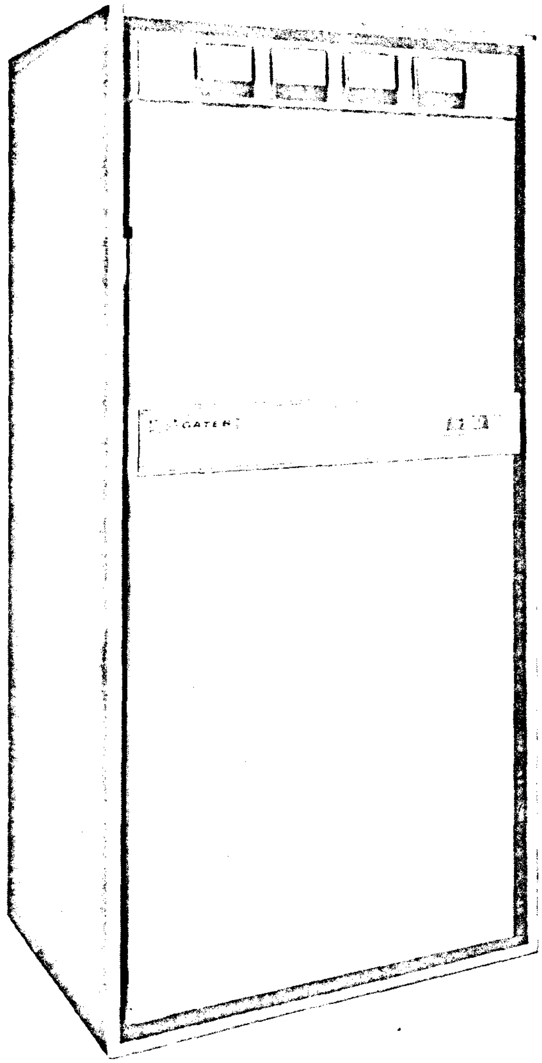
500 Watt AM Broadcast Transmitter



MODEL BC-500G

The B-500G broadcast transmitter is essentially the same transmitter as the BC-1G, 1,000 watt model described on pages 20 and 21. It differs only in the use of a single type 833A RF power tube. So complete is standardization that an increase to 1,000 watts at any later date is easily accomplished. As the basic design is around 1,000 watt construction, a bonus of conservatism is built into this 500 watt model.

All of the features found in the 1,000 watt BC-1G are also found in the BC-500G. These features include: a built-in dummy antenna for easier maintenance, solid state power supplies throughout, total accessibility from the front, modulation of the RF driver and power amplifiers, inverse feedback and lower distortion. RF harmonic reduction meets FCC regulations within the transmitter itself as the Pi-Tee output network does not assume that the outside antenna coupler will perform this function. The specifications herein are pertinent to the Model BC-500G, 500 watt transmitter. Any other data is the same as the Model BC-1G.

SPECIFICATIONS

POWER OUTPUT: FCC rated 500 watts. Capability 550 watts.

RF FREQUENCY RANGE: 540 kHz to 2000 kHz (as ordered).

RF OUTPUT IMPEDANCE: 50/70 ohms.

FREQUENCY STABILITY: ±5 Hz.

CARRIER SHIFT: 3% or less at 100% modulation.

AUDIO RESPONSE: ±1½ dB, 30-12,000 Hz. (Typical: ±1½ dB, 30-16,000 Hz under practical programming conditions.)

AUDIO DISTORTION: 3% or less 50-10,000 Hz at 95% modulation.

NOISE: 60 dB, or better, below 100% modulation level.

AUDIO INPUT: 150 or 600 ohms, +9 dBm, ±2 dB for 100% modulation.

POWER INPUT: 230 volts, 3 wire, 50/60 Hz single phase. Power consumption (0 modulation) 1900 watts; (program modulation) 2200 watts; (100% modulation) 2600 watts.

DUMMY ANTENNA: 50 ohms.

MONITORS: Will accommodate all current models. Gates FCC approved M-4990 Frequency Monitor and M-6659 Modulation Monitor recommended.

SIZE: 78" high, 37" wide, 29" deep. Front door swing 32".

WEIGHT AND CUBAGE: (Domestic) 950 lbs. net., 1100 lbs. packed. (Export 1350 lbs. packed. Cubage: 100.

FINISH: Two-tone beige-gray.

TUBES: 12BY7A oscillator, 12BY7A 1st IPA, (2) 807 2nd IPA, (1) 833A power amplifier, (2) 807 1st audio, (2) 807 2nd audio, (2) 833A modulators.

ORDERING INFORMATION

Model BC-500G AM broadcast transmitter, 500 watts, with tubes, *one crystal, silicon rectifiers* ____ 994-6333

Spare 100% tube complement for BC-500G ____ 990-0481

Recommended minimum spare tube kit for BC-500G ____ 990-0479

NOTES: (1) Be sure to specify carrier frequency when ordering. (2) *Available for 208 volts, 3 wire, at slight additional cost.* (3) *Available on special order with tube rectifiers at no increase in price.* (4) 500 watt stations may use a 1000 watt transmitter operated at 500 watts power. If 1000 watts is later contemplated, the customer should purchase the Model BC-1G.

SECTION I - INTRODUCTION

The Gates BC-500GY Transmitter 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 BC-500GY Transmitter is 500 watts and is officially approved on the records of F.C.C. as a Gates Radio Company Model BC-500GY Transmitter for amplitude modulation.

The radio frequency range of the BC-500GY 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:

1. Check packing list for all materials.

2. Read this book through before proceeding.

3. Have a place for all parts so you will not step on or otherwise break a needed component removed for shipment.

4. ~~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.)

5. Use No. 6 wire to connect the power to the transmitter. Note the transmitter uses 230 volts A.C.

6. 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 eight 500 watt heater elements to the line and graph the load over several 18 hour periods, noting especially mealtime periods.

7. Do the job of installing well. Haste oftentimes means hours off the air later on.

8. Most Important -- Acquaint yourself with this equipment by studying it thoroughly.

The BC-500GY Transmitter is supplied standard with one set of 100% tubes, one crystal and oven, 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 inch remote meter with scales of your choice. 3, 5 and 10 ampere scales are stock.

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

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

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.

SECTION II - BC-500GY TRANSMITTER DETAILS

The following information on the BC-500GY 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 three 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, on 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 one 833A tube. 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 accommodates 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 accommodates 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 H. V. 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.

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 rectifiers employ 8008 tubes in two full-wave circuits. 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 heaving 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 illustations 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 equipment 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

Directly under the fuse blocks on the left rear will be found two jacks (see J1 and J2 of Figure 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 is connected to any good quality amplifier having an output impedance of 500/600 ohms. The power line connections are made directly to the fuse blocks A7 and A8 (see Figure 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 feedthru 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. Make certain that 230 volts A.C. is used on the transmitter.

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 proceed 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 R.F. drive connection to

Final tuning

Grid drive to 813

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 feedback condenser adjacent to the 807 tube socket will undoubtedly correct this condition. Generous use of the feedback 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 rectifier plate leads from V7 and V8. Final PA Neutralizing

Turn modulator bias resistors R4 and R5 in a maximum CCW direc tion in order to prevent high modulator plate current.

Reduced plate voltage may be obtained by removing the plate cap from either V11 or V12 rectifier tubes. Now by resonating tank condenser C24 of the intermediate amplifier to minimum 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 one rectifier plate lead on V7 or V8 which has assumedly been removed previously. 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.

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 C36 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 45 Ma static. Then adjust the remaining potentiometer until the plate current reads 90 Ma. Slight readjustment of these potentiometers may be necessary later on to obtain minimum distortion.

Bypass

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.

Freq. Change

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 equidistant 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 0-5 amperes, while for a 250 ohm transmission line, meter M1 is usually 0-3 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. Of course, it is necessary to so arrange the lamps that proper resistance and wattage is presented to the transmitter. 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 well 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 BC-500GY 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, 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 BC-500GY Transmitter should produce uniform frequency response within 1-1/2 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 50 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 R4 and R5 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 reradiation 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 +18 VU for 100% modulation, but, of course, will vary depending upon the final determined efficiency of operation of the transmitter.

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's 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-500GY TRANSMITTER

These readings are average and subject to variation:

		With 250 Watt Power Reduction
(a) 6L6 Audio Driver		
Plate Voltage	330 V.	330 V.
Screen Voltage	230 V.	230 V.
Total Cathode Current	110 Ma.	110 Ma.
Cathode Voltage	14 V.	14 V.
Filament	6.3 V. AC	6.3 V. AC
(b) Modulators		
Plate Voltage	2000 V.	2000 V.
Total Static Plate Current (M2)	90 Ma	90 Ma
Bias (Approx.)	-32	-32
Filament (M7)	10 V. AC	10 V. AC

		With 250 Watt Power Reduction
(c) 807 Oscillator		
Plate Voltage	250 V.	250 V.
Cathode Current (M8)	30 Ma	30 Ma
Screen Voltage	125 V.	125 V.
Filament	6.3 V. AC	6.3 V. AC
Cathode Voltage	3 V.	3 V.
(d) 813 R.F. Driver		
Plate Voltage	1400 V.	1400 V.
Screen Voltage	330 V.	330 V.
Cathode Current (M6)	130-160 Ma	130-160 Ma
(e) Power Amplifier		
Plate Voltage (M5)	2000	1450
Plate Current (M4)	350 Ma (typical only, will vary)	250 Ma
Filament	10 V. AC	10 V. AC
Grid Current (M3)	75-100 Ma	75-100 Ma
(f) Line Current (M1) (500 Watts Output)		
250 Ohm Load	1.42 Amp.	1 Amp.
72 Ohm Load	2.64 Amp.	1.84 Amp.
50 Ohm Load	3.16 Amp.	2.24 Amp.

INPUT POWER REQUIREMENTS: 230 V., 60 Cy., single phase; 13 Amps. at 100% mod., 11 Amps. with no modulation; 2 Amps. in standy position (Filament and Low Voltages).

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 BC-500GY Transmitter 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 analysis 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.

