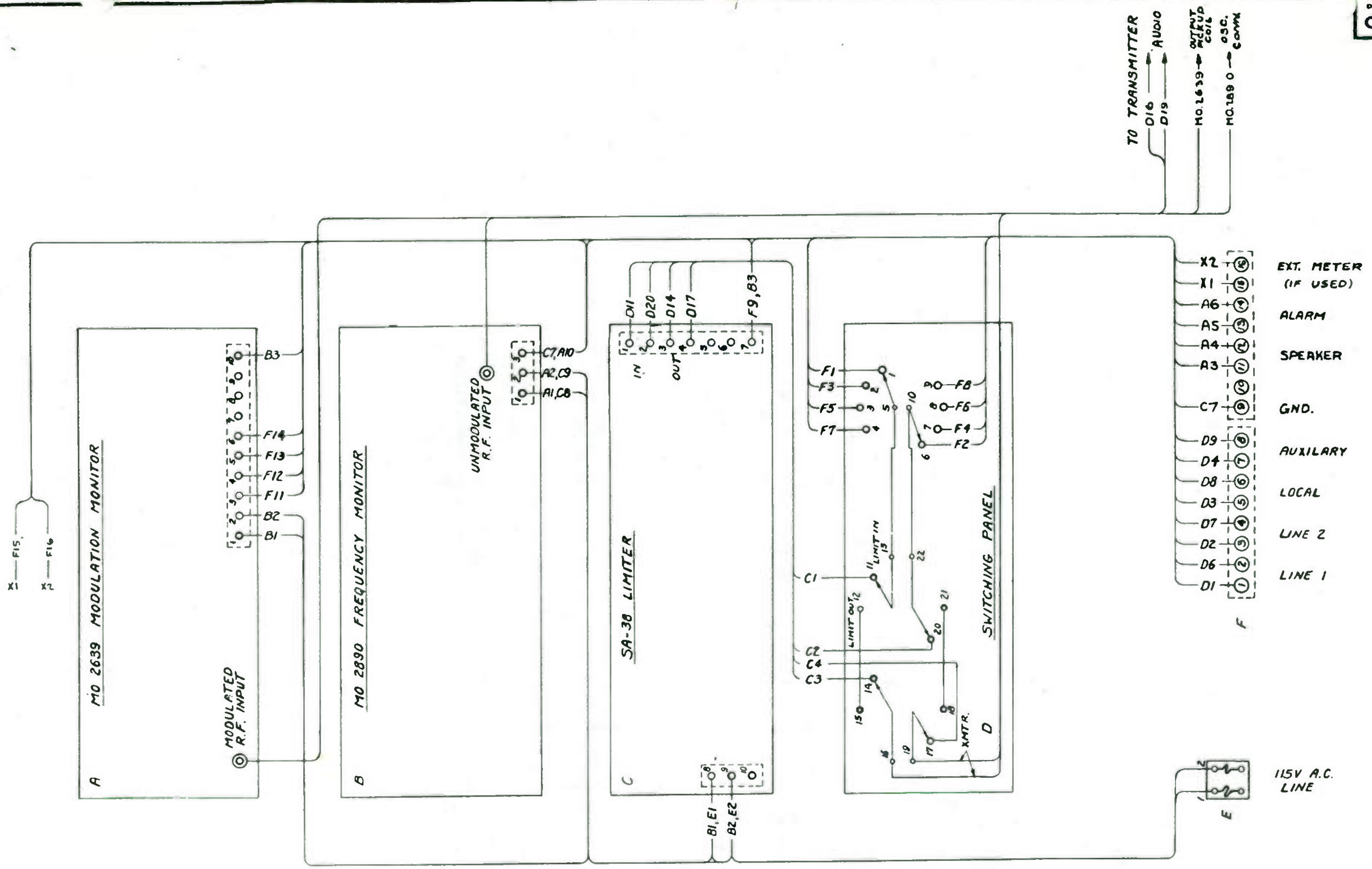
SYMBOL NO.	DRAWING NO.	DESCRIPTION
C28		Neut. Condenser, 12G70 Johnson
C29		Capacitor, .02 mfd., 600 W. V., Type H Sangamo
C30		Capacitor, .02 mfd., 600 W. V., Type H Sangamo
C31		Capacitor, .001 mfd., 5000 W. V., F2L Sangamo
C32		250 mmfd., Variable Cond., 250D70 Johnson
C33		Cap., G1, (or Type F2L) Sangamo (Value Det. by Freq.)
C34✓		500 mmfd., Variable Cond., 500D35 Johnson
C35		Cap., G1, (or Type E) Sangamo (Value Det. by Line Impedance)
C36		Type E Sangamo (Capacity as required)
C37		25 mmfd., Variable Cond., LC-2077 Bud
C38		25 mmfd., Variable Cond., LC-2077 Bud
C39		15 mmfd., Variable Cond., LC-2076 Bud
C40		Capacitor, .000051 mfd., 500 W. V. Type K Sangamo
C41		Capacitor. Type F2L Sangamo (Value Det by Frequency)
C42		Capacitor, .00024 mfd., Type K Sangamo
C43		
C44		Capacitor, .00024 mfd., Type K Sangamo
C45		Capacitor, 4 mfd., 2000V., TJL-20040 C-D
E1		P.A. Overload, SPDT-2.2 ohms 300 MA. Closing, LP-1004 P&B
E2		Mod. Overload, SPDT-2.2 ohms, 300 MA. Closing, LP-1004 P&B
E3		Overload Aux. 220 V. 60 cy coil, Normally Closed, MR-5A P&B
E4		Plate Relay, Class 8502, Type AO-20 2 pole Coil 220V., 60 cy., Square D
E5		Time Delay Relay, 6N030, Amperite
F1		Fuse Plug, 10 amp. 125 V.
F2		Fuse Plug, 10 amp. 125 V.
F3		Fuse Plug, 10 amp. 125 V.
F4		Fuse Plug, 10 amp. 125 V.
F5		Fuse 2 amp, 3AG Littlefuse
J1		Connector, Single 83-1R Amphenol (Female)
J2		Connector, Double 83-22R Amphenol (Female)

SYMBOL NO.	DRAWING NO.	DESCRIPTION
L1	AC-7427K	Swinging Choke 16HY@0.3A TO 5HY@1.0A ?
L2		Modulation Reactor, RR-1 Chitran
L3		R.F. Choke, 7949 Miller
L4		
L5		Choke, 8 hy. 80 ma. R-18 U.T.C.
L6		Plate Tank Coil, 6VT-4554 Gates
L7	C-16572-101	813 Tank Coil Assembly
L8	A-4159-101	Osc. Plate Tank Coil Ass'y
L9		R.F. Choke, R-100U Miller
L10		R.F. Choke, 4550 Miller
L11	C-16083-101	Antenna Coil Assembly
L12	A-4155-101	R.F. Monitor Coupling Coil Ass'y
L13	A-7033-101	Parasitic Suppressor
L14		Part of L13
L15		Filter Choke, R-65 Chicago Standard
M1		R.F. Line Current Meter, Type RT-35 Westinghouse, C-3R.F. amps, Int. Thermo Style 1-159-636 (Cal. for Non-Magnetic Panel)
M2		Mod. Plt. Current Meter, 0-500 MADC, Type RX-35, Style 1-159-749 Westinghouse (Cal. for Non-Magnetic Panel)
M3		P.A. Grid Current Meter, 0-200 MADC, Type RX-35, Style 1-159-745 Westinghouse (Cal. for Non-Magnetic Panel)
M4		P.A. Plate Current Meter, 0-500 MADC, Type RX-35, Style 1-159-749 Westinghouse, (Cal. for Non-Magnetic Panel)
M5		P.A. Plate Voltage Meter, 0-1 MA D. C., RX-35, Similar to Style 1159-687, except with 0-2500 Volt Scale, W'hse (Cal. for Non-Magnetic Panel)
M6		R.F. Driver Plate Current, 0-200 MADC, Type RX-35, Style 1-159-745 Westinghouse (Cal. for Non-Magnetic Panel)
M7		Filament Voltage Meter, 0-15V.A.C., Type RA-35 Style 1-159-023 Westinghouse (Cal. for Non-Magnetic Panel)
M8		Osc. Plate Current Meter, 0-50 MADC, Model 127 Simpson

SYMBOL NO.	DRAWING NO.	DESCRIPTION
P1		Plug (Male) P-408SB Jones
P2		Plug (Female) S-408CCE Jones
P3		Connector 33-1SP Amphenol (Male) (for J1)
P4		Connector 33-223P Amphenol (Male) (for J2)
R1		1000 ohms Potentiometer, Model K, 0457 Ohmite
R2		200 ohms 50W. Wirewound Resistor, 0400H Ohmite
R3		2.5 megohm Meter Multiplier, Ferrule Ends, 5-3/8" lg.
R4		1500 ohm Potentiometer, Model H #0159 Ohmite
R5		1500 ohm Potentiometer, Model H #0159 Ohmite
R6		15K ohm 10W. Wirewound Resistor
R7		125 ohm 10W. Wirewound Resistor
R8		220K ohms 1W. 10% A-B
R9		220K ohms 1W. 10% A-B
R10		180K ohms 1/2W. 10% A-B
R11		180K ohms 1/2W. 10% A-B
R12		8000 ohms, 160W. Lectrohm Type 9-5/8", K20-18
R13		10K ohms 110W. Lectrohm Ferrule Type
R14		3000 ohms 10W. Wirewound Resistor
R15		3000 ohms 10W. Wirewound Resistor
R16		5000 ohms 50W. Lectrohm Lug Type
R17		47K ohms 1W. 10% A-B
R18		100 ohms 10W. Wirewound
R19		27K ohms 2W. 10% A-B
R20		5000 ohms 10W. Lectrohm P.T.
R21		20K ohms 45W. Ferrule Type Lectrohm
R22		50K ohms 110W Ferrule Type Lectrohm
R23		3000 ohms 100W. Lug Type Ohmite #0613
R24		16 ohm Potentiometer, Model K, 0447 Ohmite
R25		2000 ohms 10W. Wirewound Lectrohm Type 1-3/4E
R26		2000 ohms 10W. Wirewound Lectrohm Type 1-3/4E
R27		10 ohm 10W. Lectrohm Adjustable Resistor
R28		10 ohm 10W. Lectrohm Adjustable Resistor
R29		200 ohms 50W. Lug Type Ohmite #0400-H
R30		50K ohms 20W. Wirewound Resistor
R32		120 ohms 1W. 10% A-B
R33		33K ohms 1W. 10% A-B
R34		33K ohms 1W. 10% A-B