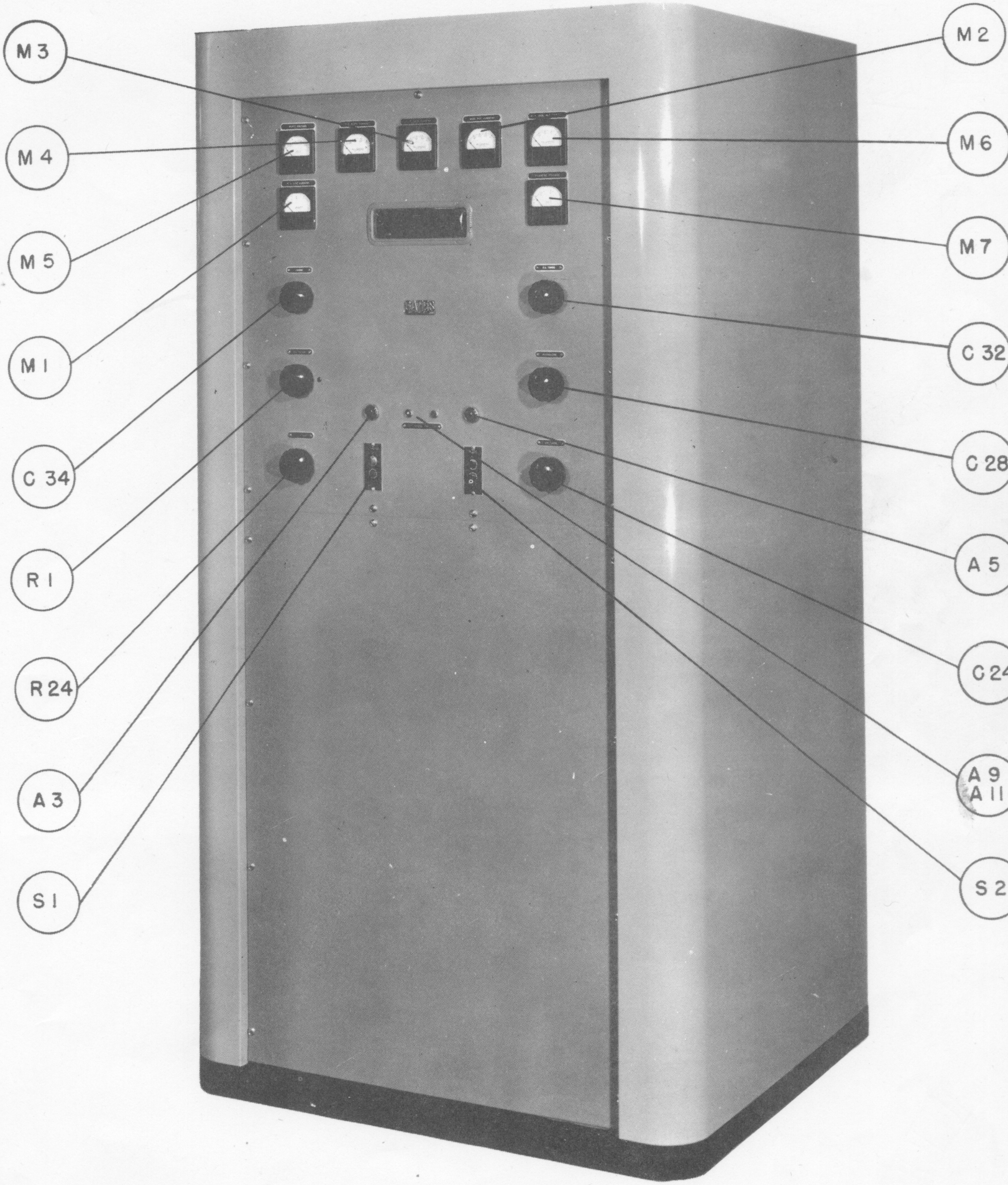
It is repeated again, make a good installation, eliminate haste and in so doing keep the record of failures a blank on your log book. Also remember that cleanliness in the maintenance of your broadcasting equipment will pay big dividends. Take a period each week for cleaning the inside and outside of 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 Radio Company who will gladly cooperate with you in every way to obtain the most satisfaction from your Gates' equipment.

DIODE REMOTE METER

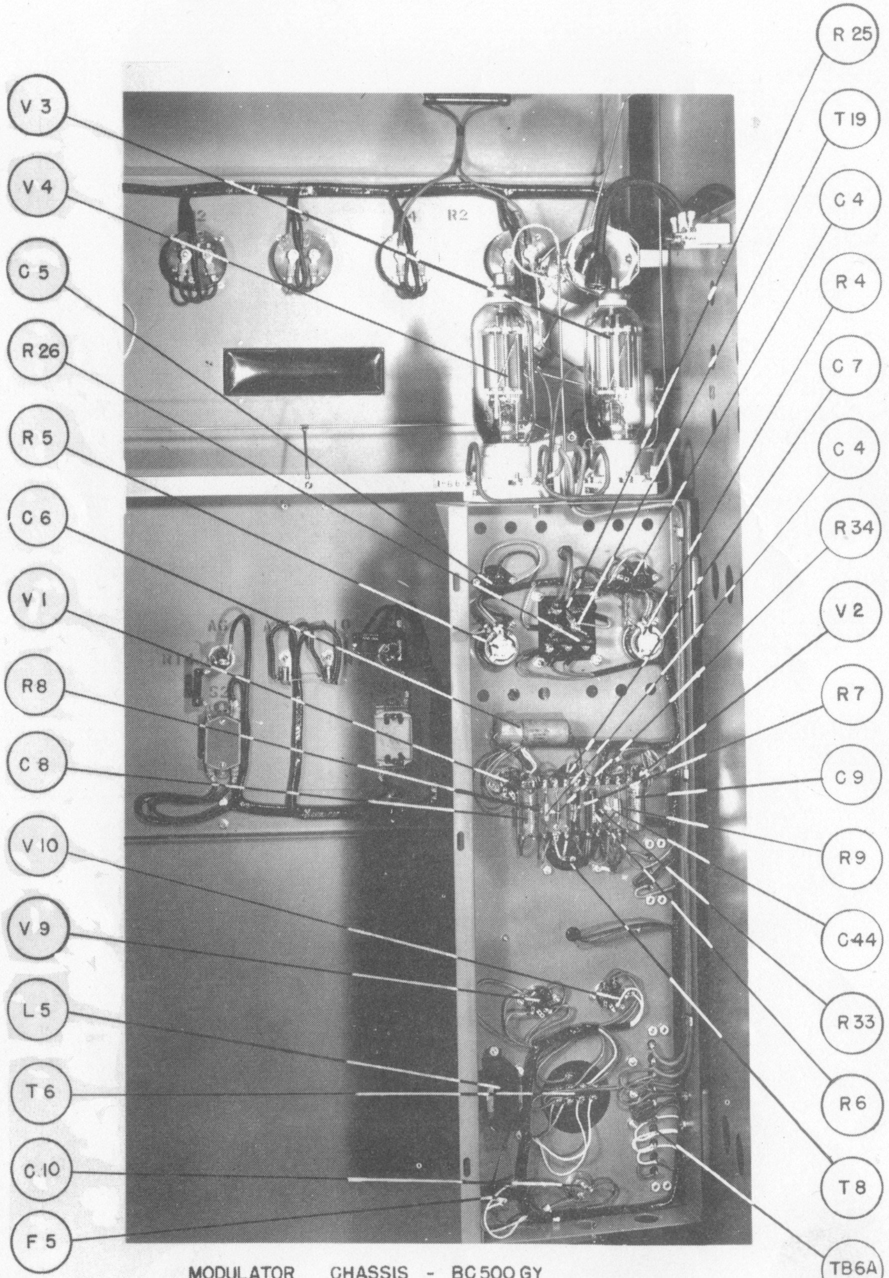
The diode type remote meter shown in schematic A-5001 is preferred because the coupling to the antenna circuit is inductive and less vulnerable to lightning damage. The main diode rectifier is located at the tower tuning house and feeds to the remote meter by an ordinary pair of lead covered wire, usually 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

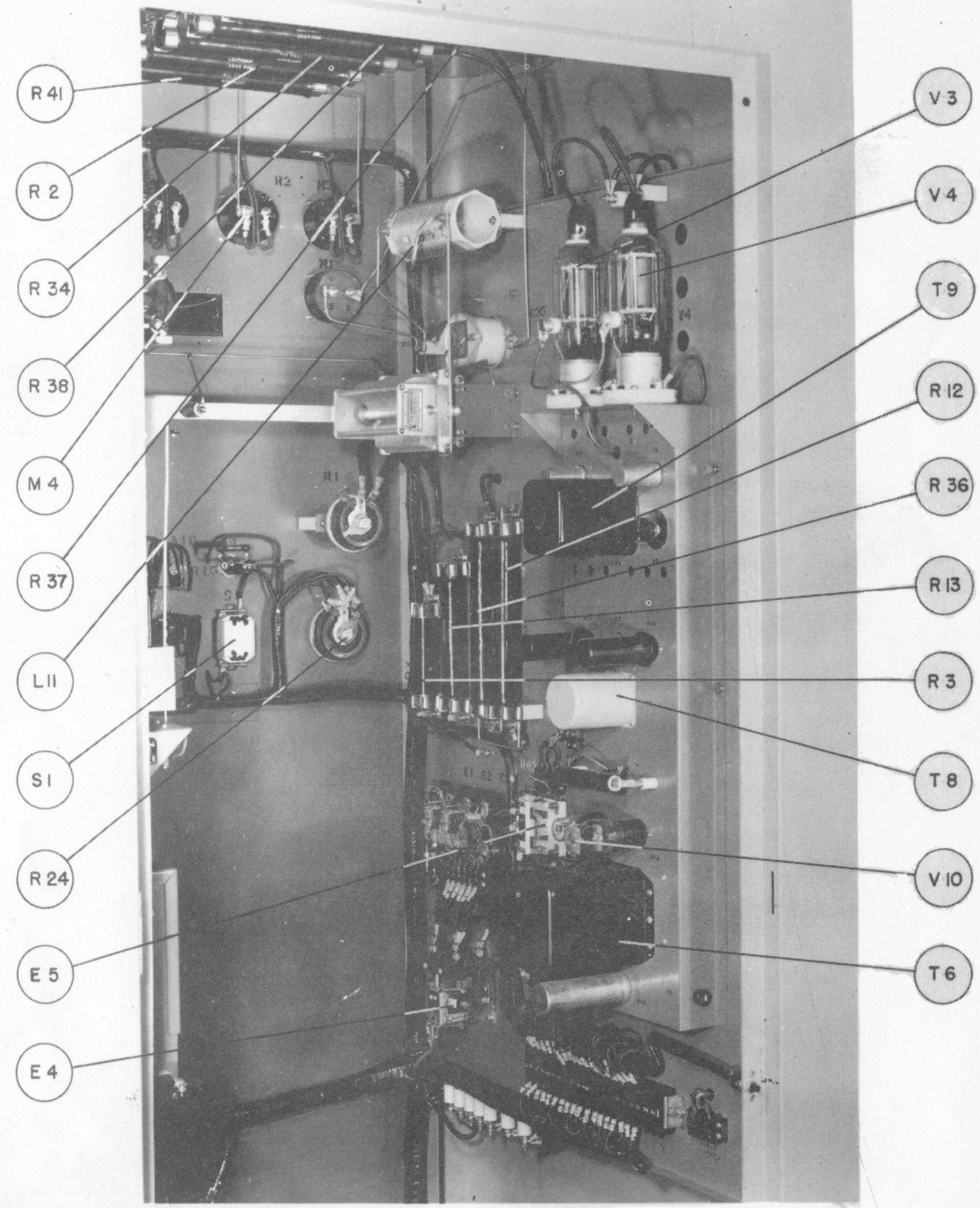
In schematic A-5479 is shown the much used thermocouple type of remote meter. This type requires no line voltage at the point of the antenna tower but is usually considered higher in maintenance cost as the thermocouple is directly in the antenna circuit and vulnerable to lightning. The choke coils 4550 and capacitors .005 mfd. are located directly adjacent to the thermocouple which choke out the R.F. current and 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 0151 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.



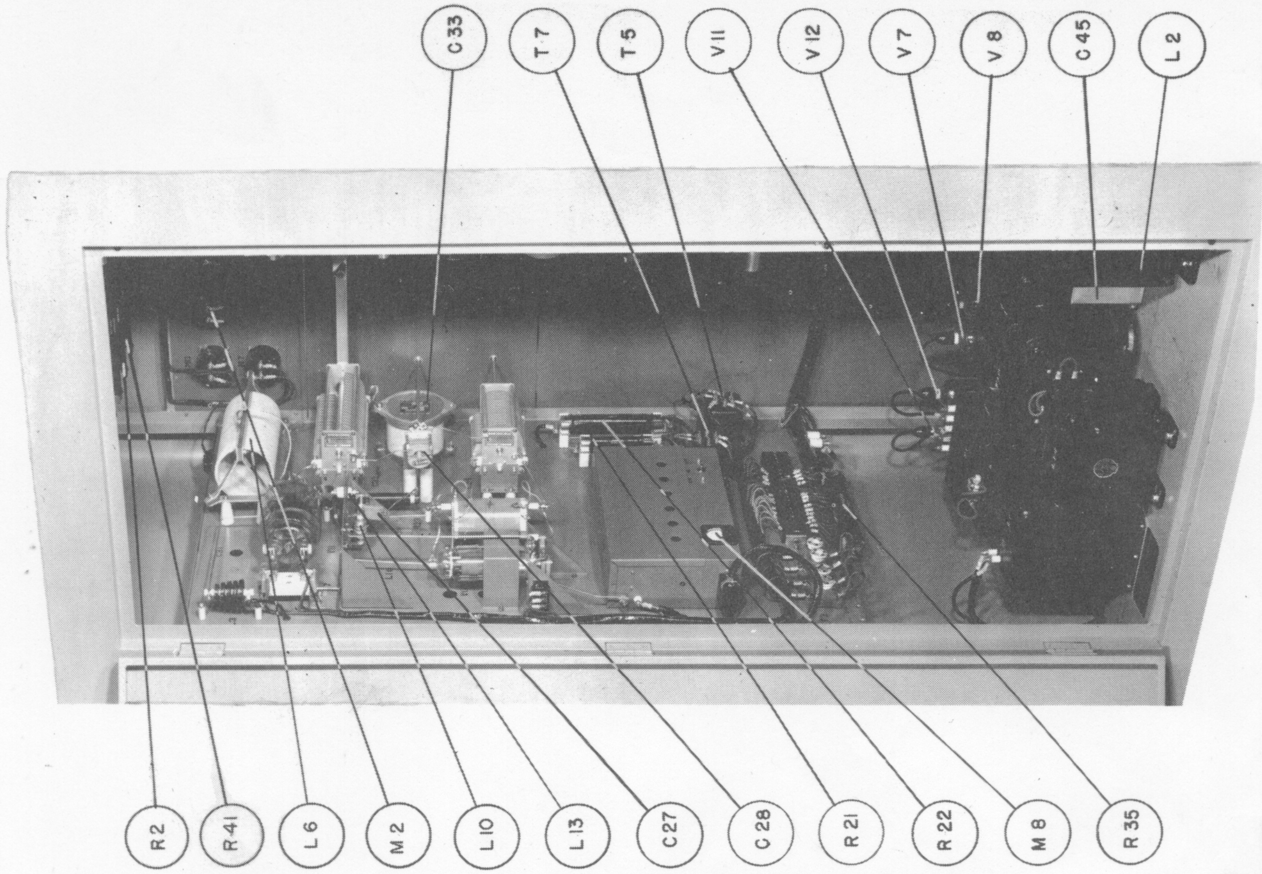
FRONT VIEW - BC 500 GY



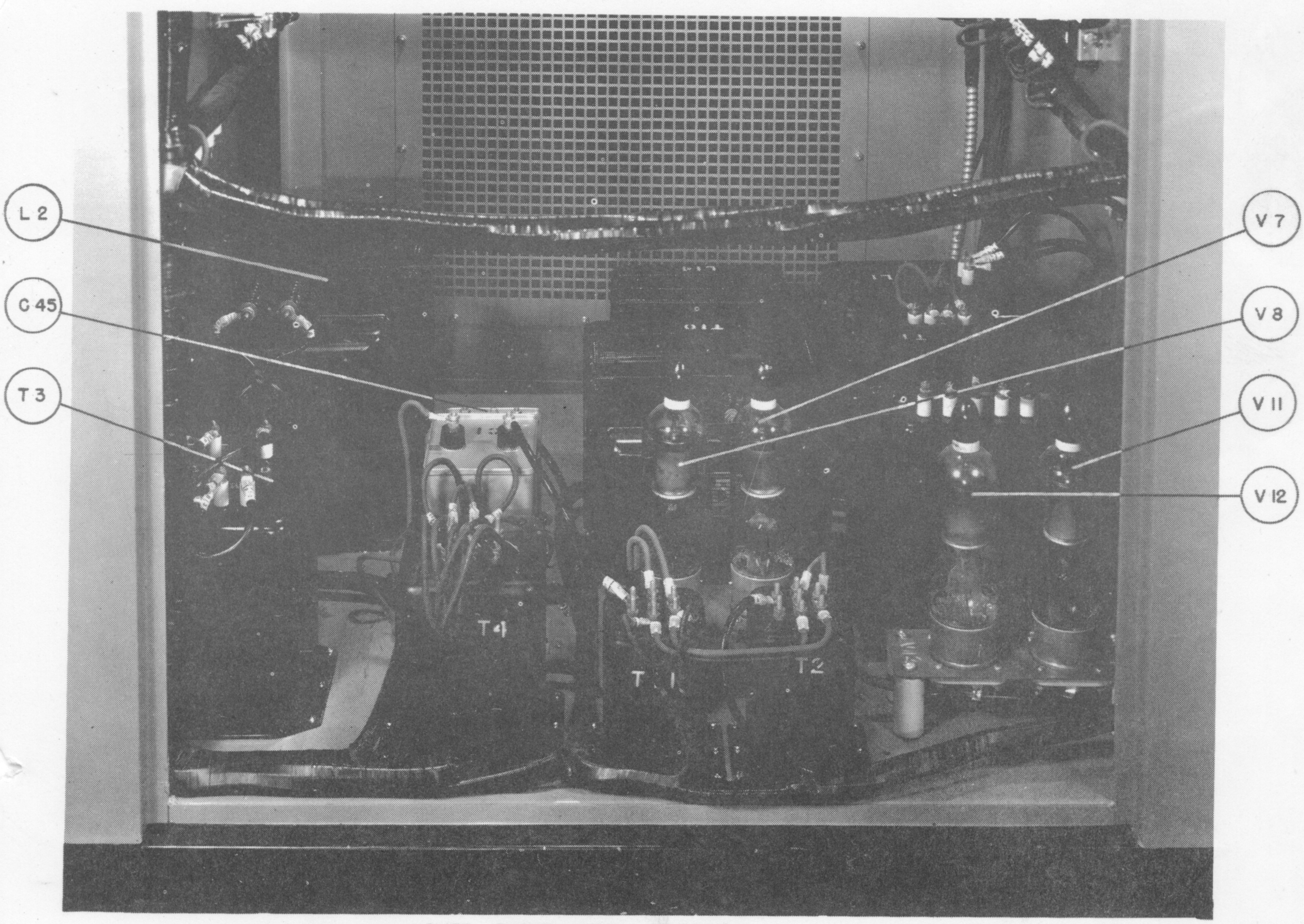
MODULATOR CHASSIS - BC 500 GY



MODULATOR PANEL - BC 500 GY



R F PANEL - BC 500 GY



LOWER FRONT VIEW - BC 500 GY

PARTS LIST

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
A4		Lamp, S6, 10W. 230V.
A5		Pilot Light Assembly, Red, #31101-111
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
A10		Lamp, 6-8V., #46
A11		Pilot Light Assembly, Red, #510M-431
A12		Lamp, 6-8V. #46
A13		Fuse Holder, 341001, (1075.) Littlefuse
C1		Capacitor, 8 mfd, 3000 W.V.,TJL-30080 (C-D)
C2		
C3		Capacitor, 2 mfd, 3000 W.V. TJU-30020 (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., 450 V., 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.,Hi-Kap DD-103 Centrala
C15		Capacitor,.01 mfd., 1 KV.,Hi-Kap DD-103 Centrala
C16		Capacitor,.01 mfd., 1 KV.Hi-Kap DD-103 Centralab
C17		250 mmfd., Variable Cond. #250 L15 Johnson
C18		Cap.,600 W. V., Type H Sangamo, (Det. by Freq.)
C19		Ceramic Trimmer, 20-125 mmfd. Type 823-AN Centralab
C20		Capacitor, .0001 mfd., 600W.V., Type H Sangamo
C21		Capacitor, .005 mfd.,1200W.V., Type H Sangamo
C22		Capacitor, .002 mfd., 600W.V.,Type H. Sangamo
C23		Capacitor, .002 mfd., 600W.V., Type H. Sangamo
C24		500 mmfd., Variable Cond., 500D35 Johnson
C25		
C26		Capacitor, .0015 mfd., 2500W.V. Type H.Sangamo
C27		Capacitor, 2500W.V., Type H Sangamo(Det. byFreq)
C28		Neut. Condenser, 12G70 Johnson
C29		Capacitor, .02 mfd., 600W.V., Type H Sangamo
C30		Capacitor, .02 mfd., 600W.V., Type H Sangamo
C31		Capacitor, .001 mfd., 5000W.V., F2L Sangamo