SYMBOL NO.	DRAWING NO.	DESCRIPTION
S1		Switch, Double P.B., S.P.S.T. #4402M A-H & H
S2		Switch, Doublo P.B., #1615 AH & H
S3		
S4		Door Interlock, 8411K4 (C-H)
S5		D.P.D.T. Bat Handle Toggle Switch 8363-K7 (C-H)
T1	AP-7235E	Plate Transformer
T2	AF-10456K	Filament Transformer
T3		Modulation Transformer, BM-1 Chitran
T4	AF-11604K	Filament Transformer
T5	AF-7434K	Filament Transformer
T6	AP*3176K	Filament & Plate Transformer
T7	AF-7237K	Filament Transformer
T8	AI-300 2	Input Transformer, UTC
T9		Driver Transformer, BD-1 Chitran
TB1		Terminal Board, CIM-20
TB2		
TB3		Terminal Board, 3-142Y Jones
TB4		Terminal Board, 2-142 Jones
TB5		Terminal Board, CIM-20
TB6		Terminal Board, 10-142 Jones
TB6A		Terminal Board, 10-142Y Jones
TB7		Terminal Board, 6-142 Jones
TB8		Terminal Board, 3-142Y Jones
TB8A		Terminal Board, 3-142 Jones
V1		6L6 Tube
V2		6L6 Tube
V3		810 Tube
V4		810 Tube
V5		807 Tube
V6		813 Tube
V7		810 Tube

SYMBOL NO.	DRAWING NO.	DESCRIPTION
V8		810 Tube
V9		5V4 Tube
V11		8008 Tube
V12		8008 Tube
X1		MIP8 Amphenol Socket
X2		MIP8 Amphenol Socket
X3		#211 Johnson Socket
X4		#211 Johnson Socket
X5		MIP5 Amphenol Socket
X6		#237 Johnson Socket
X7		#211 Johnson Socket
X8		#211 Johnson Socket
X9		MIP8 Amphenol Socket
X10		MIP8 Amphenol Socket
X11		#244 Johnson Socket
X12		#244 Johnson Socket
X13		MIP5 Amphenol Socket
X14		MIP5 Amphenol Socket



WIRING VIEWED FROM BACK OF RACK

2	ECN 1064 H.A.Y. 4-20-48 ADDED X1 & X2 & NEW TERMINAL BOARD
1	ECN #1023 HGH 3-20-48

GATES RADIO COMPANY
QUINCY, ILLINOIS

AUDIO RACK WIRING FOR MO 3066

MATERIAL		SCALE
DR. BY H.A.Y.	DATE 1-13-48	DRAWING NUMBER C- 16044
CH. BY L.P.E.	ENG. L.P.E.	

M1 0.0.0.100. RF Line Amps

M2 Mod Plate Curr

M3 PA Grid Amps

M4 PA Plate Amps

M5 PA Plate Voltage

M6 RF Driver Plate A

M7 FIL Voltage

M8 OSC Plate Amps

M1 0.00100. RF Line Amps

M2 Mod Plate Curr

M3 PA Grid Amps

M4 PA Plate Amps

M5 PA Plate Voltage

M6 RF Driver Plate A

M7 FIL Voltage

M8 OSC Plate Amps

M1 0.00100. RF Line Amps

M2 Mod Plate Curr

M3 PA Grid Amps

M4 PA Plate Amps

M5 PA Plate Voltage

M6 RF Driver Plate A

M7 FIL Voltage

M8 OSC Plate Amps

HOW CAN WE HELP YOU?

Where problems exist, we want to help. — The best way is to work out the problems together. In that way, you are completely familiar with what is done and future maintenance will be routine.

1. You will note the SERVICE QUESTIONNAIRE. Fill this out completely and mail back today, if possible. Use an extra sheet of paper if further comments are necessary. The following are statements of fact or things to look for. Always remember that most problems have a simple solution. If some of the statements below are elementary, it is because busy, intelligent people often assume that the simple, elementary things are okay.

2. LOW OR HIGH EFFICIENCY. This is important as a first test. As efficiency will vary with transmitter powers, these estimates will help:

250 watts	-----	65 to 75% efficiency
500 watts	-----	65 to 75% efficiency
1000 watts	-----	68 to 77% efficiency
5000 watts	-----	72 to 80% efficiency

   (a) The above variances in limits could be for many reasons such as slight meter error, tune-up and/or variance in transmission line length.

3. COMPUTING EFFICIENCY. To compute wattage input, multiply the plate voltage by the plate current in the final radio frequency amplifier. For example, if plate volts were 2500 and plate current was 550 MA., we have:

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

This means the power input to the final P.A. stage as required to compute power is 1375 watts, which would be approximate for a 1000 watt transmitter. If, at this power input, the transmitter is delivering 1000 watts output as computed by antenna current (see Par. 4), then we find the transmitter is approximately 73% efficient, or:

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

4. COMPUTING POWER OUTPUT. The formula I^2R is employed here. I = the current reading of your antenna meter at the tower and R = the resistance measurement of your tower as provided by your consultant who measured your tower after it was erected. If the tower resistance was 50 ohms (they vary widely from tower to tower), then the antenna current squared, multiplied by the tower resistance, would be the power output. Using 1000 watts as the transmitter power, we find if the antenna current was $4\frac{1}{2}$ amperes that the square of this, or 4.5 x 4.5, is 20.25 and we have this simple problem:

$$20.25 \times 50 = 1012.5 \text{ (watts)}$$

5. CORRECTING LOW EFFICIENCY. Basically a broadcast transmitter by inherent design cannot produce low efficiency unless it is tuned up incorrectly. If you have low efficiency, your first check should be into an approved dummy antenna. Light bulbs or dummy antennas of unknown resistance under power do not help. As every station should have a dummy antenna for off-hours testing, etc., this should be part of your test equipment. Several types are listed in the Gates catalog and they are not expensive. By use of the dummy antenna, we have a known resistance to compute the transmitter efficiency without using the antenna tower, antenna coupling equipment or transmission line. By using the formula in Par. 4 above, we use the resistance of the dummy antenna as R. The I^2R gives us the power out of the transmitter.

6. When using a dummy antenna and efficiency is low or below that in Par. 2, the first thing to do is check the accuracy of the plate voltmeter and P.A. milliammeter. This is the gas tank that is always full but often turns out to be the offender. Meters are delicate and the transportation company could have dropped the box in just a way to render a meter inaccurate. You must have another meter of known accuracy for both circuits. A reliable volt-ohm-meter will suffice. Be careful as the voltage is lethal. If you find either of these meters is off, you have found the trouble.

7. If all is normal, then reconnect the transmitter to the antenna. Get another R.F. ammeter (perhaps you can borrow one from a nearby station) and check the accuracy of this meter. An error of only a couple tenths on the scale makes a huge difference. Using our example in Par. 4 above, you will note we used a meter reading of 4.5 amperes as an example which gave us 1012.5 watts output. If this meter had read 4.4 amperes, the output would have been 968 watts. Thus, if the meter was off only 0.1 amperes, we lose 44 watts or nearly 5% of our 1000 watts output.

8. ARCING PROBLEMS. Power must go to the antenna. When it gets sidetracked, it has to go somewhere and this often causes arcing. As efficiency, discussed above, tells many stories, we often find that low efficiency and arcing go together. If the dummy antenna shows good efficiency and the antenna itself shows poor efficiency, it means part of the power is not getting to the antenna. This could indicate several things:

   — Improper tuning of antenna coupler.
   — Standing waves on the transmission line usually indicated by different current readings at each end of the line.
   — Improper ground return from the ground radials to the transmitter.
   — Incorrect resistance measurement of the tower.

9. TUNING ANTENNA COUPLER. Your consultant can help you by tuning up your coupler with an R.F. bridge at the same time he measures your tower. --- Where this is not possible and a bridge is not available, consult the graphs in the instruction book and use the cut and try method. Result desired is the greatest antenna current without increasing the power input to the transmitter to get the increased antenna current.

10. STANDING WAVES on the transmission line are caused by improper impedance match between the output of the line and the antenna coupler. Poor match between transmitter output and input to line will reduce power transfer and cause low efficiency. Standing waves may also be caused by a poor or no ground on the outer shield of the transmission line. This line should be grounded to the ground radials at the tower end and to the transmitter at the transmitter end.

11. IMPROPER GROUND. Here is where many good installations go astray. We plow in 120 ground radials but fail to connect them well to the transmitter. Remember, this is the second conductor of our radiating circuit. Where the radials are bonded together at the tower, extend at least a 2-inch copper strap directly to the ground of the broadcast transmitter. Do not attach to one radial closest to the transmitter. Vision your transmitter the same as an ordinary light bulb circuit. The transmission line to the tower is one wire. The other is the ground strap from the radials under the tower back to the transmitter. And don't forget to ground the antenna coupler box too. In fact, you can't do enough good grounding.

12. INCORRECT RESISTANCE MEASUREMENT OF TOWER. Here is where Gates might offend a consulting engineer. It can be said that consultants seldom miss because they know the importance but it has happened. We recall one world-famous consultant that came up with a wrong one and there are lots of good reasons, such as an error in the R.F. bridge. One cause is making changes in the ground system after the measurements are made. This one has upset all of us at times. Any good consultant will recheck his measurements if everything points that way. Be sure first because these consultants are mighty accurate. — The importance of this point is understood by reading Par. 4 again. If the resistance was actually 40 ohms instead of 50 ohms, the power output would be 20% less and the efficiency would be nothing short of horrible.