PARTS LIST

SYMBOL NO.	DRAWING NO.	DESCRIPTION
C32		250 mmfd.,Variable Cond., 250D70 Johnson
C33		Type G3 Sangamo (Value Det. by Freq.)
C34		500 mmfd., Variable Cond., 500D35 Johnson
C35		Cap.Type G1 Sangamo (Det. by Freq.)
C36		Cap. Type G1 Sangamo (Det. by Freq.)
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, . F2L Sangamo (Used (Det. by Freq.)
C42		Capacitor, .00024 mfd., Type K Sangamo
C43		
C44		Capacitor, .00024 mfd., Type K Sangamo
C45		Cap., 8 mfd., 3000 W.V.,Type TJL-30080 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 220 V., 60 cy., Square D
E6		Time Delay Relay, 6N030, Amperite
F1		Fuse Plug, 20 amp. 125 V.
F2		Fuse Plug, 20 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
J2		Connector, Double 83-22R Amphenol
L1	AC-74270	Swinging Choke
L2		Modulation Reactor, BR-4 Chitran
L3		R. F. Choke, 7949 Miller
L4		
L5		Choke, 8 hy. 80 ma. R-18 U.T.C.
L6		Plate Tank Coil, 87FA4634 Gates
L7	C-16572-101	813 Tank Coil Assembly
L8	A-4159-101	Osc. Plate Tank Coil Assembly
L9		R. F. Choke, R-100U National
L10		R.F. Choke, 4550 Miller
L11	C-16083-101	Antenna Coil Assembly

PARTS LIST

Symbol No.	Part No.	Description
L12	A-4155-104	R.F. Monitor Coupling Coil Assy.
L13	A-8626-101	Parasitic Suppressor
L14		Filter Reactor
M1		R.F. Line Current Meter (Det. by Line Impedance) Int. Thermo (Cal. for non-mag. Panel)
M2		Mod. Plate Current Meter, 0-500 MADC (Cal. for non-mag. Panel)
M3		P.A. Grid Current Meter, 0-200 MADC, (Cal. for non-mag. panel)
M4		P.A. Plate Current Meter, 0-500 MADC, (Cal. for non-mag. panel)
M5		P.A. Plate Voltage Meter, 0-1 MA. DC, Similar to except with 0-2500 V. Scale (Cal. for non-mag. panel)
M6		R.F. Driver Plate Current, 0-200 MADC, (Cal. for non-mag. panel)
M7		Filament Voltage Meter, 0-15V. AC, (Cal. for non-mag. panel)
M8		Osc. Plate Current Meter, 0-50 MADC
P3		Connector (For J1) Male
P4		Connector (For J2) Male
P1		Plug (Male)
P2		Plug (Female)
R1		Potentiometer, 1000 ohms
R2,R41		Resistor, 1000 ohm, 190W. Ferrule
R3		Meter Multiplier, 2.5 megohm, Ferrule Ends 5-3/8" lg.
R4,R5		Potentiometer, 1500 ohm
R6		Resistor, 15K ohm, 10W. wirewound
R7		Resistor, 125 ohm, 10W. wirewound
R8,R9		Resistor, 150K ohm, 1W. 10%
R10,R11		Resistor, 180K ohm, 1/2W. 10%
R12		Resistor, 8000 ohms, 160W. 9-5/8"
R13		Resistor, 10K ohms, 110W. Ferrule
R14,R15		Resistor, 3000 ohms, 10W. wirewound

PARTS LIST

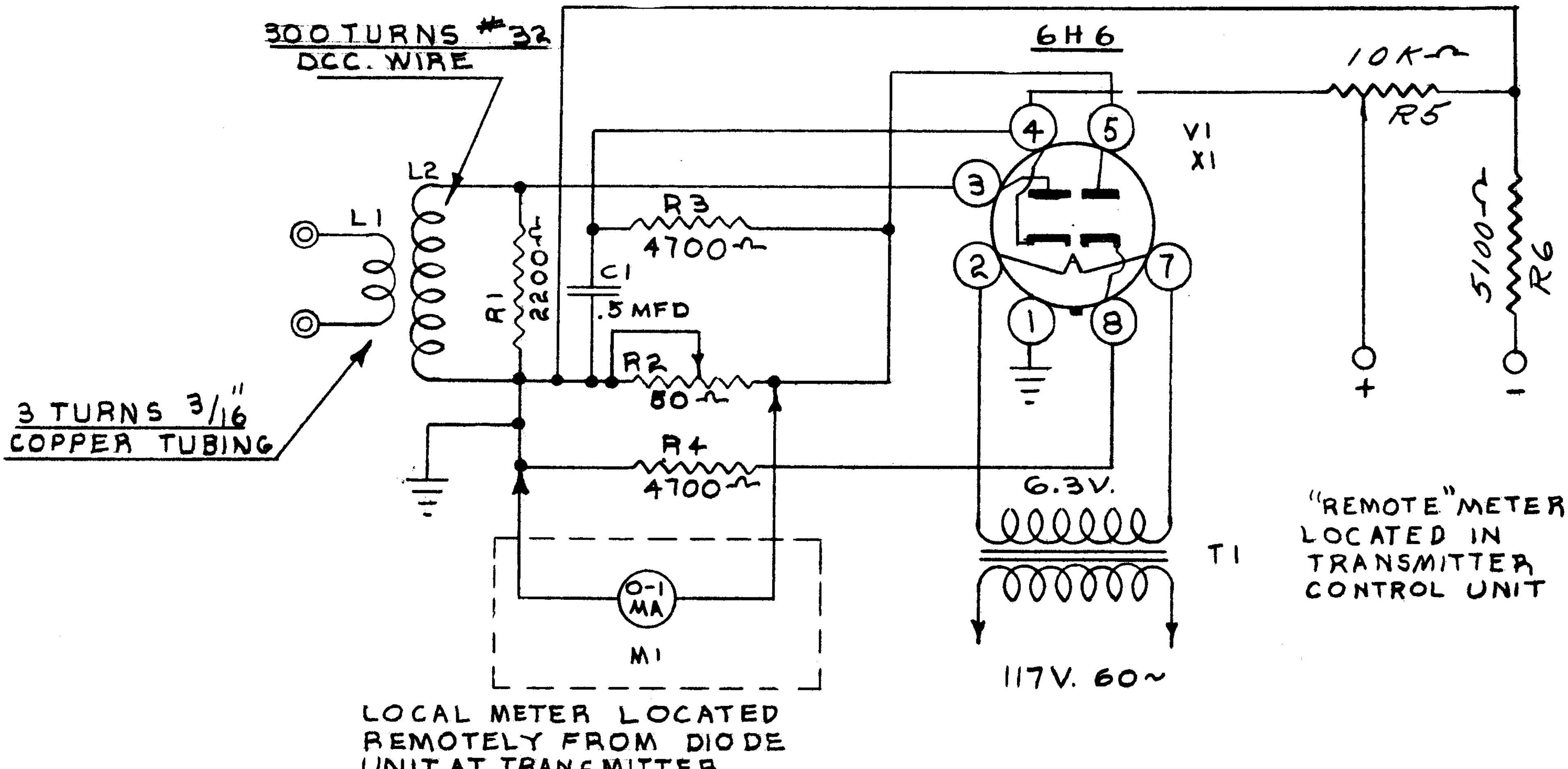
SYMBOL NO.	DRAWING NO.	DESCRIPTION
R16		5000 ohms, 50W., Lectrohm Lug Type
R17		47K ohms, 1W., 10% A-B
R18		100 ohms, 10W., Wirewound
R19		27K ohms, 2W., 10% A-B
R20		5000 ohms, 10W., Lectrohm P.T.
R21		20K ohms, 45W., Ferrule Type Lectrohm
R22		50K. Ohms, 110W., Ferrule Type Lectrohm
R23		1500 ohms, 100W., Lug Adjustable Type 6-1/2KV, Lectrohm
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
R35,R36		3500 ohms, 160W.,Lectrohm,Ferrule Type
R37		100K ohms, 190W.,Lectrohm, Ferrule Type
S1		Switch, Double P.B.,S.P.S.T.#4402M AH & H
S2		Switch, Double 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		Plate Transformer, P-2126 Chitran
T2,T11		Filament Transformer, F-520HB Chicago Standard
T3		Modulation Transformer, BM-4 Chitran
T4	AF-11604K	Filament Transformer
T5	AF-7434K	Filament Transformer
T6	AP-3176K	Combination Filament & Plate Transformer
T7	AF-7237K	Filament Transformer
T8	AI-3002	Input Transformer, UTC
T9		Driver Transformer, BD-1 Chitran
T10		Plate Transformer, P-2520 Chitran
TB1		Terminal Board, CDM-20
TB2		
TB3		Terminal Board, 3-142Y Jones
TB4		Terminal Board, 2-142 Jones
TB5		Terminal Board, CDM-20
TB6		Terminal Board, 10-142 Jones
TB6A		Terminal Board, 10-142Y Jones

PARTS LIST

SYMBOL NO.	DRAWING NO.	DESCRIPTION
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		8008 Tube
V8		8008 Tube
V9		5V4 Tube
V11		8008 Tube
V12		8008 Tube
V13		833A 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		#244 Johnson Socket
X8		#244 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
X15		#212 Johnson Socket

INDEX

DRAWING NUMBER
A-5001



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6	REDRAWN S.D.R 3-1-57
5	ECN 6102 RGK 3-4-55
4	ECN 5871 AWC 11-15-54
3	ECN 4876 PHH 6-23-53
2	REDRAWN AWC 6-9-53
1	CHANGED PER ECN #2671 R.L.W. 4-25-51

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

MTL.
FIN.

UNLESS OTHERWISE SPECIFIED, ALL TOLERANCES PER GATES SPEC 08M108.

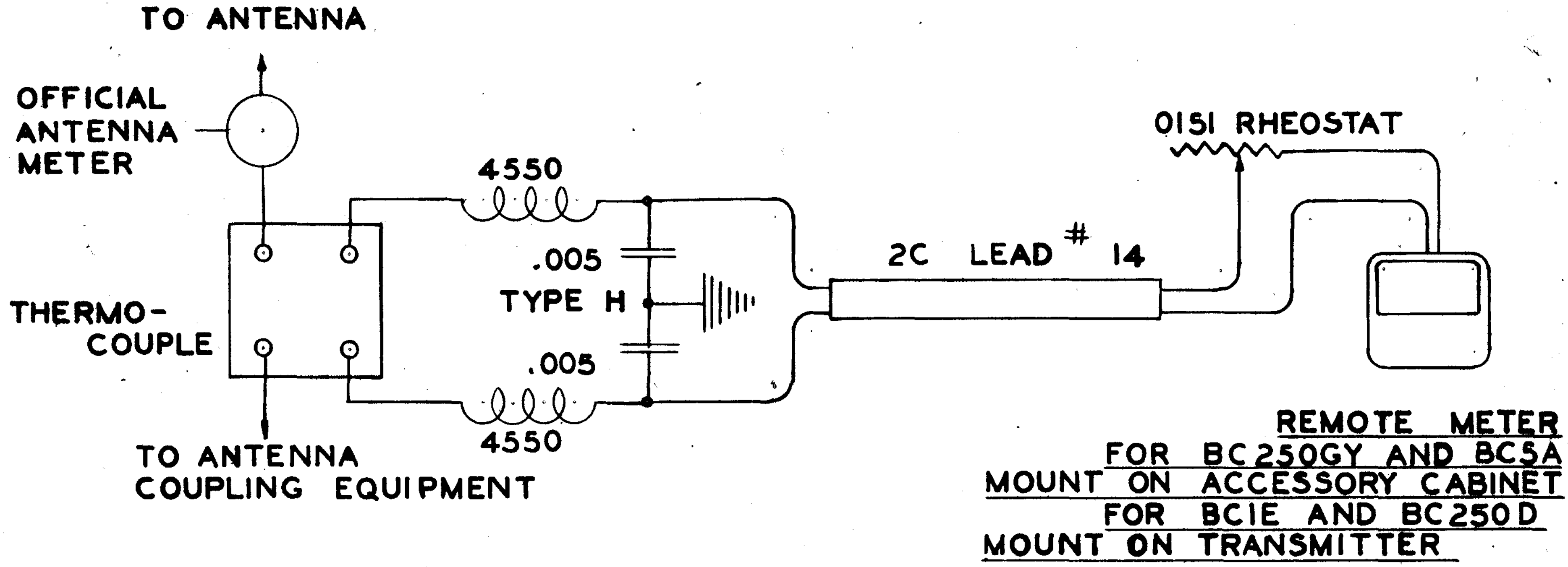
DR. BY H.G.H. DATE 11-19-48
CH. BY FWW DATE
ENG. APR. DATE

GATES RADIO COMPANY
QUINCY, ILLINOIS

DRAWING NUMBER
A 5001

810 5479 001

A-5479



GATES RADIO COMPANY QUINCY, ILLINOIS		
THERMOCOUPLE TYPE REMOTE METER		
DR. BY	DATE	A-5479
CHK. BY	ENG.	

810 5479 001

BC-500-GY FREQ./LOAD DETERMINING COMPONENTS

FREQ. (KC/S)	OSC. C18 TYPE "H" 600WV	813 C41 TYPE F2L	833A C33 TYPE G3	833A C35 TYPE G1 250 Ohm. Load	833A C35 TYPE G1 70 Ohm. Load	833A C35 TYPE G1 50 Ohm. Load
1600	None	None	0.0002	0.001	0.002	0.002
1300					0.003	0.003
1250			0.0003	0.002		
1150			0.0004	0.003		0.004
860			0.0005		0.004	0.005
780		0.0002				
700	0.0001					
690			0.0006	0.004	0.005	0.006
650	0.0002					
620		0.0004				
600			0.0007	0.005	0.006	0.007
550			0.0009	0.006	0.007	0.01
R.F. AMMETER FS READING (M1)				0-3A	0-5A	0-5A

780 KKMO

833A-810 Coupling Capacitor (C27)

1600-750 KC/S 0.0001 mfd. TYPE "H" 2500W.V.
750-550 KC/S 0.0005 mfd. TYPE "H" 2500W.V. *

* Alternate Adjustment: 0.0001 mfd. at C27 and increase 833A Grid Tap on L7. Use whichever gives satisfactory P.A. drive with lowest 813 plate current.

A-9139

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

These items could cause poor quality:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Dummy antenna (frequently supplied in Gates transmitters).

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

A good grade of voltohmmeter.

A spare antenna current meter.

An inexpensive oscilloscope.

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

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

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

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

GATES RADIO COMPANY
Subsidiary of Harris-Intertype Corporation
Quincy, Illinois, U.S.A.

BC-500GY

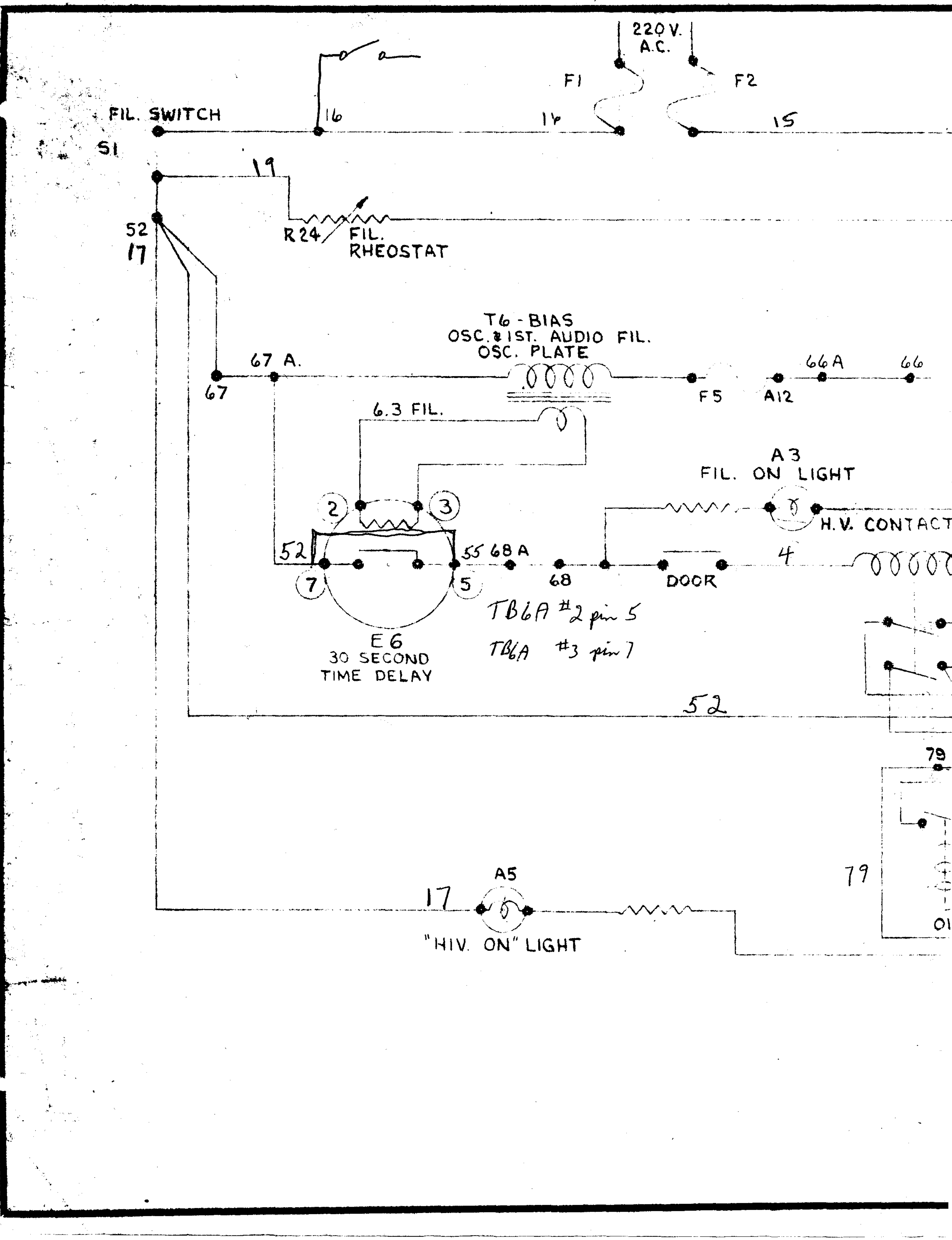
MODULATION TRANSFORMER INSTRUCTIONS

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

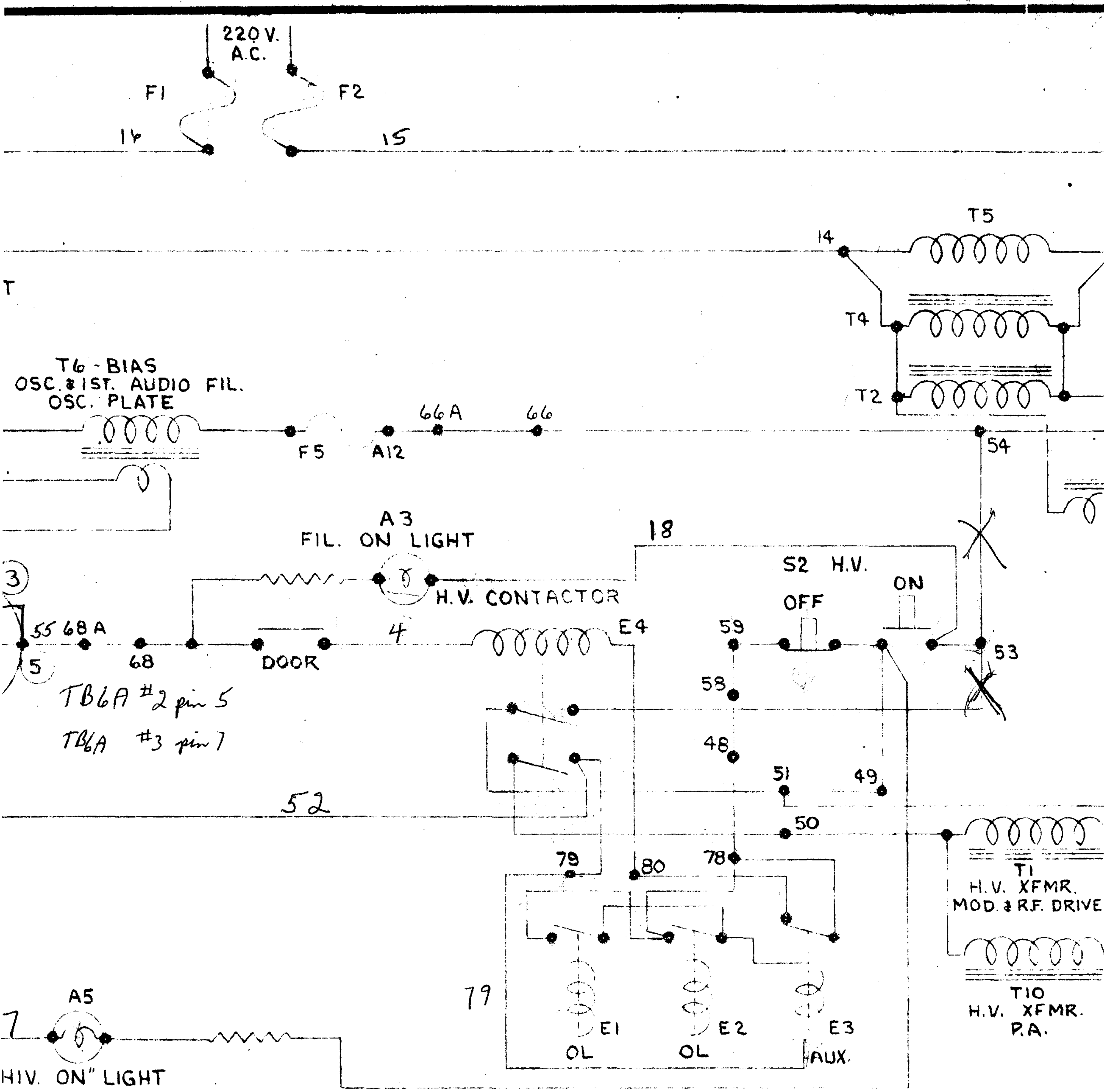
The modulation transformer employed in this transmitter may be of a type which will indicate unequal resistance in the primary windings. An ohmmeter check of the windings may indicate that the transformer is defective; whereas in reality, this is a normal reading and the modulation transformer is performing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