13. FUSE BLOWING. This doesn't happen often but when it does, it is a big problem. Especially in remote control unattended operation. It is a little embarrassing to suggest the fuses as too small. Don't forget the fuse power is computed by a good safety factor as you may have some things on these fuses that you have forgotten about, such as a window fan or a well pump. ---- Also fuse rating and heat go together. A hot day and border line fuses is asking for trouble.

14. More important is the deeper causes of fuse blowing. Here are a few points:

— In extremely cold weather if you blow a fuse at morning turn-on, it is a safe bet the temperature of the room has gone very low and the mercury in your rectifiers has collected, causing an arc-back. You can correct this by placing a light bulb or small heating element next to the rectifiers which turns on when the transmitter is turned off.

— Dirt or scum is the evil of all transmitters. Enough will cause arc-overs that will blow fuses.

— Look for cable abrasions.

15. It is also important to note that if you have had a fuse blowing ordeal, that after locating the cause, the fuse clips may be so badly charred that you will continue to blow fuses until the clips are replaced. Fuses will often blow while circuit breakers either in the transmitter or in the wall will not act. Fuses are faster but if you have proper size fuses the circuit breaker ahead of them will usually operate first.

16. UNEXPLAINED OUTAGES. This is the one that puzzles all technicians and often 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 always brings the question, "What caused that?" — Of course, if this happens infrequently we can say it is normal as power line dips, a jump across the arc gap at the tower base, or other normal things will cause this and it should remove the transmitter momentarily to protect it. Some circuits include an automatic carrier reset while other transmitters require the operator, either remote or in attendance, to push the start button. In either case, frequent outages demand the cause to be located.

17. Your transmitter always looks like the offender. It is the device with meters and it is the device that quits if there is a failure anywhere in the entire system. An open or short circuit in a transmission line does not hoist a flag at the point of trouble in the transmission line. It does react at the transmitter. A faulty insulator in an antenna guy wire or a bad connection in the antenna tuning unit only shows at the transmitter. — In fact, as you can see, the transmitter always shows as the offender. Often it is not, in fact more often it is not. ---- If the drive shaft between your car motor and the rear wheels fails, it does not mean the motor is defective.

18. Earlier we mentioned the need of a dummy antenna at every radio station. Here again we see how valuable it becomes because you can disconnect everything after the transmitter and use the dummy antenna. By quick process of elimination of the tower, coupler, transmission line, tower chokes and ground system, you are able to determine if the transmitter is the offender. By modulating the transmitter and doing regular programming for an hour or so into the dummy antenna you experience the same transmitter outages, then you can hang it on the transmitter. Conversely, if the transmitter gives no trouble into the dummy, you can conclude that the fault is not the transmitter but in what is connected to it.

19. Step by step trouble shooting is always best. Trouble shooting is never on the basis of "It might be this or that." Instead, follow through from the beginning. If the transmitter was okay on the dummy antenna, the question becomes — "Where is the trouble?" If a transmission line connects the transmitter to the antenna coupler, then move the dummy antenna to the far end of the line and repeat the tests. Always remember that tests should be made, in part, under full modulation because often an open or an arc will occur under conditions of the greatest voltage and/or current. If, in this condition, an irregularity is noted, you have found the point of trouble in the transmission line. If not, reconnect the antenna coupler and the next job is to visually observe the antenna coupler under operation. In so doing, you may actually note a small arc or corona during a modulation peak. This could be caused by dirt, a bad connection, or even a component that is defective.

HOW CAN WE HELP YOU?

Where problems exist, we want to help. — The best way is to work out the problems together. In that way, you are completely familiar with what is done and future maintenance will be routine.

1. You will note the SERVICE QUESTIONNAIRE. Fill this out completely and mail back today, if possible. Use an extra sheet of paper if further comments are necessary. The following are statements of fact or things to look for. Always remember that most problems have a simple solution. If some of the statements below are elementary, it is because busy, intelligent people often assume that the simple, elementary things are okay.

2. LOW OR HIGH EFFICIENCY. This is important as a first test. As efficiency will vary with transmitter powers, these estimates will help:

250 watts	-----	65 to 75% efficiency
500 watts	-----	65 to 75% efficiency
1000 watts	-----	68 to 77% efficiency
5000 watts	-----	72 to 80% efficiency

(a) The above variances in limits could be for many reasons such as slight meter error, tune-up and/or variance in transmission line length.

3. COMPUTING EFFICIENCY. To compute wattage input, multiply the plate voltage by the plate current in the final radio frequency amplifier. For example, if plate volts were 2500 and plate current was 550 MA., we have:

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

This means the power input to the final P.A. stage as required to compute power is 1375 watts, which would be approximate for a 1000 watt transmitter. If, at this power input, the transmitter is delivering 1000 watts output as computed by antenna current (see Par. 4), then we find the transmitter is approximately 73% efficient, or:

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

4. COMPUTING POWER OUTPUT. The formula I^2R is employed here. I = the current reading of your antenna meter at the tower and R = the resistance measurement of your tower as provided by your consultant who measured your tower after it was erected. If the tower resistance was 50 ohms (they vary widely from tower to tower), then the antenna current squared, multiplied by the tower resistance, would be the power output. Using 1000 watts as the transmitter power, we find if the antenna current was $4\frac{1}{2}$ amperes that the square of this, or 4.5 x 4.5, is 20.25 and we have this simple problem:

$$20.25 \times 50 = 1012.5 \text{ (watts)}$$

5. CORRECTING LOW EFFICIENCY. Basically a broadcast transmitter by inherent design cannot produce low efficiency unless it is tuned up incorrectly. If you have low efficiency, your first check should be into an approved dummy antenna. Light bulbs or dummy antennas of unknown resistance under power do not help. As every station should have a dummy antenna for off-hours testing, etc., this should be part of your test equipment. Several types are listed in the Gates catalog and they are not expensive. By use of the dummy antenna, we have a known resistance to compute the transmitter efficiency without using the antenna tower, antenna coupling equipment or transmission line. By using the formula in Par. 4 above, we use the resistance of the dummy antenna as R. The I^2R gives us the power out of the transmitter.

6. When using a dummy antenna and efficiency is low or below that in Par. 2, the first thing to do is check the accuracy of the plate voltmeter and P.A. milliammeter. This is the gas tank that is always full but often turns out to be the offender. Meters are delicate and the transportation company could have dropped the box in just a way to render a meter inaccurate. You must have another meter of known accuracy for both circuits. A reliable volt-ohm-meter will suffice. Be careful as the voltage is lethal. If you find either of these meters is off, you have found the trouble.

7. If all is normal, then reconnect the transmitter to the antenna. Get another R.F. ammeter (perhaps you can borrow one from a nearby station) and check the accuracy of this meter. An error of only a couple tenths on the scale makes a huge difference. Using our example in Par. 4 above, you will note we used a meter reading of 4.5 amperes as an example which gave us 1012.5 watts output. If this meter had read 4.4 amperes, the output would have been 968 watts. Thus, if the meter was off only 0.1 amperes, we lose 44 watts or nearly 5% of our 1000 watts output.

8. ARCING PROBLEMS. Power must go to the antenna. When it gets sidetracked, it has to go somewhere and this often causes arcing. As efficiency, discussed above, tells many stories, we often find that low efficiency and arcing go together. If the dummy antenna shows good efficiency and the antenna itself shows poor efficiency, it means part of the power is not getting to the antenna. This could indicate several things:

— Improper tuning of antenna coupler.
--- Standing waves on the transmission line usually indicated by different current readings at each end of the line.
— Improper ground return from the ground radials to the transmitter.
--- Incorrect resistance measurement of the tower.

9. TUNING ANTENNA COUPLER. Your consultant can help you by tuning up your coupler with an R.F. bridge at the same time he measures your tower. — Where this is not possible and a bridge is not available, consult the graphs in the instruction book and use the cut and try method. Result desired is the greatest antenna current without increasing the power input to the transmitter to get the increased antenna current.

10. STANDING WAVES on the transmission line are caused by improper impedance match between the output of the line and the antenna coupler. Poor match between transmitter output and input to line will reduce power transfer and cause low efficiency. Standing waves may also be caused by a poor or no ground on the outer shield of the transmission line. This line should be grounded to the ground radials at the tower end and to the transmitter at the transmitter end.

11. IMPROPER GROUND. Here is where many good installations go astray. We plow in 120 ground radials but fail to connect them well to the transmitter. Remember, this is the second conductor of our radiating circuit. Where the radials are bonded together at the tower, extend at least a 2-inch copper strap directly to the ground of the broadcast transmitter. Do not attach to one radial closest to the transmitter. Vision your transmitter the same as an ordinary light bulb circuit. The transmission line to the tower is one wire. The other is the ground strap from the radials under the tower back to the transmitter. And don't forget to ground the antenna coupler box too. In fact, you can't do enough good grounding.

12. INCORRECT RESISTANCE MEASUREMENT OF TOWER. Here is where Gates might offend a consulting engineer. It can be said that consultants seldom miss because they know the importance but it has happened. We recall one world-famous consultant that came up with a wrong one and there are lots of good reasons, such as an error in the R.F. bridge. One cause is making changes in the ground system after the measurements are made. This one has upset all of us at times. Any good consultant will recheck his measurements if everything points that way. Be sure first because these consultants are mighty accurate. — The importance of this point is understood by reading Par. 4 again. If the resistance was actually 40 ohms instead of 50 ohms, the power output would be 20% less and the efficiency would be nothing short of horrible.

13. FUSE BLOWING. This doesn't happen often but when it does, it is a big problem. Especially in remote control unattended operation. It is a little embarrassing to suggest the fuses as too small. Don't forget the fuse power is computed by a good safety factor as you may have some things on these fuses that you have forgotten about, such as a window fan or a well pump. — Also fuse rating and heat go together. A hot day and border line fuses is asking for trouble.

14. More important is the deeper causes of fuse blowing. Here are a few points:

- In extremely cold weather if you blow a fuse at morning turn-on, it is a safe bet the temperature of the room has gone very low and the mercury in your rectifiers has collected, causing an arc-back. You can correct this by placing a light bulb or small heating element next to the rectifiers which turns on when the transmitter is turned off.
- Dirt or scum is the evil of all transmitters. Enough will cause arc-overs that will blow fuses.
- Look for cable abrasions.

15. It is also important to note that if you have had a fuse blowing ordeal, that after locating the cause, the fuse clips may be so badly charred that you will continue to blow fuses until the clips are replaced. Fuses will often blow while circuit breakers either in the transmitter or in the wall will not act. Fuses are faster but if you have proper size fuses the circuit breaker ahead of them will usually operate first.

16. UNEXPLAINED OUTAGES. This is the one that puzzles all technicians and often 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 always brings the question, "What caused that?" — Of course, if this happens infrequently we can say it is normal as power line dips, a jump across the arc gap at the tower base, or other normal things will cause this and it should remove the transmitter momentarily to protect it. Some circuits include an automatic carrier reset while other transmitters require the operator, either remote or in attendance, to push the start button. In either case, frequent outages demand the cause to be located.

17. Your transmitter always looks like the offender. It is the device with meters and it is the device that quits if there is a failure anywhere in the entire system. An open or short circuit in a transmission line does not hoist a flag at the point of trouble in the transmission line. It does react at the transmitter. A faulty insulator in an antenna guy wire or a bad connection in the antenna tuning unit only shows at the transmitter. — In fact, as you can see, the transmitter always shows as the offender. Often it is not, in fact more often it is not. — If the drive shaft between your car motor and the rear wheels fails, it does not mean the motor is defective.

18. Earlier we mentioned the need of a dummy antenna at every radio station. Here again we see how valuable it becomes because you can disconnect everything after the transmitter and use the dummy antenna. By quick process of elimination of the tower, coupler, transmission line, tower chokes and ground system, you are able to determine if the transmitter is the offender. By modulating the transmitter and doing regular programming for an hour or so into the dummy antenna you experience the same transmitter outages, then you can hang it on the transmitter. Conversely, if the transmitter gives no trouble into the dummy, you can conclude that the fault is not the transmitter but in what is connected to it.

19. Step by step trouble shooting is always best. Trouble shooting is never on the basis of "It might be this or that." Instead, follow through from the beginning. If the transmitter was okay on the dummy antenna, the question becomes — "Where is the trouble?" If a transmission line connects the transmitter to the antenna coupler, then move the dummy antenna to the far end of the line and repeat the tests. Always remember that tests should be made, in part, under full modulation because often an open or an arc will occur under conditions of the greatest voltage and/or current. If, in this condition, an irregularity is noted, you have found the point of trouble in the transmission line. If not, reconnect the antenna coupler and the next job is to visually observe the antenna coupler under operation. In so doing, you may actually note a small arc or corona during a modulation peak. This could be caused by dirt, a bad connection, or even a component that is defective.

20. It is well to remember that one bad connection in the radiating system can cause outages. Several years ago an engineer solved weeks of investigation by stepping on a poorly brazed connection at the base of the tower. When he did so, he noted the antenna current increase nearly ½ ampere. So don't assume. Be sure the entire chain is well connected. Carelessness around the base of the tower, where wires are brazed and at which point is the hub of the entire ground system, has caused many problems.

21. Other outage conditions not affecting the transmitter are listed for their value in checking:

--- Under certain conditions, especially at higher altitudes, the guy insulators will arc across, caused by static. This will 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 vulnerable insulators 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 unlikely but keeping it clean is very necessary. A low resistance path at this point can cause trouble.
--- Look at the tower chokes. Though they are husky, they are in a vulnerable position as to lightning.
--- Shunt fed towers (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.
--- One side of the tower lighting circuit shorted to the tower itself can cause a lot of trouble, yet the lights may function perfectly.

22. OTHER OUTAGES. If the transmitter is the offender or it acts improperly on a dummy antenna, the process of elimination by starting at the first and following through is preferred unless the cause is actually known. The following hints may help both as to outages and improper operation:

(FALL OUT) The transmitter kicks out a relay at high modulation. Possibly the overload relay is set too sensitive. Look for an arc at any variable condenser. If this condition is noted, it usually indicates improper tune-up or lack of complete neutralization. Improper L/C ratio means the amount of coil to the amount of capacitor used can cause high circulating current and arcs. Use of more coil and less capacity, and in some instances just the reverse, will solve the problem.

(HARD TO MODULATE) Cause can be either improper impedance match at output of transmitter or low grid drive to the final power amplifier. Consult instruction book for recommended grid drive. Correct match of transmitter to load is covered, in part, in the instruction book. The remainder depends on local conditions. It is a very important part of good performance. Indication is a sluggish line or antenna meter, does not move up under modulation or even moves down.

(BAD REGULATION) Usually power line is too small and voltage varies at input under modulation. Often hard to find as public utility meters and graphs are slow speed. Best check is to apply sine wave to transmitter. Check line voltage at zero modulation and then at 100% modulation. If line voltage drops at 100% modulation, then call your utility company. Watch for high line voltage. If much over the stated primary voltage for the transmitter, you are headed for parts failure. Likewise, low line voltage causes poor performance. ---- Improper loading of the transmitter to the tower will also cause poor regulation. 23d ✓

23. SHORT TUBE LIFE is usually not the fault of the tubes. Instead, is caused by over-working the tubes. If efficiency is low, tubes must put out more watts to make it up and thus last longer. Answer is get the efficiency up (see Par. 2). Arc-overs anywhere, may under certain conditions, cause the big tubes, the expensive ones, to self-oscillate. Find and stop the arc-over. Short tube life is compared to using more gas if the car is running up hill all the time. Eliminate the cause for your running up hill and tube life will be long.

24. POOR QUALITY can be for so many reasons that to list them all would take many pages. It seems foolish to even suggest that a poor stylus in the transcription turntable is a cause for poor quality, but it happens. --- Every station must take proof of performance measurements. This proof of performance equipment is usually owned by the radio station. In fact, it is difficult to keep a radio station at top performance without one. With this equipment, each major equipment may be checked for distortion, noise and frequency response and it is these checks that tell good or bad quality. Where studios are separate from transmitter, even the quality of the telephone line may be checked.

25. Poor quality is often guessed at as to cause and yet we all know that the finest broadcast transmitter is only as good as the microphone used, which is to say, "A broadcast system is as strong as its weakest link." We thus can agree that poor quality usually ties down to any one item in the entire system. By use of proof of performance equipment, we find out what this item is and fix it. --- Though this data is not intended in any way to be sales data, some may wonder where to get "Proof of Performance Equipment". This will be found in the Gates catalog. The SA-131 complete proof of performance package sells for $498.00 and is available on time payments as we feel every station should have one regardless of budget.

26. Earlier it was stated that poor quality is possible from many places. The obvious is easiest to find, such as the poor microphone or bad turntable styli. Radio frequency leakage is often a cause for poor quality. This leakage is where a small amount of R.F. voltage gets into other equipment, such as the limiter, audio cables, and in combination installations the speech input console. --- In most cases, this leakage is small enough to be quickly eliminated but also small enough to be hard to indicate by use of the usual methods such as a small neon lamp, etc. --------- R.F. leakage is usually caused by lack of grounding or grounds at varied potentials. Grounding to one common ground is best. Of course, be sure you have a ground connection. Once in awhile a

full rack of equipment will be found with the only ground coming through a shield of the audio cable. This, of course, is poor grounding and copper strap should be employed.

27. Care should always be taken not to run R.F. cables in the same conduit or cable group as audio cables. For example, running the coaxial connecting cables from transmitter to monitors in the same cable as audio lines would be very wrong. Likewise, inserting high and low level cables, even if individually shielded, in the same conduit or cable group is very wrong. A high level circuit would be any output circuit. A low level circuit would be any input circuit. Thus, a microphone or turntable pair in the same conduit or cable group as the output of the program amplifier or monitoring amplifier would be asking for trouble.

28. Poor quality is possible through overloading. All equipment is usually rated as to maximum input and output levels. For example, if an input circuit is rated at 0 Db., this means that putting more than 0 Db. into this circuit is overloading. If an output circuit is rated at +18 Db. and you are developing +24 Db., the distortion goes up. ---- Careful attention to good sensible engineering practice is the answer. Short-cuts, speed in getting the equipment installed and throwing long known precautions to the wind cause many quality problems and usually demand rework.

29. 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 trouble 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 has to be found, the solution will take longer. ---- 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 regular preventive maintenance and his being there when problems arise.

30. PREVENTIVE MAINTENANCE. Few of us would fly in commercial airlines if we felt the planes were not carefully checked after every flight and, of course, they are. --- We even check our automobile tires before we take a trip. Our lives are lived and protected, even our homes are run on preventive maintenance. The good wife cleans to prevent moths. -------- In broadcasting equipment, preventive maintenance is mandatory. Most offages can be eliminated before they happen by checking before instead of fixing afterwards.

31. Dirt is the first cause of all trouble. Excessive heat is Number 2. With the advent of unattended operation, both have grown. With the transmitter in a locked building, it is cleaned much less and with the windows closed it becomes an oven in summer months. In all cases, remember:

---- The dirt-free transmitter is the trouble-free transmitter.
---- The cool transmitter is the longest lasting transmitter.

Clean once weekly and duct hot air out of closed transmitter buildings. Check tubes at least monthly. Poor tubes mean poor quality and eventual outage. Rotate the bigger tubes every month. Include spares in this rotation, both to prevent gassing and also remember the guarantee will run out. If you have a defective spare and you rotate it into the equipment, you will find the defect before the guarantee runs out.

32. Other things in preventive maintenance include oiling of motors in blowers and turntables, burnishing relay contacts as needed, cleaning attenuators, checking batteries where used, cleaning inside of all equipment. The inside is more important than the outside. Every station should have a small suction type cleaner such as used to clean an overstuffed chair. This will pick out dirt and dust from pesky trouble-making nooks and corners. If we take a leaf from the Navy book which says everything must at all times be sparkling clean or what is called "Shipshape" ------ we have preventive maintenance in the complete form.

33. ADEQUATE TEST EQUIPMENT. When you go out to take pictures you must have a light meter to test exposure time. This light meter has nothing to do with the camera. It is test equipment.