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

Gates Radio Company
Quincy, Illinois



220 V.
A.C.
F1
F2
FIL. SWITCH
S1
16
14
15
19
52
17
R24
FIL.
RHEOSTAT
T6 - BIAS
OSC. & 1ST. AUDIO FIL.
OSC. PLATE
67 A.
67
F5
A12
66A
66
6.3 FIL.
A3
FIL. ON LIGHT
H.V. CONTACT
2
3
52
55
68 A
68
DOOR
4
7
5
E6
30 SECOND
TIME DELAY
TB6A #2 pin 5
TB6A #3 pin 7
52
79
79
A5
17
"HIV. ON" LIGHT



2	ECN 5570 3-15-54 D.L.
1	ECN #5170 RGK 9-25-53

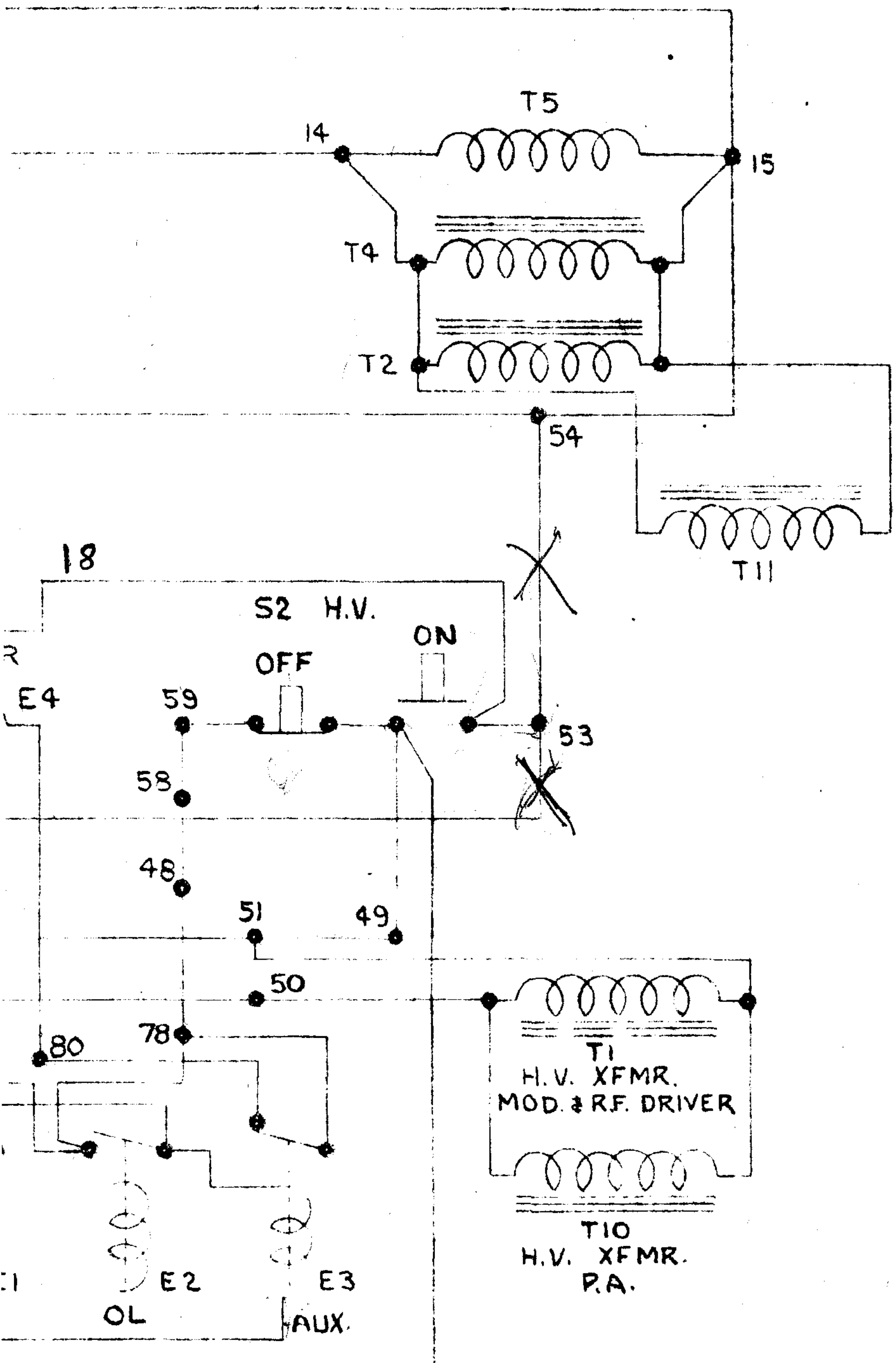
Variations on Finished Dimensions unless otherwise marked

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	± 1/16	± .015

821-2474-001

Drawing Number

B-12494



ECN 5570 3-15-54 D.L.	ECN #5170 RGK 9-25-53
2	—

Variations on Finished Dimensions unless otherwise marked

Basic Dimensions	Fractional Dimensions	Decimal Dimensions
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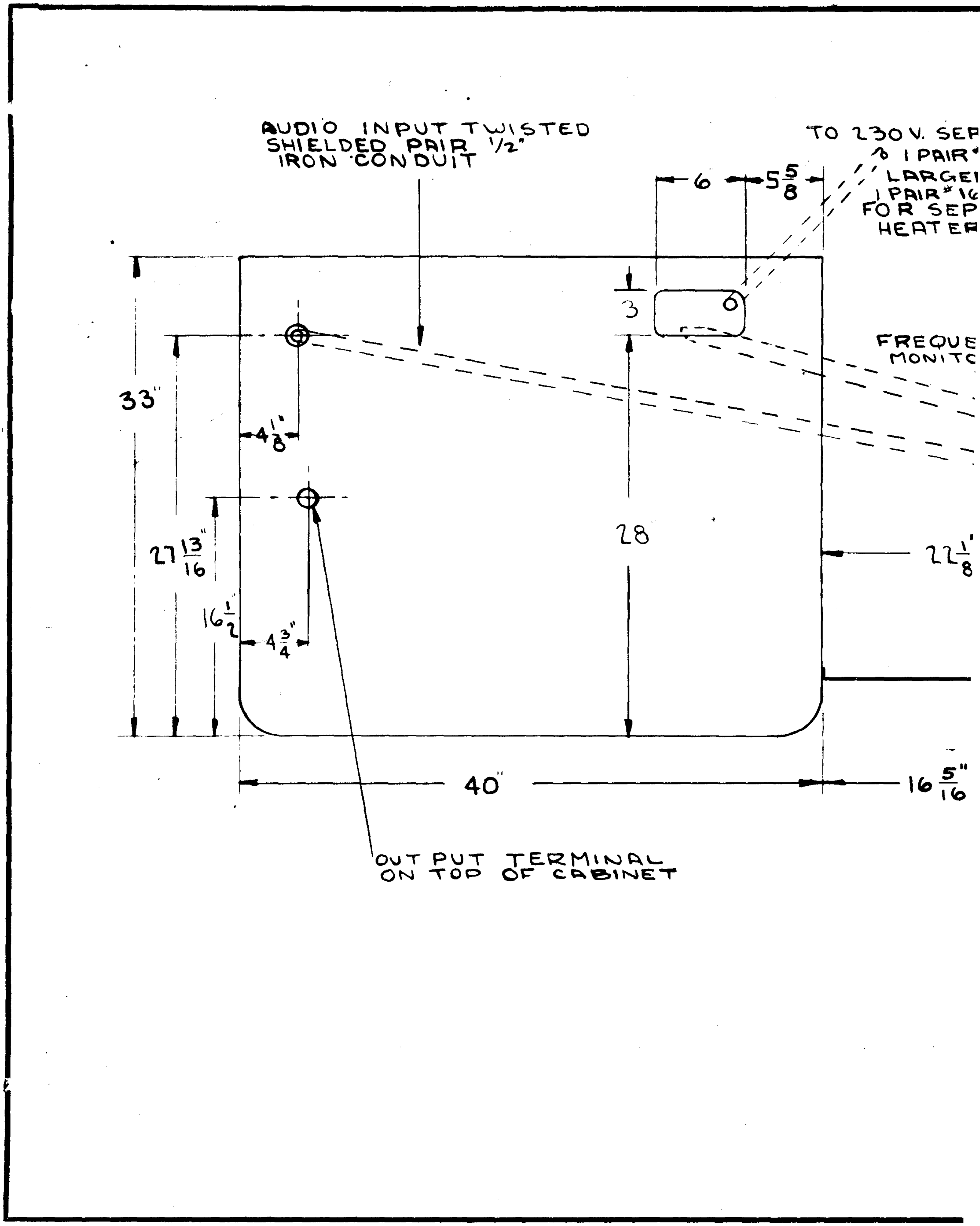
Above ¼ to 6	± 1/64	± .005
Above 6 to 24	± 1/32	± .010
Above 24	± 1/16	± .015