34. Comparatively, you can neither maintain nor correct without the tools to do the job. An investment in expensive broadcasting equipment dictates a modest investment in the necessary equipment to keep it operating at top performance. Listed below is suggested test equipment for the average radio station. Where the station is directional (uses more than one tower), an item or two more will be required, such as a field strength meter for sure. Here is the suggested list:

---- Dummy antenna.
---- Proof of performance equipment consisting of:
1. Audio oscillator.
2. Distortion meter.
3. Gain set.
4. R.F. pickup coil or rectifier.
---- Good grade volt-ohm-meter.
---- Spare antenna current meter.
---- Oscilloscope.

35. GATES ASSISTANCE TO HELP YOU. The Gates Radio Company sincerely believes that the best type of assistance it can render to the technical personnel in the radio broadcast field is in full cooperation with them in solving any problem, no matter how small. It is believed that the solution of any problem is best accomplished by getting to the seat of it through mutual working together between the station engineer and Gates technical people. As we all have a certain amount of pride, there is often some reluctance to write, asking about a problem that might seem simple. It is emphasized that often the problem that appears the simplest might be the most complex. It is only by the asking of questions that assistance can be rendered.

36. Gates engineers and technical personnel invite the correspondence of the technical people that are using Gates equipment, and for that matter, even if they are not using Gates equipment, and are willing and ready to spend any amount of time necessary to not only be of help and assistance but to make the life of the broadcast technician more pleasant -- and most important of all, to make the radio broadcasting equipment always a pleasant experience by continued satisfactory performance.

GATES RADIO COMPANY - - QUINCY, ILLINOIS, U. S. A.

20. It is well to remember that one bad connection in the radiating system can cause outages. Several years ago an engineer solved weeks of investigation by stepping on a poorly brazed connection at the base of the tower. When he did so, he noted the antenna current increase nearly ½ ampere. So don't assume. Be sure the entire chain is well connected. Carelessness around the base of the tower, where wires are brazed and at which point is the hub of the entire ground system, has caused many problems.

21. Other outage conditions not affecting the transmitter are listed for their value in checking:

- Under certain conditions, especially at higher altitudes, the guy insulators will arc across, caused by static. This will 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 vulnerable insulators 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 unlikely but keeping it clean is very necessary. A low resistance path at this point can cause trouble.
- Look at the tower chokes. Though they are husky, they are in a vulnerable position as to lightning.
- Shunt fed towers (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.
- One side of the tower lighting circuit shorted to the tower itself can cause a lot of trouble, yet the lights may function perfectly.

22. OTHER OUTAGES. If the transmitter is the offender or it acts improperly on a dummy antenna, the process of elimination by starting at the first and following through is preferred unless the cause is actually known. The following hints may help both as to outages and improper operation:

(FALL OUT) The transmitter kicks out a relay at high modulation. Possibly the overload relay is set too sensitive. Look for an arc at any variable condenser. If this condition is noted, it usually indicates improper tune-up or lack of complete neutralization. Improper L/C ratio means the amount of coil to the amount of capacitor used can cause high circulating current and arcs. Use of more coil and less capacity, and in some instances just the reverse, will solve the problem.

(HARD TO MODULATE) Cause can be either improper impedance match at output of transmitter or low grid drive to the final power amplifier. Consult instruction book for recommended grid drive. Correct match of transmitter to load is covered, in part, in the instruction book. The remainder depends on local conditions. It is a very important part of good performance. Indication is a sluggish line or antenna meter, does not move up under modulation or even moves down.

(BAD REGULATION) Usually power line is too small and voltage varies at input under modulation. Often hard to find as public utility meters and graphs are slow speed. Best check is to apply sine wave to transmitter. Check line voltage at zero modulation and then at 100% modulation. If line voltage drops at 100% modulation, then call your utility company. Watch for high line voltage. If much over the stated primary voltage for the transmitter, you are headed for parts failure. Likewise, low line voltage causes poor performance. — Improper loading of the transmitter to the tower will also cause poor regulation. 230 ✓

23. SHORT TUBE LIFE is usually not the fault of the tubes. Instead, is caused by over-working the tubes. If efficiency is low, tubes must put out more watts to make it up and thus last longer. Answer is get the efficiency up (see Par. 2). Arc-overs anywhere, may under certain conditions, cause the big tubes, the expensive ones, to self-oscillate. Find and stop the arc-over. Short tube life is compared to using more gas if the car is running up hill all the time. Eliminate the cause for your running up hill and tube life will be long.

24. POOR QUALITY can be for so many reasons that to list them all would take many pages. It seems foolish to even suggest that a poor stylus in the transcription turntable is a cause for poor quality, but it happens. — Every station must take proof of performance measurements. This proof of performance equipment is usually owned by the radio station. In fact, it is difficult to keep a radio station at top performance without one. With this equipment, each major equipment may be checked for distortion, noise and frequency response and it is these checks that tell good or bad quality. Where studios are separate from transmitter, even the quality of the telephone line may be checked.

25. Poor quality is often guessed at as to cause and yet we all know that the finest broadcast transmitter is only as good as the microphone used, which is to say, "A broadcast system is as strong as its weakest link." We thus can agree that poor quality usually ties down to any one item in the entire system. By use of proof of performance equipment, we find out what this item is and fix it. — Though this data is not intended in any way to be sales data, some may wonder where to get "Proof of Performance Equipment". This will be found in the Gates catalog. The SA-131 complete proof of performance package sells for $498.00 and is available on time payments as we feel every station should have one regardless of budget.

26. Earlier it was stated that poor quality is possible from many places. The obvious is easiest to find, such as the poor microphone or bad turntable styli. Radio frequency leakage is often a cause for poor quality. This leakage is where a small amount of R.F. voltage gets into other equipment, such as the limiter, audio cables, and in combination installations the speech input console. — In most cases, this leakage is small enough to be quickly eliminated but also small enough to be hard to indicate by use of the usual methods such as a small neon lamp, etc. ——— R.F. leakage is usually caused by lack of grounding or grounds at varied potentials. Grounding to one common ground is best. Of course, be sure you have a ground connection. Once in awhile a

full rack of equipment will be found with the only ground coming through a shield of the audio cable. This, of course, is poor grounding and copper strap should be employed.

27. Care should always be taken not to run R.F. cables in the same conduit or cable group as audio cables. For example, running the coaxial connecting cables from transmitter to monitors in the same cable as audio lines would be very wrong. Likewise, inserting high and low level cables, even if individually shielded, in the same conduit or cable group is very wrong. A high level circuit would be any output circuit. A low level circuit would be any input circuit. Thus, a microphone or turntable pair in the same conduit or cable group as the output of the program amplifier or monitoring amplifier would be asking for trouble.

28. Poor quality is possible through overloading. All equipment is usually rated as to maximum input and output levels. For example, if an input circuit is rated at 0 Db., this means that putting more than 0 Db. into this circuit is overloading. If an output circuit is rated at +18 Db. and you are developing +24 Db., the distortion goes up. ---- Careful attention to good sensible engineering practice is the answer. Short-cuts, speed in getting the equipment installed and throwing long known precautions to the wind cause many quality problems and usually demand rework.

29. 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 trouble 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 has to be found, the solution will take longer. ---- 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 regular preventive maintenance and his being there when problems arise.

30. PREVENTIVE MAINTENANCE. Few of us would fly in commercial airlines if we felt the planes were not carefully checked after every flight and, of course, they are. --- We even check our automobile tires before we take a trip. Our lives are lived and protected, even our homes are run on preventive maintenance. The good wife cleans to prevent moths. -------- In broadcasting equipment, preventive maintenance is mandatory. Most offages can be eliminated before they happen by checking before instead of fixing afterwards.

31. Dirt is the <u>first</u> cause of all trouble. Excessive heat is Number 2. With the advent of unattended operation, both have grown. With the transmitter in a locked building, it is cleaned much less and with the windows closed it becomes an oven in summer months. In all cases, remember:

---- The dirt-free transmitter is the trouble-free transmitter.
---- The cool transmitter is the longest lasting transmitter.

Clean once weekly and duct hot air out of closed transmitter buildings. Check tubes at least monthly. Poor tubes mean poor quality and eventual outage. Rotate the bigger tubes every month. Include spares in this rotation, both to prevent gassing and also remember the guarantee will run out. If you have a defective spare and you rotate it into the equipment, you will find the defect before the guarantee runs out.

32. Other things in preventive maintenance include oiling of motors in blowers and turntables, burnishing relay contacts as needed, cleaning attenuators, checking batteries where used, cleaning inside of all equipment. The inside is more important than the outside. Every station should have a small suction type cleaner such as used to clean an overstuffed chair. This will pick out dirt and dust from pesky trouble-making nooks and corners. If we take a leaf from the Navy book which says <u>everything</u> must at all times be sparkling clean or what is called "Shipshape" ------ we have preventive maintenance in the complete form.

33. ADEQUATE TEST EQUIPMENT. When you go out to take pictures you must have a light meter to test exposure time. This light meter has nothing to do with the camera. It is test equipment.

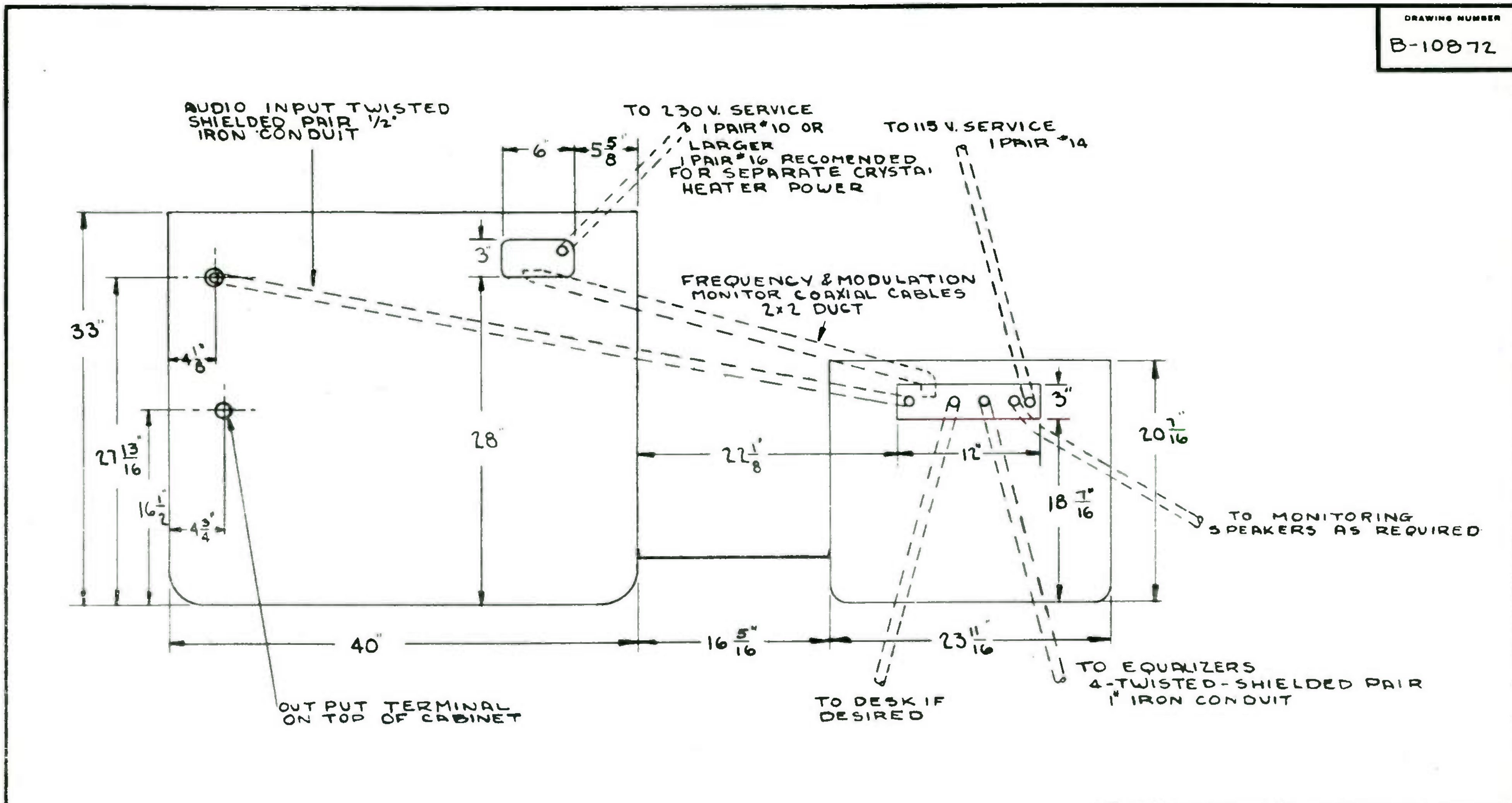
34. Comparatively, you can neither maintain nor correct without the tools to do the job. An investment in expensive broadcasting equipment dictates a modest investment in the necessary equipment to keep it operating at top performance. Listed below is suggested test equipment for the average radio station. Where the station is directional (uses more than one tower), an item or two more will be required, such as a field strength meter for sure. Here is the suggested list:

---- Dummy antenna.
---- Proof of performance equipment consisting of:
1. Audio oscillator.
2. Distortion meter.
3. Gain set.
4. R.F. pickup coil or rectifier.
---- Good grade volt-ohm-meter.
---- Spare antenna current meter.
---- Oscilloscope.

35. GATES ASSISTANCE TO HELP YOU. The Gates Radio Company sincerely believes that the best type of assistance it can render to the technical personnel in the radio broadcast field is in full cooperation with them in solving any problem, no matter how small. It is believed that the solution of any problem is best accomplished by getting to the seat of it through mutual working together between the station engineer and Gates technical people. As we all have a certain amount of pride, there is often some reluctance to write, asking about a problem that might seem simple. It is emphasized that often the problem that appears the simplest might be the most complex. It is only by the asking of questions that assistance can be rendered.

36. Gates engineers and technical personnel invite the correspondence of the technical people that are using Gates equipment, and for that matter, even if they are not using Gates equipment, and are willing and ready to spend any amount of time necessary to not only be of help and assistance but to make the life of the broadcast technician more pleasant -- and most important of all, to make the radio broadcasting equipment always a pleasant experience by continued satisfactory performance.

GATES RADIO COMPANY - - QUINCY, ILLINOIS, U. S. A.

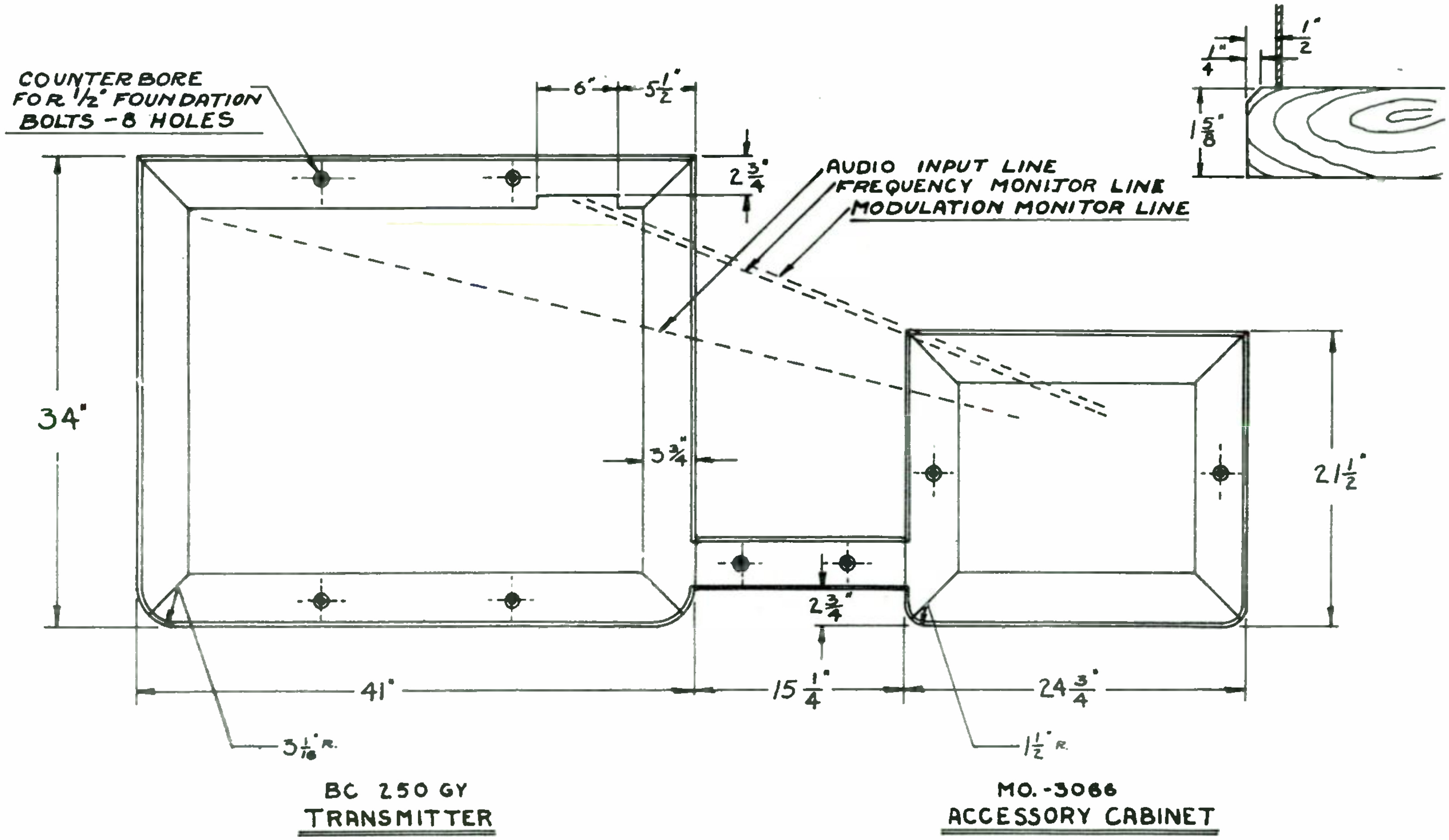


GATES RADIO COMPANY
QUINCY, ILLINOIS

PROPOSED CONDUIT LAYOUT FOR GY-48 RADIO STATION.

MATERIAL	SCALE
DR. BY H.G.H.	DATE 4-15-48
CH. BY	ENG. L.B.P.
DRAWING NUMBER	B-10872

DWG. NO. B-10852



GATES RADIO COMPANY
QUINCY, ILLINOIS

WOOD BASE FOR GY-48 TRANSMITTING STATION

MATERIAL HICKORY OR OAK 2 X 4'S	SCALE 1/8
DR. BY H.G.H.	DATE 3-15-48
CH. BY	ENG.
DWG. NO.	B-10852

BC-250-GY FREQ./LOAD DETERMINED COMPONENTS						
FREQ.	OSC. C18 TYPE "H" 600 WV	813 C41 TYPE F2L	810 C33 TYPE F2L OR G1	810 C35 TYPE G1 OR E 250	810 C35 TYPE G1 OR E 70	810 C35 TYPE G1 OR E 50
1600	None	None	0002	001	002	002
1300	↓	↓	↓	↓	003	003
1250	↓	↓	0003	002	↓	↓
1150	↓	↓	0004	003	↓	004
860	↓	↓	0005	↓	004	005
780	↓	0002	↓	↓	↓	↓
700	0001	↓	↓	↓	↓	↓
690	↓	↓	0006	004	005	006
650	0002	↓	↓	↓	↓	↓
620	↓	0004	↓	↓	↓	↓
600	↓	↓	0007	005	006	007
550	↓	↓	0009	006	007	.01
LINE CURRENT METER M1				0-1.5A	0-3A	0-3A