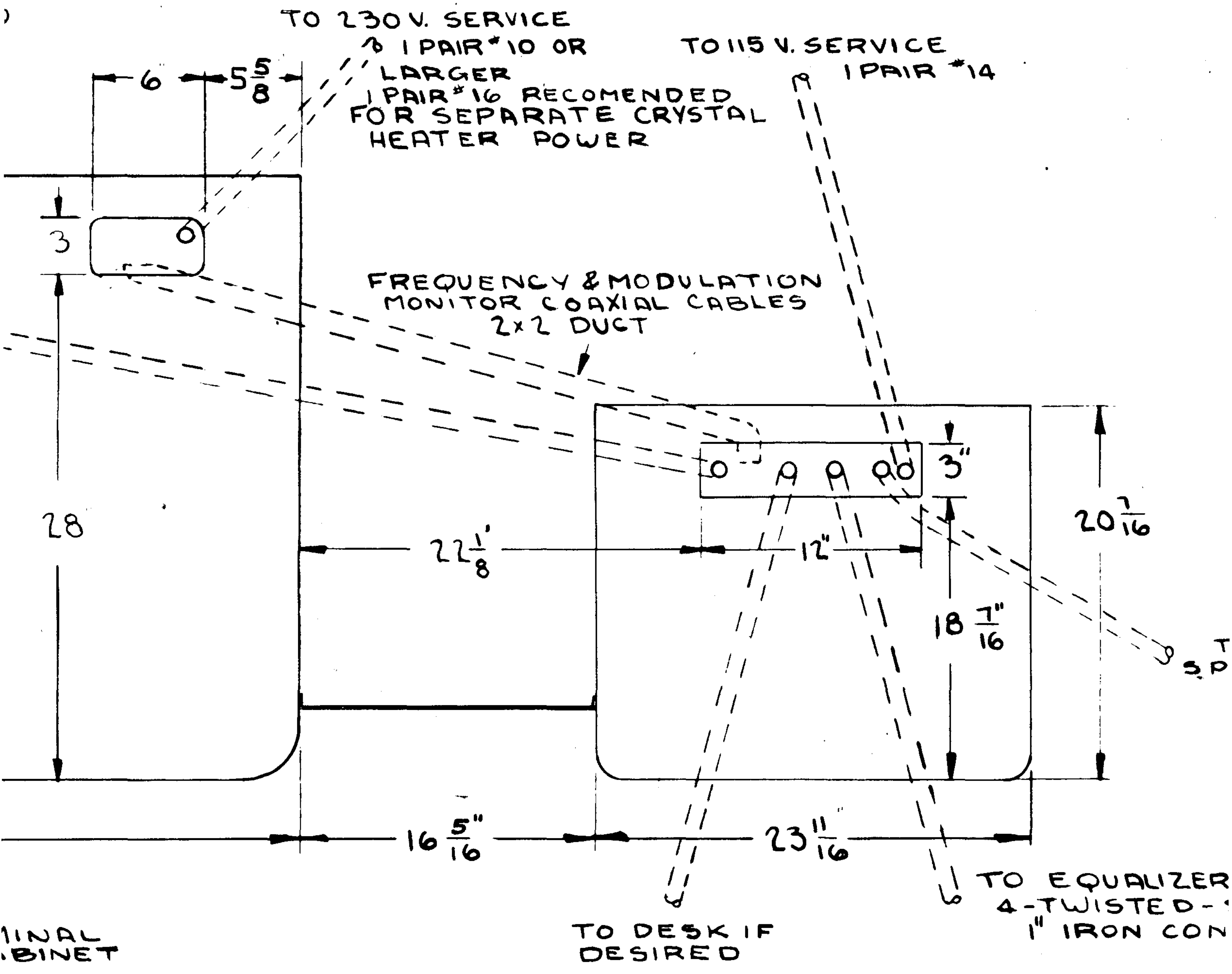
DETAIL CONTROL CIRCUIT

BC 500 GY - M4549

MATL.	FIN.	PART NO.
DRAWN BY RGK 2.50 DATE 2-26-53		
CHECKED BY DATE 3-6-53		DWG. NO.
GATES RADIO COMPANY **QUINCY, ILLINOIS**		B-12494

821-2474-001


AUDIO INPUT TWISTED SHIELDED PAIR 1/2" IRON CONDUIT
TO 230 V. SEP
1 PAIR
LARGE
1 PAIR #16
FOR SEP
HEATER
6
5 5/8
3
FREQUE
MONITO
33"
4 1/8"
28
27 13/16
22 1/8
16 1/2
4 3/4"
40"
16 5/16"
OUT PUT TERMINAL ON TOP OF CABINET



GATES

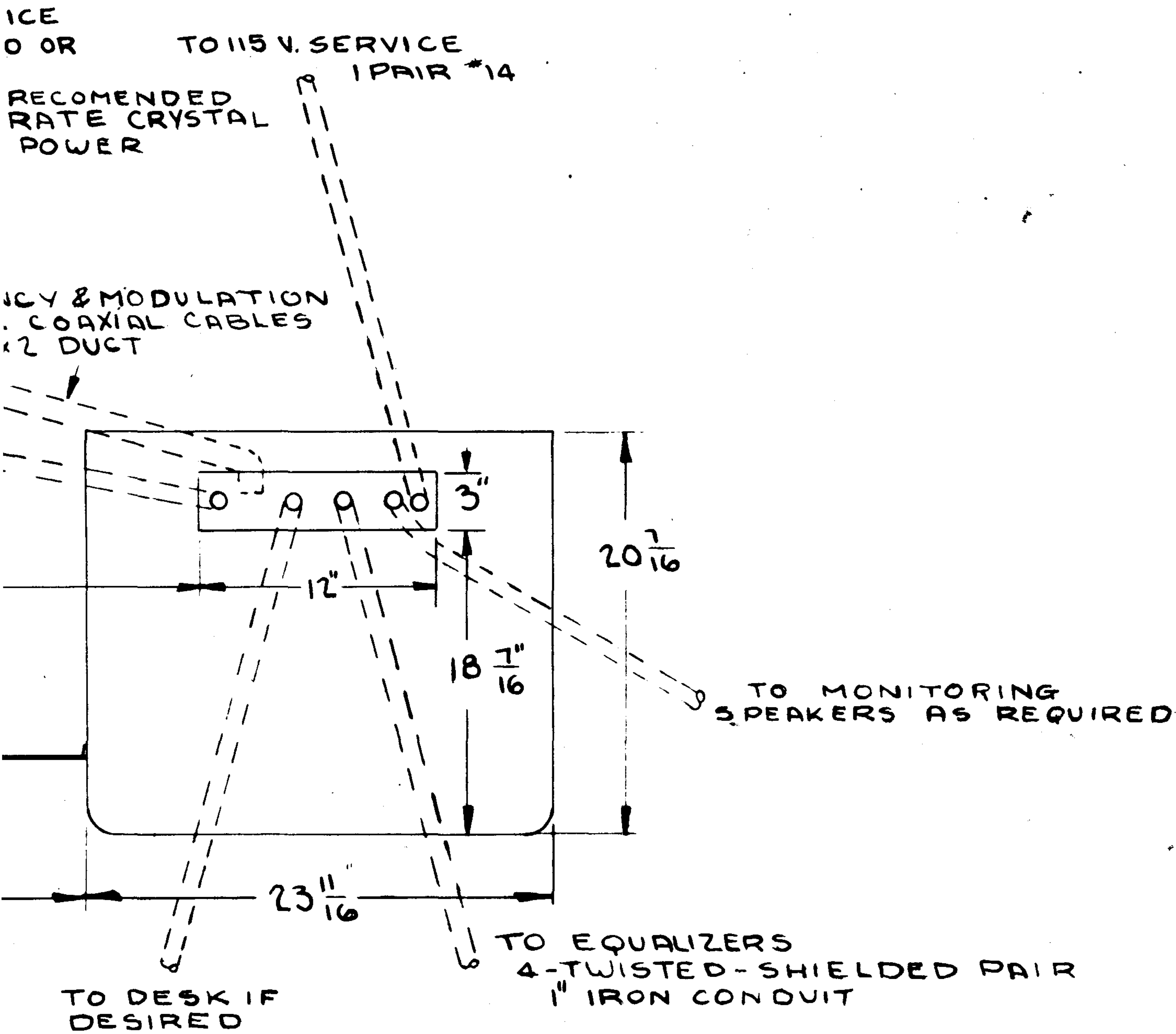
PROPOSED
GY-48

MATERIAL

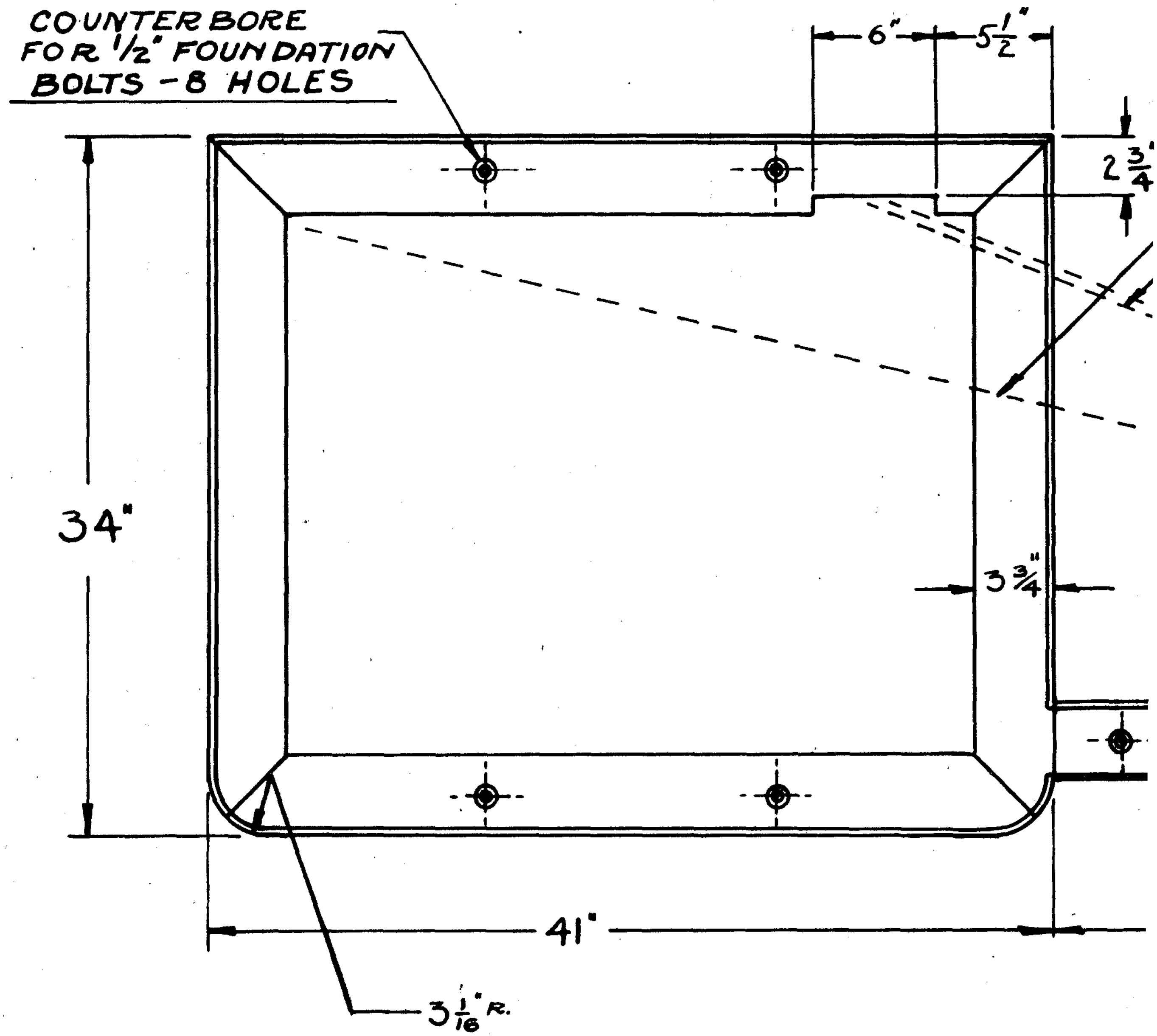
DR. BY HG.H.