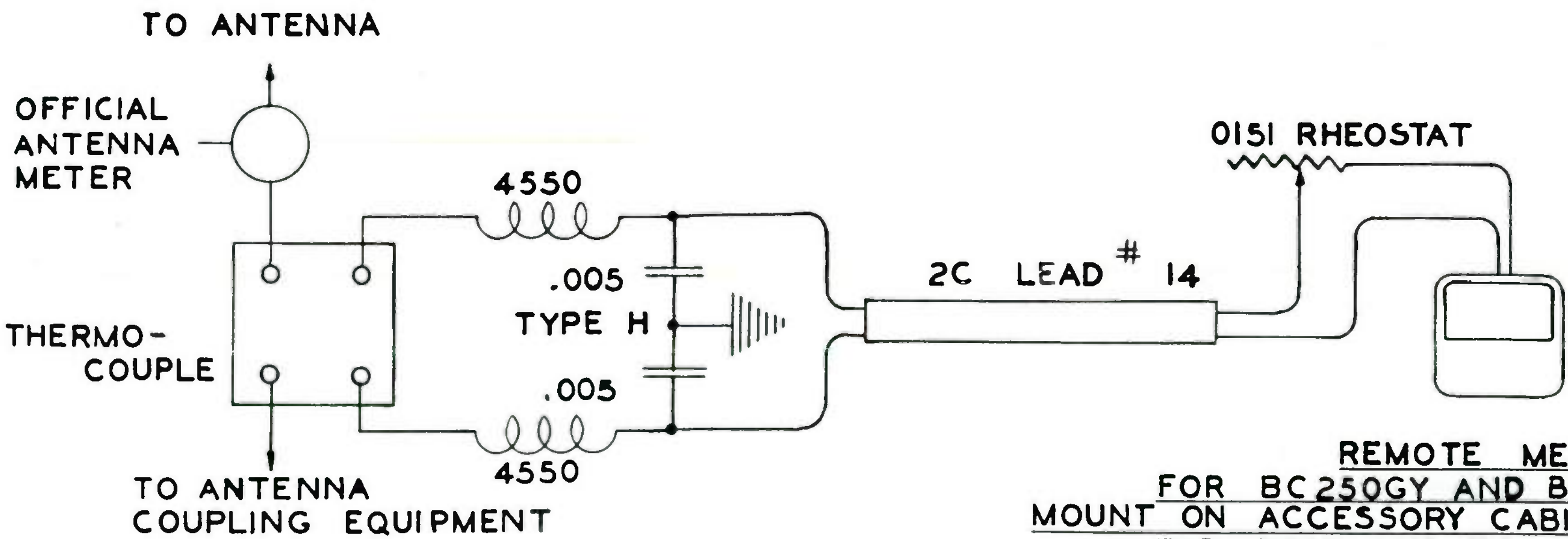
813-810 COUPLING CONDENSER (C27)

1600 - 750 KC	0001 Type H 2500 WV
750 - 550 KC	0005 Type H 2500 WV*

NOTE:
Higher capacities may be obtained by parallel connection of two condensers.

*Alternate Adjustment: .0001 mfd. at C27 and increase 813 grid tap on L7. Use whichever gives satisfactory P.A. drive with lowest 813 plate current.

A- 5479

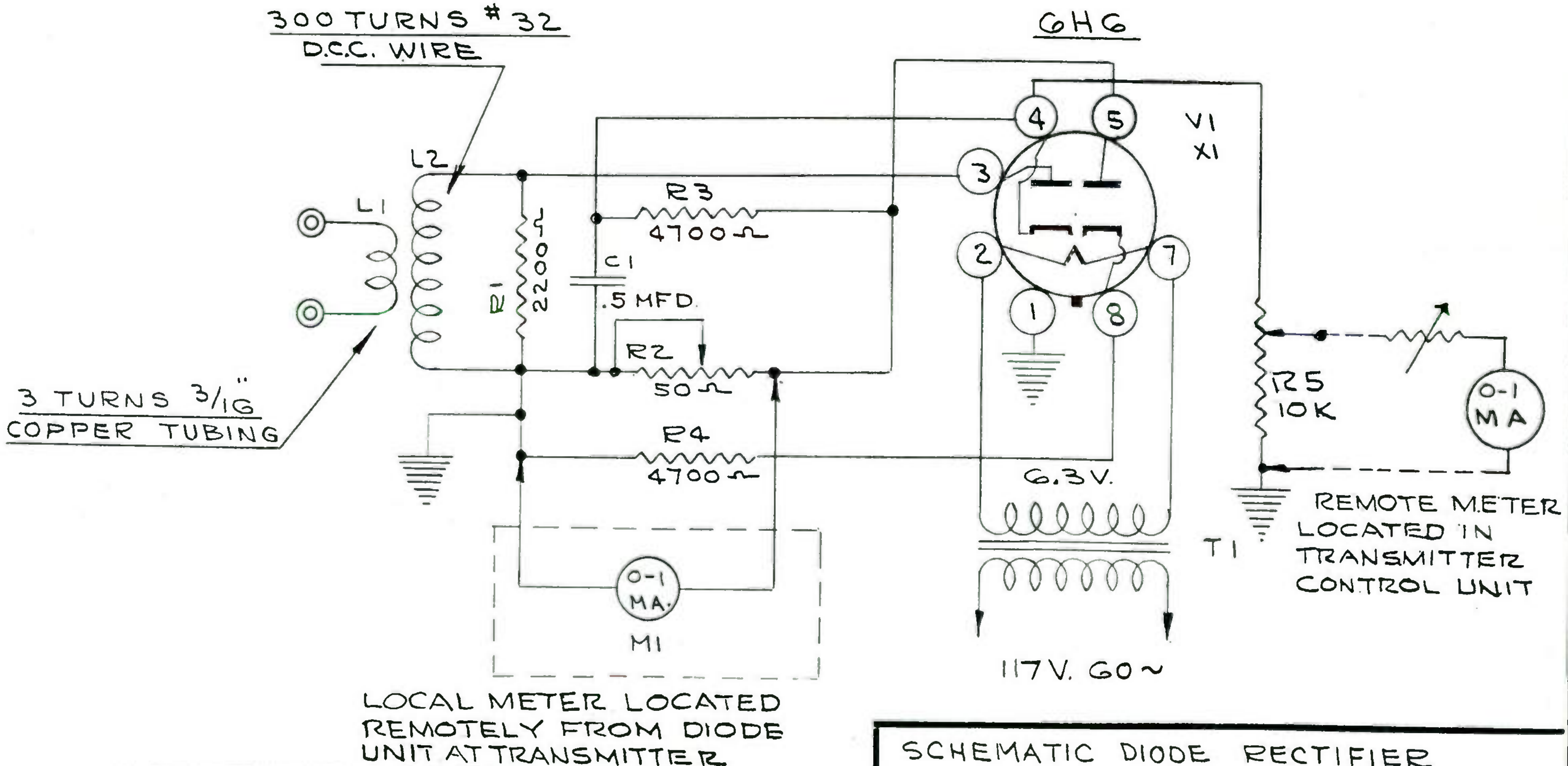


REMOTE METER
FOR BC250GY AND BC5A
MOUNT ON ACCESSORY CABINET
FOR BC1E AND BC250D
MOUNT ON TRANSMITTER

GATES RADIO COMPANY QUINCY, ILLINOIS		
THERMOCOUPLE TYPE REMOTE METER		
DR. BY	DATE	A-[illegible]479
CHK. BY	ENG.	

DRAWING NUMBER

A5001



5	4	3	2	1
ECN 6102 RGK 3-4-55	ECN# 5871 AWC 11-15-54	ECN 4876 PHM 6-23-53	REDRAWN AWC 6-9-53	CHANGED PER ECN # 2617 RLW 4-25-51

Variations on Finished Dimensions unless otherwise marked

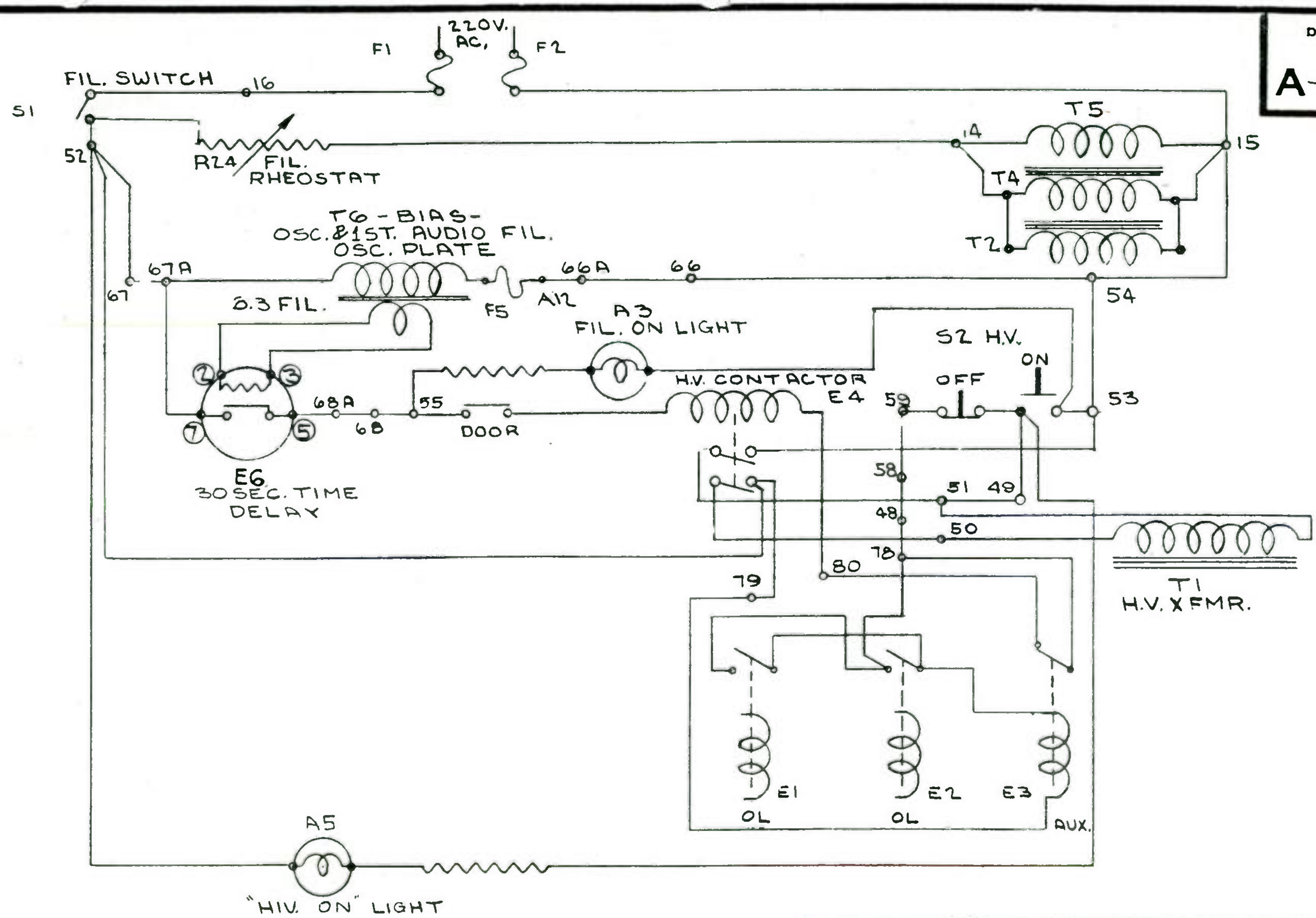
Basic Dimensions	Fractional Dimensions	Decimal Dimensions
Up to ¼	± 1/128	± .005
Above ¼ to 6	± 1/64	± .005
Above 6 to 24	± 1/32	± .010
Above 24	± [illegible]	± .015

SCHEMATIC DIODE RECTIFIER
250 W. - 1KW - 250 V.R.M.S.

MATL.	FIN.	PART NO.
DRAWN BY HGH DATE 11-19-48		
CHECKED BY F.W.W DATE		DWG. NO.
GATES RADIO COMPANY QUINCY, ILLINOIS		A5001

DRAWING NUMBER

A-4339



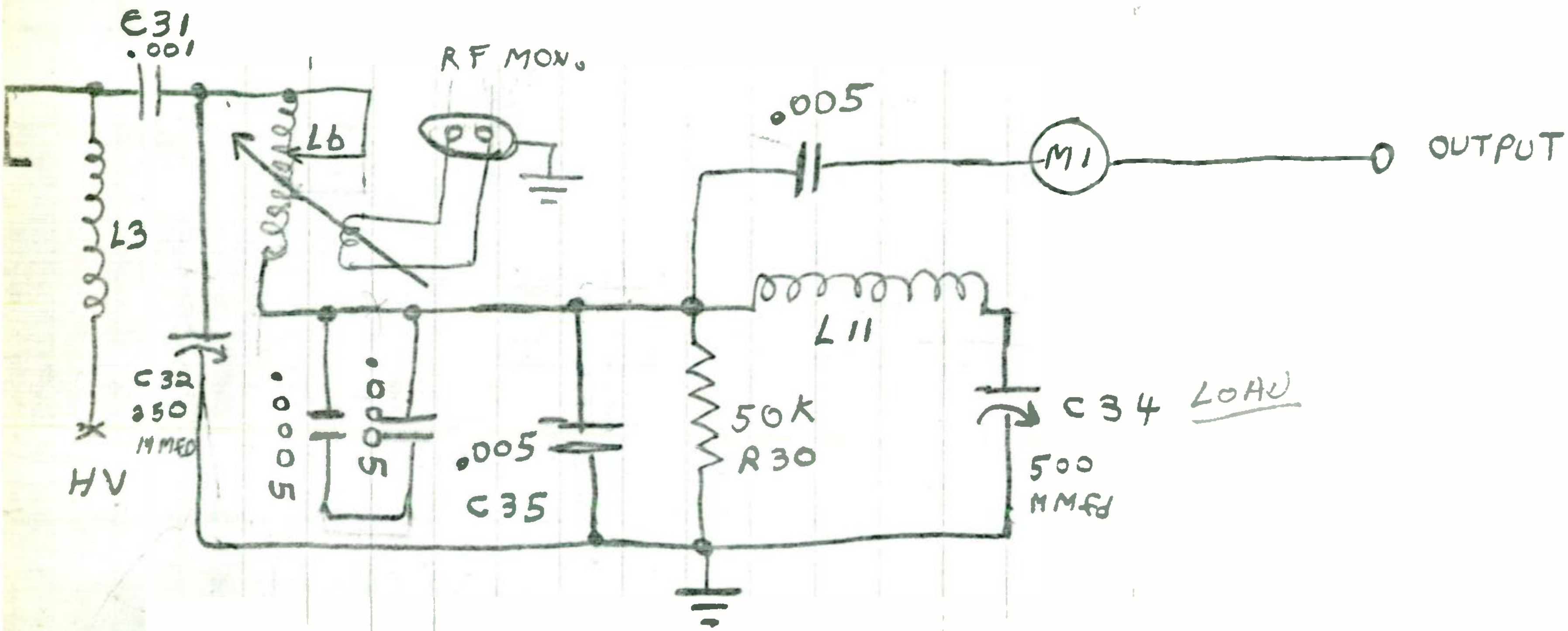
1	ECN 1508 ADDED FUSE F5-A12 RLW 3-8-49
2	[illegible] #5170 RGK 9-25-53
3	ECN-5567 3-4-54

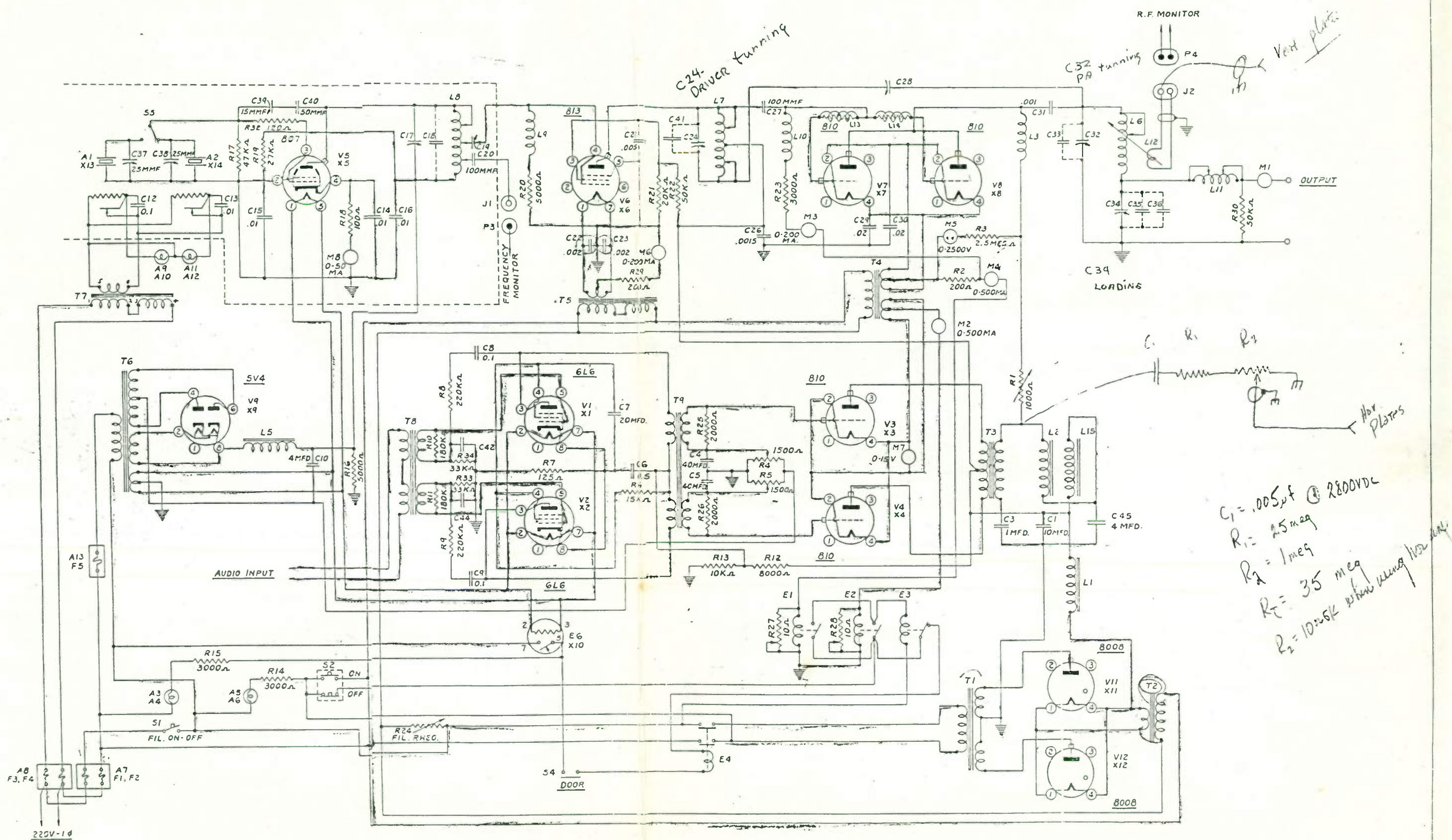
GATES RADIO COMPANY
QUINCY, ILLINOIS

DETAIL CONTROL CIRCUIT
250 GY

MATERIAL	SCALE
DR. BY HGH	DATE 4-13-48
CH. BY [illegible]	ENG. L.B.P.

DRAWING NUMBER A-4339


C31
.001
RF MON.
.005
M1
OUTPUT
L6
L3
L11
C32
250
MMFD
HV
.0005
.0005
.005
C35
50K
R30
C34
LOAD
500
MMFd



M0-3760

ECN 5656 R.W. 5-25-59	ECN 5042 A.W.C. 4-28-59	ECN 5567 3-4-54 D.L.	ECN 5485 1-25-54 D.L.	ECN 5196 D.L. 10-7-53	CHANGE PER ECN 4732 ...	3		

GATES RADIO CO.
QUINCY, ILL.

OVERALL SCHEMATIC FOR BC-250GY TRANSMITTER WITH CHICAGO TRANSFORMER

DR. BY D.L.	DATE 5-27-53	D-20670
CH. BY	ENG. L.B.P.	