CH. BY

DRAWING NUMBER
B-10872

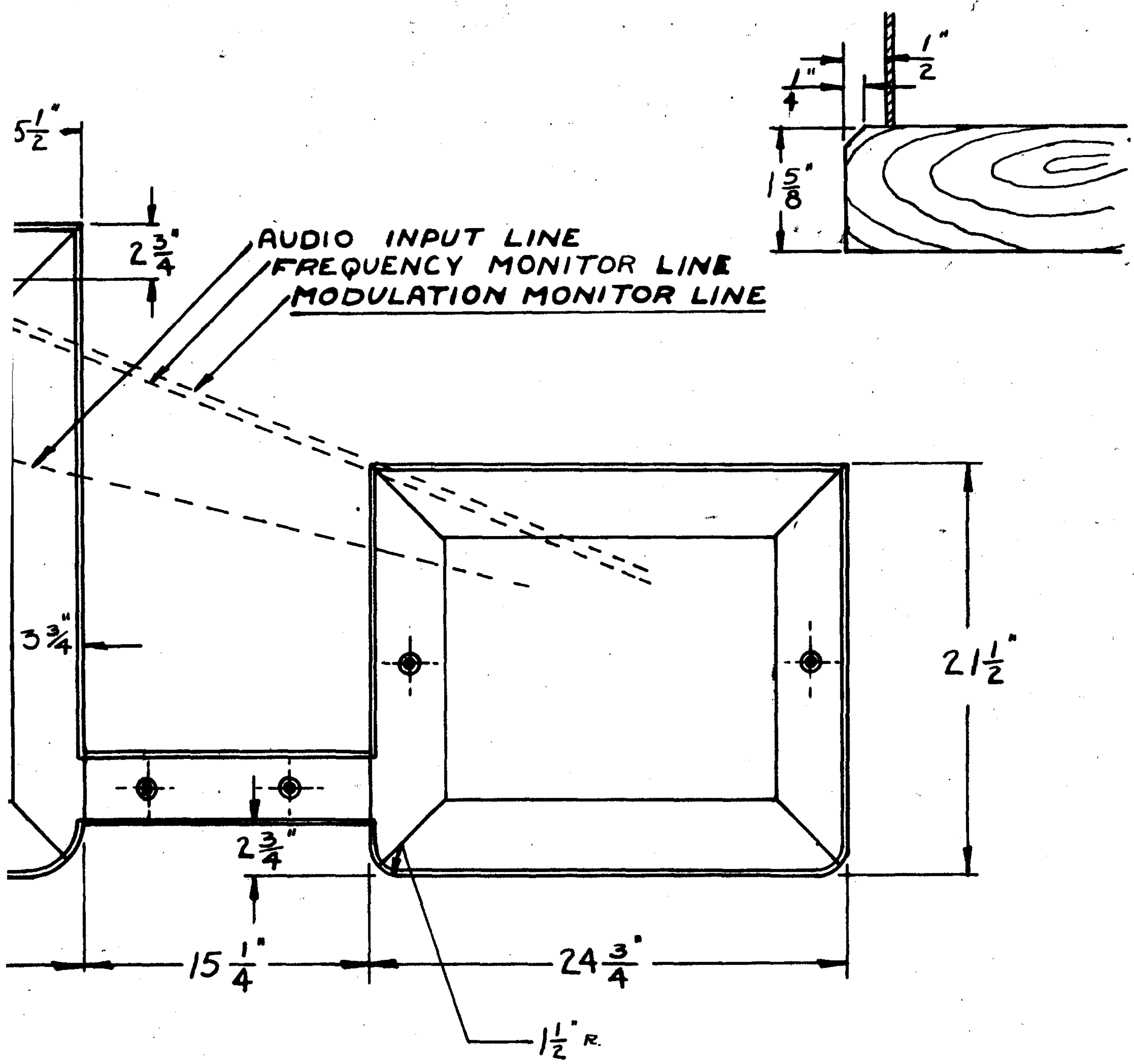


GATES RADIO COMPANY QUINCY, ILLINOIS	
PROPOSED CONDUIT LAYOUT FOR GY-48 RADIO STATION.	
MATERIAL	SCALE
DR. BY H.G.H.	DATE 4-15-48
CH. BY [illegible]	ENG. L.B.P.
DRAWING NUMBER	B-10872



BC 250 GY
TRANSMITTER

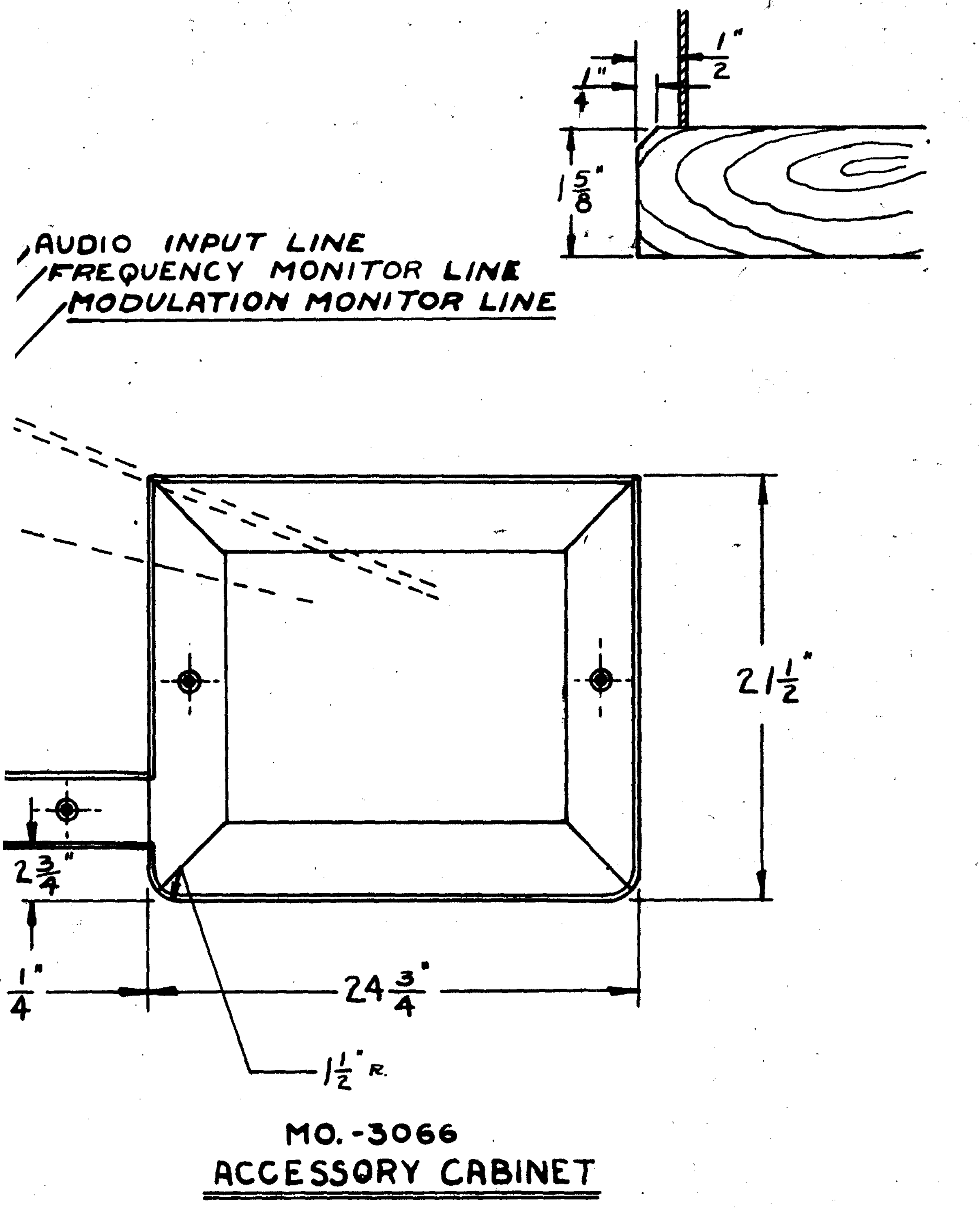
DWG
B-10



MO.-3066
ACCESSORY CABINET

GATES RADIO COMPAN QUINCY, ILLINOIS		
WOOD BASE FOR GY-48 TRANSMITTING STATION		
MATERIAL HICKORY OR OAK 2X4's		SCALE 1/8
DR. BY H.G.H.	DATE 3-15-48	DWG
CH. BY [illegible]	ENG.	B-10

DWG. NO.
B-10852



GATES RADIO COMPANY
QUINCY, ILLINOIS

WOOD BASE FOR GY-48 TRANSMITTING STATION

MATERIAL HICKORY OR OAK 2X4'S	SCALE 1/8
DR. BY H.G.H.	DATE 3-15-48
CH. BY [illegible]	ENG.

DWG. NO.
B-10852

TRANSMITTER READINGS

AM TRANSMITTER

CIRCUIT	METER READING	DIAL READING	REMARKS
Oscillator Plate Current			
Buffer Grid Current			
Buffer Plate or Cathode Current			
RF Driver Grid Current			
RF Driver Plate Current			
PA Grid Current			
PA Plate Current			
PA Plate Voltage			
PA Efficiency			
Filament Voltage			
Line Voltage			
Mod 1 Static Plate Current			
Mod 2 Static Plate Current			
RF Line Current			

FM TRANSMITTER

CIRCUIT	METER READING	DIAL READING	REMARKS
Driver Grid Current			
Driver Screen Current			
Driver Plate Current			
Driver Plate Voltage			
RF Output			
VSWR			
Filament Voltage			
PA Grid Current			
PA Screen Current			
PA Plate Current			
PA Plate Voltage			
PA Screen Voltage			
RF Output			
VSWR			
Efficiency			
Filament Voltage			
Line Voltage			